



Environmental Impact Post Assessment of the First Phase of Qinghai San Jiang Yuan ---Based on AHP

Zhang Yanning, Yao Hongyi

Institute of Finance and Economics, Qinghai University, Xining, China

Email address:

390339941@qq.com (Zhang Yanning), 15897188197@126.com (Yao Hongyi)

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Abstract: This paper is based on the post-project evaluation perspective, which combined with the general theories, methods and practice of project evaluation and post-evaluation, choosing the First Phase of Qinghai San Jiang Yuan Ecological Protection and Construction project as a case to evaluate its environmental impact and according to characteristics of the project itself analyze its ecological benefits through the comparative analysis, analytic hierarchy process and fuzzy evaluation method. On one hand to provide useful references for similar projects after the evaluation, on the other hand to give the suggestion to relevant departments about how to formulate investment plans and policies of ecological construction.

Keywords: Environmental Impact Post Assessment, Ecological Benefits, Comparative Analysis, AHP

1. Introduction

Since the reform and opening up more than 30 years, China's economy maintains a rapid development with the great improvement of people's material and living conditions. But with the growing economy, China's ecological environment begin to deteriorate gradually, a large number of ecological environmental problems have appeared across country. It leads us to pay much attention to ecological civilization construction because of serious ecological problems, like rapid decline in air quality, fog haze, water and soil erosion, many lakes and wetlands continue to shrink, and deterioration of grassland. On one hand, the imbalance of ecosystems has restricted the sustainable development of China's economy and society, on the other hand, the persistent deterioration of ecological environment has brought serious economic losses to our country. Therefore, how to achieve our social and economic development with the sustainability of ecological environment has become our urgent problem to be solved. The Third Plenary Session of the Eighteenth Central Committee of the Communist Party of China put forward the construction of ecological civilization in the "Five-in-One" height for the first time and propose the institutional mechanism of speed up the system construction of ecological civilization, completing the development of spatial of nation land, importance of resource conservation use and ecological

environmental protection. It not only shows China is determined to solve the current ecological and environmental problems, but also reflects the importance of ecological civilization construction. The post-evaluation of environmental impact is the important theoretical basis and practice work both in environmental management and post-project evaluation, it plays an important role in ecological civilization construction, as well as in ecological control and environmental prevention mechanism.

The first phase of Qinghai San Jiang Yuan ecological protection and construction project is a state key project that invest by government and Qinghai Province is main responsibility unit of this project. The main purpose of the project is to improve the ecological environment in the San Jiang Yuan area and enhance the quality of the ecological environment in this region. Thus, the environmental impact post assessment has become an important and necessary part of this project, for one thing to assess the ecological benefits of the project in order to reflect the actual operation effect of the project, for another to ensure the sustainability of the project ecological effects, and to achieve green sustainable development.

2. Brief Introduction of the First Phase of San Jiang Yuan Project

2.1. Project Background

San Jiang Yuan Nature Reserve, located in the hinterland of the Qinghai-Tibet Plateau, is the source of the Yangtze River, the Yellow River and the Lan-Cang River, so named as 'San Jiang Yuan' or 'China Water Tower'. In recent years because of the warmth of the atmospheric environment, glaciers and snow mountains in San Jiang Yuan area had shrunk year by year. It was not only led water supply problem in surrounding plateau lakes and wetlands, more serious was due to the lakes and wetlands areas' shrinking the swamp had disappeared, land had become arid and other ecological problems had appeared as well. In addition, the farmers and herdsmen living in San Jiang Yuan had continued to expand their production and business activities, which led to a large number of grassland has degraded and pasture coverage has declined sharply. On one hand, this situation destroyed the life style of farmers and herdsmen who depended on thoroughly, on the

other hand a large number of grassland degradation had aggravated the deterioration of the ecological environment. The ecological environment in San Jiang Yuan had already in an imbalance state and the ecosystem could not be able to self-regulation. Environmental problems, like low coverage on ground, biomass reduction and land desertification emerged in an endless stream. The region's industrial development was constrained, the economy cannot be developed and people's living standards were always under the poverty line. Hence, on January 26, 2005, the 79th executive meeting of the State Council approved the implementation of the overall plan of "Qinghai San Jiang Yuan Nature Reserve ecological protection and construction", to achieve three goals---recovery of ecological functions, promoting the harmony and sustainable development of man and nature in the San Jiang Yuan area and creating a fairly comfortable life for farmers and herdsmen. Since then, San Jiang Yuan ecological protection and construction project has begun. As shown in Figure 1, it is a distribution map of Qinghai San Jiang Yuan Nature Reserve.

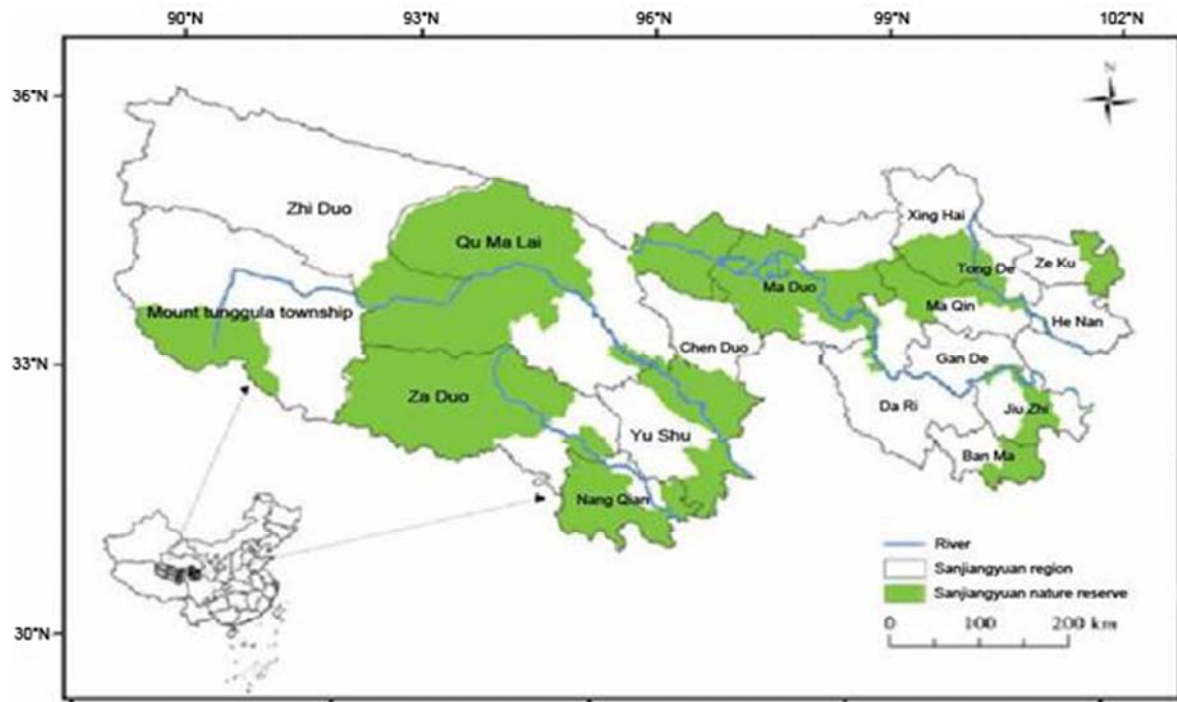


Figure 1. Distribution map of Qinghai San Jiang Yuan Nature Reserve.

2.2. The Main Content of the Project

Based on the adequate investigation and the in-depth study of key issues, the relevant departments of the project reached a consensus that according to the principle of overall consideration, the main content of San Jiang Yuan project should be taken the ecological and environmental protection and construction, the local people's life and regional economy development into consideration. Therefore, the main contents of San Jiang Yuan project are the ecological protection and construction, the infrastructure construction for farmers and herdsmen and supporting project of ecological protection.

3. Environmental Impact Post Assessment of the First Phase of San Jiang Yuan

3.1. Principles of Evaluation

The first phase of San Jiang Yuan project belongs to ecological construction project, that is, non-polluting project. Its main purposes are to improve the ecological environment of a region, to achieve the development of economy and

ecological environment, to create a win-win situation as well. Therefore, the environmental impact post assessment of the first phase of Qinghai San Jiang Yuan should comply with the basic guiding thought and evaluating principles of the post-evaluation of ecological construction project. The first principle is authenticity, ecological construction projects concerning wide scope with the long construction period, thus, it is necessary to ensure the materials, data and relevant construction indexes of ecological construction projects are true and reliable, which have no false information. The second principle is rationality, the design of post-evaluation indexes of ecological construction projects should be based on different attributes of each sub-project and deal with each sub-project on its merits is a crucial step to guarantee the objectivity of each sub-project. Finally, it is the principle of

practicality, the methods of post-evaluation of ecological construction projects should be based on the actual operation conditions and characteristics of each ecological construction project in order to ensure the operability of the post-evaluation.

3.2. Construction of Evaluation Index System

According to the actual situation of the first phase of San Jiang Yuan and the references like “The Compilation of the Acceptance Data of the First Phase of Ecological Protection and Construction of San Jiang Yuan in Qinghai Province” [7], establishment the three-tier structure of the environmental impact post assessment indexes of the first phase of San Jiang Yuan. The indexes and contents are shown in Table 1.

Table 1. The evaluation indexes and contents of first phase of San Jiang Yuan.

	Evaluation Indexes		Evaluation Contents
	Second Class Indexes	Third Class Indexes	
Environmental impact post assessment indexes of the first phase of San Jiang Yuan A	Ecosystem structure _{B1}	Macro structure _{C1}	The features of ecosystem type, grassland degradation / restoration
		Characteristics of community structure _{C2}	Plant composition, The function, height, coverage, degree, frequency, dominance of community structure, grassland diversity and variety
	Ecosystem quality _{B2}	Net primary production _{C3}	NPP
		Production _{C4}	Vegetation over-ground and underground biomass
		Surface coverage _{C5}	Vegetation coverage, pasture coverage
		Water conserving efficiency _{C6}	Regulating water, water storage capacity, volume of runoff, runoff coefficient
	Ecosystem services _{B3}	Soil and water conservation _{C7}	Water and Soil Loss, Total Soil Conservation
		Wind sheltering and sand fixation _{C8}	Volume of wind sheltering and sand fixation, soil erosion and wind erosion.
		Forage supply _{C9}	The quantity of forage, the ratio of edible forage, and the coverage of forage per unit area
		Water supply _{C10}	Water quality
		Biological diversity _{C11}	Biological growth, Habitat food and water supply, Human disturbance
	Factors affecting ecosystems _{B4}	Climate change _{C12}	The change of temperature, precipitation and moisture coefficient
		Human activities _{C13}	Artificial precipitation, grazing, mining, urbanization, road construction

3.3. Assessment Process

3.3.1. AHP to Index Weight Determination

In order to ensure the objectivity and rationality of the index weight, ask 10 experts to score the indexes of the first phase of San Jiang Yuan and calculate their weighted mean to obtain the unified weight of indexes, using spss19.0 to calculate the correlation coefficient. The specific indexes shown in table 2 to 6.

Table 2. Value of weight of each index of environment assessment.

Evaluation indexes	Ecosystem structure	Ecosystem quality	Ecosystem services	Factors affecting ecosystems	W _i
Ecosystem structure	1	5	5	3	0.548
Ecosystem quality	1/5	1	1/5	1/3	0.069
Ecosystem services	1/5	5	1	1	0.199
Factors affecting ecosystems	1/3	3	1	1	0.183
$\lambda_{\max}=4.23$	CI=0.007	RI=0.94	CR=0.08		

CR = 0.08 < 0.1 through consistency examination.

Table 3. Value of weight of each index of ecosystem structure.

Evaluation indexes	Macro structure	Characteristics of Community structure	W _i
Macro structure	1	5	0.833
Characteristics of Community structure	1/5	1	0.167
$\lambda_{\max}=2.00$	CI=0.00	RI=0.00	CR=0.00

CR=0.00<0.1 through consistency examination.

Table 4. Value of weight of each index of ecosystem quality.

Evaluation indexes	NPP	Production	Surface coverage	W_i
NPP	1	1/5	1	0.134
Production	5	1	7	0.746
Surface coverage	1	1/7	1	0.120
$\lambda_{\max}=3.013$	CI=0.006	RI=0.58	CR=0.01	

CR=0.01<0.1 through consistency examination.

Table 5. Value of weight of each index of ecosystem services.

Evaluation indexes	Water conserving efficiency	Soil and water conservation	Wind sheltering and sand fixation	Forage supply	Water supply	Biological diversity	W_i
Water conserving efficiency	1	1	5	5	1/2	3	0.216
Soil and water conservation	1	1	3	5	1/3	3	0.187
Wind sheltering and sand fixation	1/5	1/3	1	3	1/5	1/5	0.062
Forage supply	1/5	1/5	1/3	1	1/5	1/5	0.039
Water supply	2	3	5	5	1	5	0.369
Biological diversity	1/3	1/3	5	5	1/5	1	0.126
$\lambda_{\max}=6.572$	CI=0.114	RI=1.24	CR=0.09				

CR=0.09<0.1, through consistency examination.

Table 6. Value of weight of each index of factors affecting ecosystems.

Evaluation indexes	Climate change	Human activities	W_i
Climate change	1	1/3	0.25
Human activities	3	1	0.75
$\lambda_{\max}=2.00$	CI=1.00	RI=0.00	CR=0.00

CR=0.00<0.1 through consistency examination.

3.3.2. Fuzzy Comprehensive Evaluation

Considering the real situation of the first phase of San Jiang Yuan, this paper establishes four levels of rating universal: {excellent, good, general, poor} and asks 10 experts to give each index a rating level, then finally to normalize them. For example, for one index 5 experts marked it as "excellent", 3 experts rated as "good", 1 expert rated as "middle", and another expert rated as "poor", then the evaluation matrix of

this index is: {5,3,1,1}, normalizing as: {0.5,0.3,0.1,0.1}. Taking the ecosystem structure as an example: (The other evaluation indexes are shown in table 9).

(1) Establish Evaluate Factor weight

The ecosystem structure are consists of macro structure and characteristics of community structure, the evaluation factors is $\{B_1, B_2\}$, based on AHP, the weight is $W_i = \{0.833, 0.167\}$, and table 7 shows the value of each index.

Table 7. The value of each index of ecosystem structure.

Evaluation index	Excellent	Good	General	Poor
Macro structure	6	2	2	0
Characteristics of community structure	7	2	1	0

After the normalization, the fuzzy evaluation matrix $R_1 = \begin{bmatrix} 0.6 & 0.2 & 0.2 & 0 \\ 0.7 & 0.2 & 0.1 & 0 \end{bmatrix}$

(2) Fuzzy comprehensive evaluation

The fuzzy comprehensive evaluation vector of the

ecosystem structure is: $B_1 = W_i * R_1 = \{0.833, 0.167\} * R_4 = \{0.6107, 0.198, 0.181, 0\}$. Similarly, the other indexes fuzzy comprehensive evaluation vectors are shown in Table 8.

Table 8. The fuzzy comprehensive evaluation vector of other evaluation indexes.

	Excellent	Good	General	Poor
Ecosystem structure	0.611	0.198	0.181	0
Ecosystem quality	0.437	0.388	0.175	0
Ecosystem services	0.351	0.482	0.166	0
Factors affecting ecosystems	0.250	0.250	0.500	0

From Table 8 and the second class index evaluation weight to get the first layer of fuzzy evaluation:

$$A = \{B_1, B_2, B_3, B_4\} * \begin{bmatrix} 0.611 & 0.198 & 0.181 & 0 \\ 0.437 & 0.388 & 0.175 & 0 \\ 0.351 & 0.482 & 0.166 & 0 \\ 0.250 & 0.250 & 0.500 & 0 \end{bmatrix} = \{0.480, 0.277, 0.236, 0\}$$

Table 9 shows the final results of the environmental impact post assessment of the first phase of Qinghai San Jiang Yuan.

Table 9. The result of environmental impact post assessment of the first phase of San Jiang Yuan.

	Excellent	Good	General	Poor	Conclusion
Ecosystem structure	0.611	0.198	0.181	0	Excellent
Ecosystem quality	0.437	0.388	0.175	0	Excellent
Ecosystem services	0.351	0.482	0.166	0	Good
Factors affecting ecosystems	0.250	0.250	0.500	0	General
Comprehensive evaluation	0.480	0.277	0.236	0	Excellent

4. Conclusion

According to the principle of maximum subordinate degree, the result of environmental impact post assessment of the first phase of Qinghai San Jiang Yuan is excellent, it means the overall operation of San Jiang Yuan project is effective and obtains a better ecological benefits. Through the implementation of the first phase of Qinghai San Jiang Yuan ecological protection and construction project the ecological environment of San Jiang Yuan area has showed a tendency of improvement---the average vegetation coverage increased significantly over the years, the pressure of carrying capacity of stock has declined apparently, the water and soil ecosystem has been restored, the capacity of water conservation and water supply of ecosystem has been improved and the habitat environment of wild animals has been perfected obviously. The ecological protection has achieved remarkable results.

Insufficient and Future Research

There are some limitations in this paper. First of all, this article is based on the environmental impact post assessment of the first phase of Qinghai San Jiang Yuan, actually there are wide range of items of post-evaluation and every index is not isolated, thus only consider the environmental assessment will influence the accuracy of the paper result. In addition, all evaluation indexes in this paper are all dynamic factors, will change over time. Therefore, future research can consider the longitudinal research method, and measure variables in different ways in order to comparative analysis.

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