

# Health Assessment and Ecological Restoration of Rural Rivers in Southern Jinan City

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**Abstract:** The ecological restoration and river environment optimization of rural and suburban rivers in the southern mountainous areas of Jinan City are of great significance to flood control, ecology, environment, spring water protection and other aspects. Through ecological restoration and river environment optimization, the drainage capacity and flood control capacity of the river can be enhanced, and the occurrence and loss of floods can be reduced. Specific measures, such as dredging rivers and reinforcing dikes, can improve the drainage efficiency of rivers and reduce the harm of floods to peoples lives and property. Based on the investigation of the present situation of rural rivers in southern mountainous areas, this paper evaluates the health of rural rivers in southern mountainous areas of Jinan City, and designs the scheme of ecological restoration.

**Keywords:** Southern Mountainous Areas of Jinan; Current Situation Investigation; River Health Assessment; Ecological Restoration Plan

## 1. Introduction

According to the List of Famous Springs in Jinan (2021), Jinan has added a list of 305 famous springs, with a total of 950 famous springs and a total of 1,209 springs, which are widely distributed in urban areas, suburban areas and rural areas in Jinan, among which there are 56 springs in the southern mountainous management committee <sup>[1]</sup>, about half of which are located in rural areas, and the springs are closely connected with rivers. At present, there are many ecological problems in the rivers in the southern mountainous areas of Jinan <sup>[2]</sup>.

## 2. Current Situation of Rural Rivers in Southern Mountainous Areas of Jinan City

The process of rural river regulation in China mainly includes three stages, namely,

comprehensive regulation of rural rivers, rural ecological river construction and rural happy river construction <sup>[3]</sup>. The current situation of rural rivers in the southern mountainous areas of Jinan is gradually improving. In recent years, the local government has intensified the management of rivers, and effectively improved the water quality of rivers and the surrounding environment by cleaning up garbage, repairing damaged river banks, and implementing the river length system <sup>[4]</sup>. Nowadays, many rural rivers have become clear and green, making them a good place for residents to take a leisure walk. However, river protection still faces challenges due to the influence of natural factors and anthropogenic activities. Some rivers still have problems such as pollution and damage, which need to be continuously strengthened and repaired <sup>[5]</sup>.

After the heavy rain on July 5, 2024, a large amount of garbage, debris, litter and leaves appeared in many rivers in Jinan City. The river dredging efforts were insufficient and the dredging methods were improper. The health and stability of the river ecosystem were weak. It was necessary to further enhance the continuous spring water <sup>[1]</sup>. Content of gushing and scientific and rational utilization of groundwater. At the same time, increasing public participation and strengthening publicity and education are also important links in protecting rural rivers <sup>[6]</sup>. In the future, the southern mountainous areas of Jinan will continue to promote river management and protection, and strive to achieve the ecological environment goal of "clear water, green shore and beautiful scenery".

## 3. Health Evaluation of Rural Rivers in Southern Mountainous Areas of Jinan City

Gao Fan et al. defined the concept of river health as: on the premise of ensuring the basic survival needs of the river itself, it can continuously provide efficient and reasonable ecological

service functions for human society, and can maximize the comprehensive value of service functions.

The comprehensive evaluation index method of river health is the most widely used. The comprehensive evaluation index method is to construct an index system according to the characteristics and service functions of rivers, and determine the health grade of rivers (as shown in Table 1).

### 3.1 Evaluation Criteria for Rural River Health in Southern Mountainous Areas of Jinan City

**Table 1. Evaluation Criteria of Rural River Health in Southern Mountainous Areas of Jinan City**

Frequency	Index	Index factor	Evaluation criteria	Fraction	Specific gravity
Tall Mark Frequency Time	Ecological benefits	Channel area	Large river > 10000 square meters	4	10%
			Large and medium-sized rivers 3000-10000 square meters	3	
			Medium-sized river channel 500-3000 square meters	2	
			Small river channel < 500 square meters	1	
		Aquatic animal species diversity	$\geq 50$ aquatic animal species	3	10%
			$30 \text{ species} \leq \text{aquatic animal species} < 50 \text{ species}$	2	
			Aquatic animal species < 30 species	1	
		Water quality chromaticity	Chromaticity 0-5 degrees	4	10%
			Chromaticity 5-15 degrees	3	
			Chromaticity 15-30 degrees	2	
			Chromaticity < 30 degrees	1	
		Suspended solids	Clear water quality, no suspended solids	4	10%
			Inorganic substances such as impurities and sediments	3	
			Organic matter produced by the spoilage of animals and plants	2	
			Obvious plankton	1	
	Flood control benefits	Water system connectivity	Longitudinal connectivity coefficient Low connectivity	5	10%
			Connectivity in the longitudinal connectivity coefficient	3	
			Longitudinal connectivity coefficient High connectivity	1	
			Lateral connectivity coefficient High connectivity	5	
			Connectivity in transverse connectivity coefficient	3	
			Lateral connectivity coefficient Low connectivity	1	
		Flood control project compliance rate	High flood control compliance rate of river embankments	5	10%
			Flood control compliance rate of river embankment	3	
			The flood control compliance rate of river embankment is low	1	
		Riverbank stability	High bank stability	5	10%
			In riverbank stability	3	
			Low bank stability	1	
Time Frequency Refers to Mark	Health State Effect Benefit	River meandering degree	High frequency of river bending	5	10%
			In the frequency of river bending	3	
			Low frequency of river bending	1	
			The amplitude of river curvature is large	5	

		Water resources development utilization rate	In the amplitude of river curvature	3	5%
			The amplitude of river curvature is small	1	
			Strong development of water resources	5	
			Moderate development of water resources	3	
			Weak development of water resources	1	
		Vegetation coverage of bank slope	Bank slope vegetation coverage > 80%	5	10%
			Bank slope vegetation coverage > 60%	4	
			Bank slope vegetation coverage < 50%	3	
			Bank slope vegetation coverage < 30%	2	
			Bank slope vegetation coverage < 10%	1	
		Ecological revetment improvement rate	Ecological revetment improvement rate > 80%	5	10%
			Ecological revetment improvement rate > 60%	4	
			Ecological revetment improvement rate < 50%	3	
			Ecological revetment improvement rate < 30%	2	
			Ecological revetment improvement rate < 10%	1	
Human landscape index	Humanistic benefits	Functional benefits	High level of urbanization	5	10%
			Low level of urbanization	2	
		Cultural benefits	High degree of historical and cultural embodiment	5	10%
			Historical and cultural embodiment	3	
	Social benefits	Service benefits	Low degree of historical and cultural embodiment	1	10%
			High public participation	5	
			Public participation	3	
			Low public participation	1	
			High public satisfaction	5	
			Public satisfaction	3	
			Low public satisfaction	1	

### 3.2 Weight of Rural River Health Assessment in Southern Mountainous Areas of Jinan City

The evaluation of rural river health in southern mountainous areas of Jinan adopts the method formed by the coupling of analytic hierarchy process (AHP) and fuzzy comprehensive

evaluation model, that is, analytic hierarchy process-fuzzy comprehensive evaluation method.

According to the investigation and relevant data analysis and extraction, three suburban river paths were determined in the southern mountainous area, including six rural river paths (as shown in Table 2).

**Table 2. List of Main Evaluation Objects in Southern Mountainous Areas**

Type	Serial number	Name	Scope	Watershed area (ha)	Retaining water storage capacity	Landscape quality
Suburban river	1	Langmaoshan Reservoir Channel	On the Juye River at the confluence of Dalongtang and Zhaikeyu in Caishi Street, Licheng District, Jinan City	82 km <sup>2</sup>	13 million cubic meters	Excellent
	2	Channel of Hancang River	Jinxiu River in Nanshan District, Jinan City flows northward into Xiaoqing River between Qilin Mountain bordering Ganggou.	154 square kilometers	1.037 million cubic meters	Excellent
	3	Mengjiazhuang Shuike River	West of Longding Avenue, Lixia District, Jinan City, near Mengjiazhuang	----	108 million cubic meters	Excellent
	4	Quanlu River	Xiaohou jia zhuang in ShililiheTown originated, flowed into Jinxiu River after passing through many villages, and finally	60 square kilometers	858,000 cubic meters	Excellent

			flowed into Wohushan Reservoir			
	5	Jinyunchuan	Zhonggong Town Walnut Garden	----	----	Middle
	6	Jinyangchuan	Changyu,Zhangxia Town and other places northof Changchengling	----	----	Middle
	7	Jinxiu River	Xiying Street, with a total length of 36 kilometers, flows through many areas and then merges into Wohushan Reservoir	221.6 square kilometers	----	Good
	8	Yufu River	Jinxiu, Jinyang and Jinyun rivers merge into Wohushan Reservoir and then flow out to form, flowing through many areas and then injecting into the Yellow River	755 square kilometers	----	Excellent
Rural river	1	Yuntai Temple Spring Water	In Yuntai Temple, Luyaling Village, Ganggou Street	----	----	Excellent
	2	Huangzhai River	Within Huangzhai Village	----	----	Middle
	3	Taoke Village River	Taoke Village	----	----	Middle
	4	Hexi Village River	Within Hexi Village	----	----	Middle
	5	Beiyu Village River	Within Beiyu Village, the village provides irrigation and domestic water	----	----	Poor
	6	Shimiao Village River	In Shimiao Village, the source of Hancang River	----	----	Poor

### 3.3 Results of Rural River Health Assessment in Southern Mountainous Areas of Jinan City

According to the formulated evaluation criteria, the Delphi expert scoring method is used to evaluate and score the river path and landscape elements in the southern mountainous area, and the grade of each landscape element is equally scored, and the comprehensive score is obtained by weighted calculation, which provides data

support and route selection basis for river ecological restoration design (as shown in Table 3).

A total of 8 expert scoring tables were distributed in this study, and 6 were recovered. The experts included 3 professors majoring in urban planning and landscape planning, 2 associate professors and 2 senior planners majoring in urban planning.

**Table 3. Comprehensive Evaluation of Rivers in Southern Mountainous Areas**

Type	Serial number	Name	Composite score
Riverway	Suburban river	1 Langmaoshan Reservoir Channel	2.00
		2 Channel of Hancang River	1.55
		3 Mengjiazhuang Shuike River	0.75
	Rural river	1 Yuntai Temple Spring Water	1.45
		2 Huangzhai River	1.05
		3 Taoke Village River	2.05
		4 Hexi Village River	1.75
		5 Beiyu Village River	1.05
		6 Shimiao Village River	0.85

### 4. Ecological Restoration of Rural Rivers in Southern Mountainous Areas of Jinan

Take river leveling and dredging, river bank replanting, and restoring ecological slope protection to restore the natural ecology of the river.

#### 4.1 Design of River Revetment

Comparison and selection of slope protection schemes: The commonly used forms of slope protection include mortar masonry slope protection, lead wire gabion slope protection and self-embedded plant retaining wall slope

protection [7]. Considering the characteristics of large river flow and fast flow rate in this project, and there are many stone materials in the local area, this design uses local materials as much as possible, and introduces as little or no foreign materials as possible. In the design of revetment, the type of slope protection with excavation conditions adopts inclined mortar masonry retaining wall revetment, and the type of slope protection without excavation conditions adopts inclined retaining wall revetment.

#### 4.2 Special Design of River Plant Planting

There are serious ecological damage and degradation in this river channel. There are many areas of waste slag and soil in the river, and the water conservation conditions are poor [8]. In addition, there is a potential threat of soil erosion, such as thin soil layer, steep slope and large valley ratio. On the one hand, tree planting construction is carried out: the planting hole is excavated manually, and the bottom of the pit is loosened and smoothed. Purchase seedlings and transport them to the site, plant them artificially, cultivate soil and tamp them in layers. After planting, maintenance measures such as watering and spraying must be carried out [9]. On the other hand, planting grass (spreading grass seeds): after fertilizing and watering the planting area and spreading grass seeds, cover it with fine soil and roll it tightly.

#### 5. Epilogue

The terrain in the southern mountainous area is complex, and most of the rivers are residential areas and commercial areas [10]. The safety of rivers is directly related to the safety of lives and property of residents along the coast. Ecological restoration and river environment optimization can effectively reduce flood risks and ensure coastal safety. Through ecological restoration, biodiversity can be increased, ecological balance can be promoted, and ecological functions can be protected and restored. River environment optimization can improve the water quality of rivers, reduce the input and accumulation of pollutants, improve the purification ability and self-purification ability of water bodies, and thus protect the health and stability of water

environment.

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