

Sustainable ecological Hunhe river system design thinking

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Abstract. Based on the design and research of the sustainable development of the ecological water system in the Hunhe River, the focus is on environmental pollution brought about by the large-scale industrialization in the Central region of Liaoning Province, the issue of efficient and low-carbon logistics transportation among urban economic groups and the problem of recycling and utilization of urban water resources. It is required that while ensuring the rapid economic development, we must actively build a green economy development system in accordance with the laws of ecological development. Design the annual navigation system of Hunhe and establish the inland (Shenyang Sihuan) to Yingkou estuary, accelerating the rapid and efficient flow of materials along the river.

1. Instructions

After analyzing the advantages and disadvantages of the development model of the economic circle in central Liaoning, which is based on Shenyang, we consider the Luan River as a green economy artery, and combine the characteristics and structure of the urban ecosystem to construct an ecological city based on sustainable development. The circle concept model divides the eco-city cluster system based on sustainable development into social ecosystem, economic ecosystem, and natural ecosystem. According to the urban ecosystem function and operation theory, the sustainable development of the ecological city system in the central city circle of Liaoning Province is planned, combined with the unique geographical advantages, ecological advantages, and potential of the Hunhe River to drive the rapid economic development in Shenyang. The ecological river system design thinking based on sustainable development was put forward.

2. Hunhe Overview

With a total length of 415 kilometers, the Hunhe River is the most abundant inland water resource in Liaoning Province. drainage area 1.15×10^4 km², where the hill area accounts for 65% of the total drainage area, plains account for 35%, and is temperate continental. Monsoon climate zone, the average annual precipitation 718.3mm. The confluence of Haicheng and the Taizi River into the DaLiao River, and the operational entrance into the Bohai Sea, the hunhe waterway has navigable conditions, with the advantage of Connecting inland and sea. After navigation, it will form a new major channel for water transport, forming a network with the land transport network. Complementary and common development. The hunhe River is rich in seasonal water resources. Gathering and exploiting surface river water resources will substantially improve the water shortage situation in Liaoning. After the navigation of the hunhe Channel, the waterway and ship lock will form a stepped reservoir for the river, thus thoroughly We will change the ecological conditions and human



settlements that are currently deteriorating on both sides of the river. It is of great significance to revive Liaoning's economy.

3. Hunhe Ecological Water System

3.1. Hunhe River Water Source

The Hunhe River originates from Gunmaling in Qingyuan County, Fushun City, Liaoning Province, flows through cities such as Fushun, Shenyang, Anshan, and Yingkou and flows southwards to Yingkou City and enters Liaodong Bay. It is the most abundant inland water resource in Liaoning Province. Hunhe water resources are mainly Xiao Liao River originating from Xinbin, and Fushun Dahuofang Reservoir and other projects can be used as auxiliary water sources. Secondly, rainwater and reclaimed water treated by urban clean water circulation system are auxiliary water sources.

3.2. Sponge City

Sponge City is a new generation of urban rainwater management concept. Its six functional modules "seepage, stagnation, storage, net, use, and scheduling" have greatly improved urban environmental issues.

Spongy urban construction includes: sponge-type buildings and community construction, sponge road construction, sponge park construction, and sponge city water system construction. Shenyang City has accumulated rich experience in the construction of sponge city construction projects. In the water system, park greenbelt systems, road systems, and buildings and communities, sponge cities are dominated by "seepage, stagnation, storage, and net" and "use" as auxiliary, has basically formed the embryonic form of Shenyang sponge city construction, It still need to further practice and perfect. Sponge city construction has a long way to go. It should combine the regional resources and geographical characteristics to conduct scientific planning and design, deploy low-impact development facilities according to local conditions, and build a sponge city with natural accumulation, natural penetration, and natural purification.

3.3. Rain, Reclaimed Water

3.3.1. Rainwater. With the shortage of fresh water resources and flood disasters gradually becoming common problems on the global scale, more than 40 countries in the world have successively conducted research and practice on the recycling of rainwater resources. China has begun to study this aspect since the 1980s, but it is still relatively backward compared with countries and regions where rainwater utilization is relatively advanced. It cannot form a complete system and lacks protection of relevant laws and regulations.

Shenyang belongs to the cold region ("National Thermal Engineering Design Division Map"). According to the statistics of Shenyang Meteorological Observatory for many years, the average annual temperature is 7.9°C, the maximum temperature is 35.7°C, the extreme minimum is -30.5°C, the average annual rainfall is 734.5mm, and the maximum daily precipitation is 178.8mm, concentrated in June to September. The annual average relative humidity is 65%. Shenyang is a water shortage area, so the collection and use of rainwater plays an important role in the city. The average annual rainfall can be used. According to the formula: the annual average amount of collected rainwater = catchment area (m²) × rainfall (m) × rainfall runoff coefficient. See Table 1.

Shenyang has established rainwater harvesting systems, such as road rainwater collection and park rainwater harvesting systems. The Yingbin Road Viaduct Rainwater Harvesting System has been completed. Under the viaduct, a rainwater collection pool and 9 permeate pools are installed. The rainwater tanks are buried module reservoirs. The collected rainwater can be processed by filtration

devices and can be used on roads. Greening and pouring, It can also be discharged into the Hunhe River through the pipeline.

Tab.1 Annual Rainwater Collection

Number	Sort	Acreage /m ²	Runoff Coefficient	Annual rainfall /m	Annual runoff /m ³ ·a ⁻¹	Results /m ³ ·a ⁻¹	Rainy results /m ³ ·a ⁻¹	Dry results /m ³ ·a ⁻¹
1	Ordinary roof	14 753	0.9	0.7	9 294.4	25.5	70.7	10.2
2	Village roads	9 079	0.9		5 719.8	15.7	43.5	6.3
3	Cyrtilage roads	5 674	0.65		2 581.7	7.1	19.6	2.8
4	Cyrtilage lawn	14 753	0.3		3 098.1	8.5	23.6	3.4
5	Public lawn	5 674	0.15		595.8	1.6	4.5	0.7
Total					21 319 .8	58.4	161.9	23.4

3.3.2. Reclaimed Water. After the urban sewage is treated by the deep purification treatment facilities (including the secondary treatment of the sewage treatment plant, the treated water treatment), the concentrated water of large buildings and living communities, such as bath water and vegetable washing water, are collectively referred to as “Zhongshui”. Water recycling and rainwater use occupy the same position in urban construction. Sewage treatment plant can be set up around the cluster factory. After the factory wastewater is treated and purified, it can be recycled. Large-scale buildings and living communities can establish septic-tank centers and partition them. After filtration and separation, sanitary water and vegetable washing water can be collected and stored separately. And recycling.

3.3.3. Shipping. The Hunhe River has favorable navigation conditions. Its rivers are large and the water flow is gentle. There are no dangerous river bends and the entire area is suitable for navigation. Due to the slow transportation speed of inland river water transport and the relatively large influence of ports, water levels and climate, it is considered that during the development of shipping at the Hunhe River, it can be considered for sightseeing, low transportation costs, and advantages of large-scale and long-distance transportation.

4. The Status of the Classification of Inland Waterways

4.1. Channel Grade

Inland river water transport is an important part of the comprehensive transport system and comprehensive utilization of water resources, and it is an important strategic resource for achieving sustainable economic and social development. At present, an inland river water transport layout has been formed nationwide focusing on the Yangtze River, the Pearl River, the Beijing-Hangzhou Canal, the Huaihe River, the Heilongjiang River, and the Songliao Water System. The service hinterland of the inland waterway has been greatly expanded and expanded, and the service quality has been significantly improved. The sustained and rapid development has played an important role.

Internationally, there are two technical indicators for classifying the waterway class: one is the water depth of the waterway as the grading indicator, and the corresponding ship type is selected, such as the United States and Russia; the other is the standard of the tonnage and ship type of the barge as the grading indicator, such as Western Europe and China. According to the provisions of the Inland Navigation Standard, China's fairway classes are graded I, II, III, IV, V, VI, and VII from high to low, and these 7th-grade fairways can be called graded fairways. Navigation channels with a navigation standard lower than Class VII may be referred to as an external navigation channel. "Inland navigation standards" 3.0.1: I-class navigation 3000 tons, II-class navigation 2000 tons, Class III navigation aviation 1000 tons, Class IV navigation 500 tons, V-class navigation 300 tons, VI-level navigation 100 tons and VII-class navigation 50 tons.

4.2. *The Factors of the Fairway Scale*

Vessel avoidance, rotation, braking, navigation and other behaviors all require certain water conditions, that is, waterway conditions, which include: depth of water, width of navigation channel, and high net of navigational structures. These factors constitute the field conditions required for the navigation of the ship. If these conditions are lacking, the ship cannot sail or it is unsafe to sail. Factors affecting the ship sector are not only limited by the size of the ship, but also by external conditions such as wind and current. However, in the navigation standards of China, the requirements on the airway width do not consider the influence of wind and current; the definition of the width of the curved channel is also rather obscure.

Considering the entrance from Sihuan of Shenyang City to Yingkou, the river is wide and the water flow is gentle, there are no curved cliffs, and there are few bridges. Basically meet the level IV navigation 500 tons. However, the premise is the need for sustainable development of green projects such as river management, dredging, and eco-environmental protection design.

5. Traffic Equipment Design

5.1. *Design Positioning Analysis*

The design of inland waterway public transport in northern cities is based on the three-month climatic factors of the annual icing period in Fushun, Shenyang, the characteristics of traditional icebreakers, the water depth of the hunhe River, the thickness of the ice, the characteristics of the ice layer, and the new icebreaking methods. With reference to comprehensive considerations of other aspects, the ship is positioned as a shallow-water vessel that can operate in the hunhe River throughout the year and has certain ice-breaking capacity, and uses a bottom-up "dump-ice" ice-breaking method suitable for shallow waterways.

5.1.1. Inland river shallow water ships with certain ice-breaking capacity. During the three-month icing period of the Shenyang section of the Xiaohe River, the normal sailing time of the ship is 9 months. The ship is positioned as year-round operation. Yuchao River is a shallow water vessel with certain ice-breaking capacity.

5.1.2. Bottom-up "Shake the ice" Icebreaking. The traditional icebreaker hull is deep and has a large tonnage and cannot be driven in the river. In addition to overcoming the ice layer's own stress, it is necessary to overcome the buoyancy of the ice during icebreaking. After the ice is broken, most of the crushed ice remains in the waterway, increasing the resistance to icebreaking and affecting the subsequent navigation of the ship. Damaged propeller propulsion unit is not suitable for icebreaking in the shallow waterways of inland rivers. The "Shake the ice" ice-breaking method can be adapted to the characteristics of small inland tonnage and shallow draft in inland shallow water ships.

5.1.3. Cone-shaped hull and double-body auxiliary hull. The design of the hull is based on the river shallow water craft, which is designed from the front to the rear of the sloping type, which is similar to the snow shovel in the head of the train when the snow is on the train track. The stern type can clean crushed ice to the upper part of the ice on both sides of the channel to reduce the crushed ice in the channel, so that the normal operation of subsequent ships can be guaranteed. The ship's bow is a cone-shaped line, adding two auxiliary hulls at the bottom of the hull. The bulky stern can provide sufficient buoyancy. The hull has better wave resistance and stability, which can reduce the impact on the hull due to the waves generated by the swaying of the hull during the hull ice-breaking process. The upper part of the hull adopts a single-story superstructure to ensure that the hull passes through buildings such as low bridge holes.

5.2. Determination of Main Hull Size and Main Parameters

Length (m)	32.58
Molded breadth (m)	7.6
Draft (m)	1.25
Design drain (m ³)	169.84
Design speed (kn)	15
Continuous ice breaking speed (kn)	3-7

5.3. Buoyancy Calculation in the Bow Area

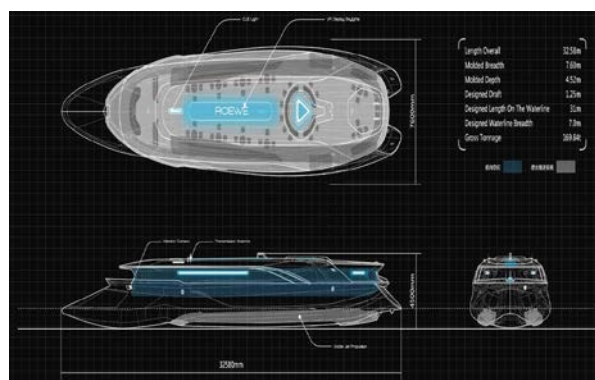
When the hull is in the ice breaking state, the hull breaks the ice surface by the “shear force” effect of the forward propulsion provided by the thruster and the upward buoyancy generated by the hull, and distributes the crushed ice to the hull during the hull forward. Both sides. According to the width of the hull, it can be determined that the width of the ice channel is the width of the ship, and the length of ice is calculated according to the maximum length of the stern. The calculation result and formula are as follows:

$$F_1 = G_1 = \rho_1 \cdot g \cdot V_1 = \rho_1 \cdot B \cdot H \cdot L_{\max} = \rho_1 \cdot g \cdot B \cdot H \cdot (L / \cos \alpha) \quad (1)$$

Note: F_1 -buoyancy, G_1 -ice gravity, ρ_1 -ice density, H -ice thickness, B -ice width (hull breakage channel width, ie hull width), L -icebreaker mast length, α -hull angle (30° - 65° , 45° here), g - Gravity acceleration constant.

According to the law of buoyancy, the buoyancy of an object is equal to the gravity of the liquid discharged when the object sinks. That is, as the stern moves forward under the ice, the volume of the submerged immersed vessel gradually increases, that is, the volume of the discharged liquid increases, that is, the buoyancy with the ship under the ice.

5.4. The Final Scheme Renderings





6. Conclusions

Hunhe River as a green economy artery to continue energy transfusions for the northeast industrial industry provides impetus for the rejuvenation of the manufacturing industry. The social, economic, and natural aspects of the compound complex ecosystem of cities and urban agglomerations are weighed against the contradictions between the rapid development of the social economy and the protection of the ecological environment, and the concept of sustainable development of the ecological economy is proposed. Planning for the water transportation economic zone along the estuary of the Sihuan - Yingkou section of the Hunhe River in Shenyang to promote the development of low-energy and environmental-friendly materials transportation in the Liao-Shen region. The design of a transport icebreaker powered by new energy sources can break the winter ice problem in the northern rivers and build an ecological navigation system that is navigable throughout the year.

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