Proceedings of the 3rd International Conference on Green Energy, Environment and Sustainable Development (GEESD2022), X. Zhang et al. (Eds.)

doi:10.3233/ATDE220390

Systematic Treatment of Water Ecological Environment in Plain River Network City: A Case Study of Jiangyin

Zhiliang DING, Zichen HU[1], Lingkai SUN, Conglin WU and Kun LUO
Institute of Water Ecology and Environment Engineering, Changjiang Survey, Planning, Design and Research Co., Ltd., Wuhan, Hubei, China

Abstract. Jiangyin is a typical plain river network city in the Yangtze River Delta. The water ecological environment in urban area faces a range of environmental challenges, including poor water quality, black and odorous water bodies, serious isolation of river network, degradation of water ecological environment and low efficiency in urban wastewater treatment. This study proposed a systematic treatment plan which includes source sewage control, river regulation, water cycle enhancement, water environment restoration and waterscape improvement. Such an approach was informed by four principles, which is prioritizing pollutant control, introducing flowing water, co-management of river and bank, and combination of construction and management. By implementing such measures, the water environment carrying capacity and water ecological restoration capacity of the urban area have been greatly improved, and the overall water ecological environment quality has been significantly improved. The urban water system has realized a new picture of smooth river, clear water, green bank and beautiful scenery.

Keywords. Plain river network, water ecological environment, systematic treatment

1. Introduction

The alluvial plain areas along the middle and lower reaches of large rivers are widely distributed with plain river networks, which are usually with low and flat terrain, well-developed water systems and convenient water and land transportation, providing favorable conditions for urbanization and economic development. Therefore, most of the plain river network areas are also economically developed, densely populated with high urbanization rates. Currently, the three biggest national urban agglomerations of China: Beijing-Tianjin-Hebei Urban Agglomeration, Yangtze River Delta Urban Agglomeration, and Guangdong-Hong Kong-Macao Greater Bay Area (GBA) are all located in the plain river network areas. Following the rapid development of China's economic, the influence of human activities on the plain river network areas increases, and the urban water environment problems becomes more and more serious, containing the encroachment of river channels and the increase of pollution load into the river caused by the rapid urban development; the decrease of water system connectivity and the weakening of hydrodynamics due to serious fragmentations of rivers and lakes; the

[1] Corresponding Author, Zichen HU, Institute of Water Ecology and Environment Engineering, Changjiang Survey, Planning, Design and Research Co., Ltd., Wuhan, China; Email: huzichen@cjwsjy.com.cn.

low compliance rate of the water functional areas due to the black and odorous water with eutrophication problems [1].

Most countries have experienced the situation of "pollution before treatment" and "first development before protection" during the process of urbanization and industrialization. To solve the water environment problems brought by urban development, studies on water system connectivity and diversion of flowing water [2, 3], sewage system quality and efficiency improvement [4, 5], river and lake sediment pollution control [6, 7], water ecological environment restoration [8, 9] have been carried out. Some countries have carried out water environment management projects and achieved relatively significant results, i.e., the Danube River in Vienna, Austria [10], the Seine River [11] and the Rhine River [12] in Paris, France, and the Cheonggyecheon River in Seoul, South Korea [13]. But China is in a different development stage with the above countries. The management and protection of the water environment of rivers and lakes are still in the initial stage. Following the guidance of the ideas of "joint protection without large-scale development" and "green water and green mountains are golden mountains and silver mountains", and some cities have successively carried out water environment treatment [14-17].

In general, the treatments on river basin and regional water environment are still fragmented, and the overall coordination between upstream and downstream, left and right banks and different industries and departments are insufficient. Systematic treatment has not been truly realized, and there is still a certain gap from the goal of "long-term treatment and long-term cleaning" [18]. Taking the central urban area of Jiangyin as a typical plain river network area and the stable improvement of water quality of rivers and lakes as the core goal, the paper proposes a study on water pollution control, river regulation, and water circulation, following the systemic policy and comprehensive management of water environment for an area with "smooth river, clear water, green bank and beautiful scenery", and puts forward some suggestions based on project construction in real life.

2. Study Area and Existing Problems

2.1. Study Area

Jiangyin is located between East longitude 119°59' and 120°34'30", and North latitude 31°40'34" and 31°57'36", in the center of Yangtze River Delta Urban Agglomeration, with the Yangtze River in the North, Jingjiang across the river, Taihu Lake in the South, Wuxi in the border, Zhangjiagang and Changshu in the east and Changzhou in the west. It is the intersection of Jiangsu Riverside City Belt and Taizhou-Wuxi-Yixing town development axis, and is also the essential passage for economic radiation from Suzhou-Wuxi-Changzhou Metropolitan area to central and northern Jiangsu. Except for a few low hills, Jiangyin is a plain area with elevations between 3.5 m and 6 m, with river crossings and lakes densely covered.

Jiangyin is located in the North subtropical monsoon climate zone, and is adjacent to the mouth of the lower Yangtze River, with oceanic climate. It is with four distinct seasons and significant monsoon, mild and humid with concentrated plum rains of strong seasonality of precipitation and uneven spatial and temporal distribution. The annual average precipitation is 1098.3mm; the maximum annual precipitation is 2217.5 mm (2016) while the maximum daily precipitation is 260.5 mm (June 6, 2015), and the

minimum annual precipitation is 581.8 mm (1978). The plum rain season is generally from mid-June to late July, with a rainy period of about 20 days, and the annual average amount of plum rain is 260 mm.

Rivers in Jiangyin are ranked in a backbone with "three horizontal and three vertical rivers" separately: the "three horizontal rivers" are the Xiheng River, Dongheng River and Yingtian River, and the "three vertical rivers" are the Old Xiagang River, the Xicheng Canal and Baiqu Port. The North-South channel is the main drainage channel, from South to North towards the Yangtze River; while the East-West channel works mainly as linking all the waters, but there is a lack of effective communication between the backbone rivers, and the smoothness is not good. The main river network of Jiangyin is shown in Figure 1.

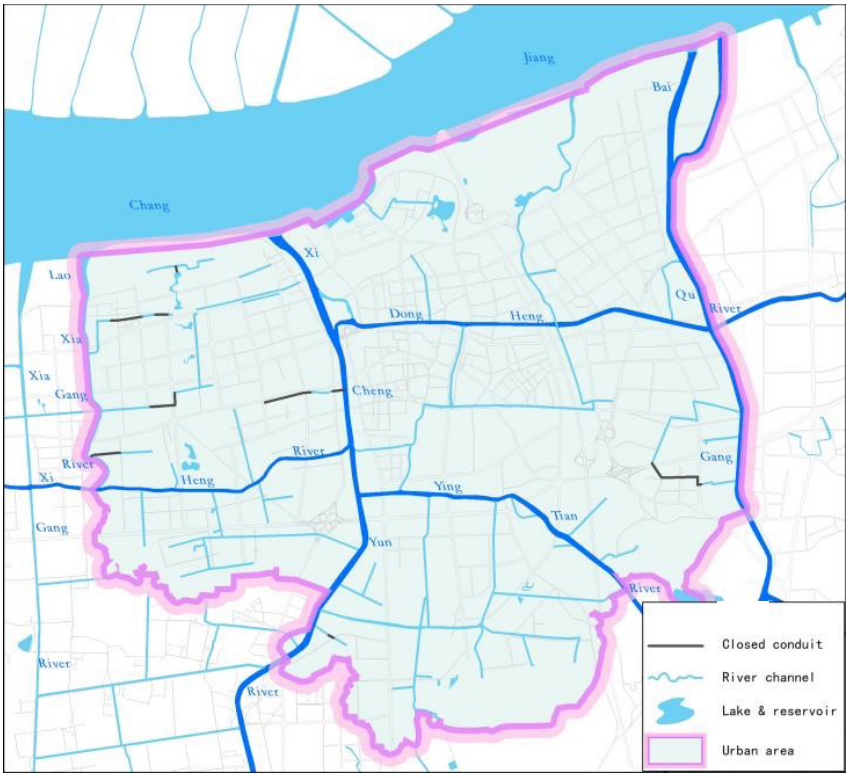

Figure 1. Water system map of Jiangyin central urban area.

2.2. Existing Problems of Water Ecological Environment

2.2.1. Poor Water Quality and Environment

The water pollution of Jiangyin is serious with poor river water quality in the backbone, broken head river, and black and odorous water bodies. In 2018, Yangtze River, Xicheng Canal, Yingtian River and other seven conventional monitoring section water quality are not up to standard, among which 50% of the section water quality are Inferior V water. In 2019, a supplementary monitoring result of 53 rivers show that seven rivers are with Inferior V water, taking 13.2%; 25 rivers are with Inferior IV water, taking 47.2%.

Among the 75 river supplementary survey sections, 17 of them are with the black and odorous water index far away from the standard. And the water quality of 5 lakes' supplementary survey sections among the 9 lakes are inferior to the class IV.

Water pollution sources are complex, with point-source pollution, diffused pollution, endogenous pollution coexisting. Point-source direct discharge and pollution is heavy with more than 200 outlets in dry season; The diffused pollution rate in urban areas is high with the issues of old town's combined sewer overflow pollution in rainy days, industrial areas' high surface runoff pollution concentration, and the farmland runoff pollution on both sides of the river banks widespread. The risk of endogenous pollution is high. And according to the results of nitrogen and phosphorus adsorption analysis experiments, the nitrogen and phosphorus pollution releases from the sediments risk in many rivers, while part of rivers' potential ecological risk index of heavy metals in the surface sediment is high.

2.2.2. Outdated Sewage Collection and Treatment System

Jiangyin plans to gradually shut down many small sewage treatment plants in its urban area, and the urban sewage is collected and treated by Binjiang and Chengxi main sewage treatment plants. At present, the main sewage pipes to Binjiang and Chengxi sewage treatment plants have been set, but some branch pipes and pump station supporting pipe networks have not been built. And the completion rate of main and branch pipe networks is only 63.2%. Moreover, with the development of Jiangyin and the shutdown of small sewage treatment plants, the sewage collection volumes of Chengxi and Binjiang sewage treatment plants have increased, which is far more than the volume of the two plants.

Most of the rivers and communities along the line in Jiangyin are separate system, and the combined sewage system takes less than 4%. The pipeline infrastructure conditions are good. However, based on the results of the pipe network census and site visits, the internal construction is not standardized, mixed with serious misconnection situations. And the rate of pipeline defects is high, among which 2, 3 structural defects take the most part, and urgent repair and reconstruction are required. In addition, the drainage network also contains imperfect interception systems, the existence of pipe network gaps and other problems.

2.2.3. Serious Degradation of Aquatic Ecosystem

The incompetent construction of the urban sewage collection and treatment system, the large pollution load into the river in Jiangyin urban area, and the overall small slope of the water system which is regulated and controlled by a large number of gates and pumps in the port canal, the poor fluidity of the water body, leads to the poor self-purification ability of the waters, the presence of black and odorous water in many places, the inability of aquatic organisms to survive, and the loss of the ecological function of the waters.

The rivers in the central urban area of Jiangyin are straight, with hard mortar masonry or concrete retaining walls built on both banks. The channelization and hardening rate of the shorelines is up to 80%. The natural form of the rivers is damaged. The horizontal connectivity between the water bodies and the coastal zones is blocked, and the suitable hydrophytic habitat is missing. As to suburban and rural rivers, the problems of lacking of vegetation on both banks, the prevalence of illegal construction and agricultural planting occupying the shoreline and the river, etc., lead to the destruction of coastal waterfront vegetation, serious situation of the river siltation, the floating weed and algal bloom covering the river surface and encroaching the water and

the river, which all result in a significant shrinkage of water ecological space, compressed aquatic organisms' habitat area and damaged biodiversity.

2.2.4. Lack of Systematic Planning on Drainage System

The rivers in the urban area of Jiangyin City network complexly, with many lock and station plants. The hydrodynamic power is insufficient in the network, and the water flows between the rivers stagnantly. Small-scale water activation projects are carried out based on the natural conditions and the lock and station projects along the rivers in the urban area. However, the bidirectional flow among the rivers in Jiangyin are subject to the original function of water projects, which lead to the interference between the intake routes and the drainage directions of the rivers on the backbone. And the overall intake routes and drainage channels in the urban areas are not in consistent and have conflicts with each other. The flowing water project proceeds only in the East Jiangyin, and the western region lacks effective methods on flowing water. According to the relevant and on-site water quality measurement data analysis, the performance of the current flowing water projects is not good enough to make progresses on water environmental capacity, and so the water quality cannot stably reach out to class III of the environmental quality standards for surface water.

3. Systematic Treatment of Water Ecological Environment

3.1. Aims of the Treatment

Focusing on the water control goal of "improving water environment quality, repairing water ecology, improving water landscape and strengthening intelligent water management", this paper takes the main rivers in the Jiangyin urban for the water quality improvement. By implementing pollution source control and interception, endogenous treatment, living water cycle, water ecological restoration, water landscape enhancement, intelligent water construction, etc., this paper tries to fundamentally eliminate urban black and odorous water, restore the water cycle of the main rivers to a normal way, significantly improve the overall quality of urban water ecological environment, and gradually realize the goal of ecological river network.

3.2. General Idea of the Treatment

Jiangyin has a well-developed water system, a dense network of rivers and abundant waterfront landscape resources. But with the deepening of urbanization, inlet pollutants increase continuously. Coupled with the lack of hydrodynamic, water quality deterioration is serious. Currently the water quality of most urban areas is class V, showing a big gap with the goal of "livable, workable and touristy". Therefore, it is necessary and urgent to carry out ecologically oriented integrated management of urban water systems, promote the restoration of water ecological functions in the watershed, improve the water environment quality to achieve water quality objectives as scheduled.

Based on the status survey and model analysis, taking water environment capacity as a constraint, and technical reliability, economic feasibility, target accessibility, effect durability and other aspects into integrated consideration, following the idea of "pollution source control and interception, endogenous treatment, water cycle, ecological restoration, landscape enhancement, intelligent management", this paper proposes this

study to improve the quality of water environment in Jiangyin by implementing the projects of pollution source control and interception, endogenous pollution treatment, water system connection and living water, water ecology restoration, landscape enhancement project, and intelligent water.

3.3. Schemes of the Treatment Measures

3.3.1. Pollution Source Control and Interception

Pollution source control and interception is the most important way to solve river pollution, and also the prerequisites and necessities for ecological restoration of rivers. Only if the source of pollution has been effectively controlled, the subsequent water environment management measures on rivers can work correctly. The key to the comprehensive improvement of urban water environment is to intercept the sewage along the rivers and prevent the sewage and initial rainwater from being discharged into the river. For point-source pollution, "source", "process", "end" are controlled respectively: In source control, the general survey data of community and rural pipe network are combined with rainwater and sewage diversion in community and natural village; In process control, the existing pipe network system is dredged and repaired after fully investigation and analysis; In end control, before the sewage is discharged into the water body, the sewage is intercepted along the river to control the overflow pollution into the river. For diffused pollution, regulation and storage measures in the agglomeration area of the industrial zone are applied, combined with the sponge storage measures on some river channels to reduce urban diffused pollution.

3.3.2. Endogenous Treatment

We take the limit value of the total nitrogen in sediment proposed in the U.S Environmental Protection Standard as reference. According to the results of the sediment survey, the total nitrogen contents in the sediment of 13 rivers in Jiangyin are 1000-2000 mg/kg, which is light pollution; while the total nitrogen contents other 7 rivers are over 2000mg/kg, which is heavy pollution with ecological risks. And we then take the limit value of total phosphorus concentration of the sediment causing minimum level ecological risk issued by the Ministry of Environment and Energy of Ontario, Canada, the contaminated layers of 21 river sediments all exceed 600 mg/kg, which is the minimum level causing ecological risk.

The 27 rivers in Jiangyin urban area are dredged, with a dredging volume of 394,200 m^3 to reduce the impact of endogenous pollution on water quality. The main dredging methods are eco-friendly stranded suction and hydrodredging. Afterwards, the sludge is formed into mud cakes by the integrated process of sludge dewatering and consolidation, and sent to landfill sites. At the same time, the operation and maintenance on rivers are strengthened to reduce the impact of endogenous pollution on water quality in the long term.

3.3.3. Flowing Water Circulation

The rivers and lakes in Jiangyin urban area are in a serious segmentation state with insufficient hydrodynamic force, but they are well related with the water system with the surrounding waters. In order to maintain the water quality of rivers and canals, it is necessary to make full use of the surrounding water sources (Xicheng canal, Baiqu port, etc.) and the existing gate pump projects of river channels in the urban area to activate

the water body, improve the hydrodynamic force, improve the reoxygenation capacity and self-purification capacity of the waters, so as to speed up the degradation rate of pollutants in the waters and increase the water environmental capacity.

According to Jiangyin's water system of "three horizontal and three vertical rivers" distributed in five drainage zones: firstly, the optimization on the route of flowing water by zones, rationalization the layout of open channels and pipe culverts for a better communication with the water system are required for a practical regional water system connection plan; secondly, combined with flood control and drainage, we develop the flood and non-flood flowing water scheduling principles, make full use of the existing gate station engineering, and set the gate station construction project in a scientific way. Water diversion Gates are priorly used, supplemented by pumping stations to divert water. The implementation of the flowing water cycle in the urban area increases the carrying capacity of the water environment of waters for the self-sustaining urban water ecosystems and a virtuous cycle of the water environment.

It is proven that Yangtze River flows into Jiangyin after Baiqu Port, Huangshan Port, Dongheng River, Xicheng Canal, Xiheng River and other backbone rivers, which is considered as the source of flowing water, and Chengxi sewage treatment plant tailwater is treated as an auxiliary water source for the landscape lake in the long run after purification. The channel storage method is used to calculate the water demand of each river channel, and the scale of buildings, pipelines and open channels are determined by comprehensively consideration of the water demand of river channel, dispatching time, current river channel/pipe culvert overflow capacity and other factors.

3.3.4. Ecological Restoration

After the analysis of the current situation of the pollution in waters, water quality and ecology in Jiangyin, on the basis of effective control of river pollution, it is clear that the overall goal is to achieve the health of river ecosystem by taking the current water system and ecological pattern as example, keeping a stable ecosystem and improving the river water quality. By implementation measures such as aquatic vegetation restoration, aquatic animal community adjustment and in-situ purification, the composition of the food chain of the river ecosystem is improved; the ecological self-purification capacity of the water body is enhanced, and a scientific long-term management mechanism and scheme of the river water ecology on the basis of the water ecological restoration engineering measures is formulated.

Engineering measures such as aquatic vegetation restoration, aquatic animal community adjustment and in-situ purification are implemented for the 16 rivers in Jiangyin to improve the composition of river ecosystem food chain and enhance the ecological self-purification capacity of the water body after the analysis of the characteristics of river water quality, water level, transparency, base and flow. At the same time, nano micro jet aeration and fountain aeration are used for reoxygenation aeration in some river sections, and high-efficiency purification bed and carbon fiber grass are used for in-situ purification.

3.3.5. Landscape Establishment

Urban waterfront space is an important link of the integration between water and city, and an important open space for residents' leisure and entertainment. With the development of social economy, people's requirements for a better life are gradually increasing, and the ecological, aesthetic and economic values of waterfront space are gradually emerging. The construction of the waterfront space as a compound space

integrating urban natural scenery belt, green ecological corridor and economic vitality area is becoming a trend of urban construction. Therefore, it is necessary that the waterfront landscape resources and historical and cultural resources in the urban area of Jiangyin are fully tapped. Based on the current situation and development strategy of the city, the influence and role of the unique geographical environment, ecosystem and human factors along the main rivers, this paper proposes to optimize the overall layout of waterfront space, focus on shaping the overall brand of "blessed land of mountains and waters and green capital in the south of the Yangtze River", optimize the water system context, and build a characteristic urban waterfront pattern of water city integration to make the water environment treatment better displayed to the public, and the hydrophilic landscape better serve the public.

3.3.6. Smart Management

Following the "Smart Jiangyin" development plan of Jiangyin, with the help of modern Internet information technology, the urban water information infrastructure of Jiangyin is built, as well as a monitoring, management and service intelligent system scheme covering the functions of three-dimensional monitoring of urban water environment, timely early warning, intelligent management and control, rapid response, convenient service and scientific decision-making to finally improve the technical guarantee and support of the comprehensive treatment system of urban water environment of Jiangyin.

The shore based automatic water quality monitoring station combined with mobile portable water quality monitoring equipment are used for water quality monitoring, and at the same time, the municipal power supply and 4G/5G wireless transmission are used. The combination of Doppler ultrasonic flowmeter, radar flowmeter and electromagnetic flowmeter is adopted in the water monitoring scheme, and municipal power supply and 4G/5G wireless transmission are used as the same time. The combination of spherical camera and AI intelligent camera is adopted in the video monitoring scheme with the municipal power supply and wired transmission at the same time.

4. Effectiveness Analysis of the Treatment

4.1. Analysis

Combining the parameters of drainage zone, land use characteristic and rainfall runoff in Jiangyin, the pollution loads into each river at the levels of 2021 and 2025 are predicted separately. With the parameters of river cross-section, hydrological water quality monitoring data and pollutant degradation coefficients and others, a one-dimensional river network water environment model of Jiangyin is constructed. The water quality conditions of each major river are calculated after the implementation of comprehensive urban management measures based on the model and the performance of the overall project is analyzed.

4.2. Construction of Water Environment Model

4.2.1. Model Selection

A technique method combining quantitative and qualitative methods is usually used in the systematic analysis of water body. Generally speaking, the theoretical analysis

method and analogy analysis method are both qualitative analysis method, while the material balance method, empirical relationship method, statistical analysis method, mathematical model method, etc. are taken as quantitative analysis method. For places with relatively sufficient basic data, a more standardized and accurate mathematical model can be used for the pollution load. But considering that we have Jiangyin's monthly water quality monitoring data for several recent years, some basic data of pollution sources are detailed and can be used for the calculation of the required hydrological data. Therefore in this paper, we use the mathematical model method to systematically analyze the improvement of water quality in Jiangyin. The one-dimensional unsteady water quality model is selected, and COD, ammonia nitrogen and total phosphorus are taken as the representative water quality indexes of the model.

4.2.2. River Network Generalization

The model is built by combining and generalizing the channels with smaller flows, and the longitudinal gradients of the channels are controlled by the elevation of the cross-sections, and a certain smoothing is done according to the model requirements. The major water transmission channels are included in the calculation when generalizing, and the minor channels and water bodies are combined into a single channel and node according to the principle of keeping the water transmission capacities and the storage capacities both remain unchanged. The Jiangyin urban area with 45 generalized rivers, 236 river sections and 3430 cross sections, 33 ship locks and water gates is taken as the calculation area. The structure of the river network model is shown in Figure 2.

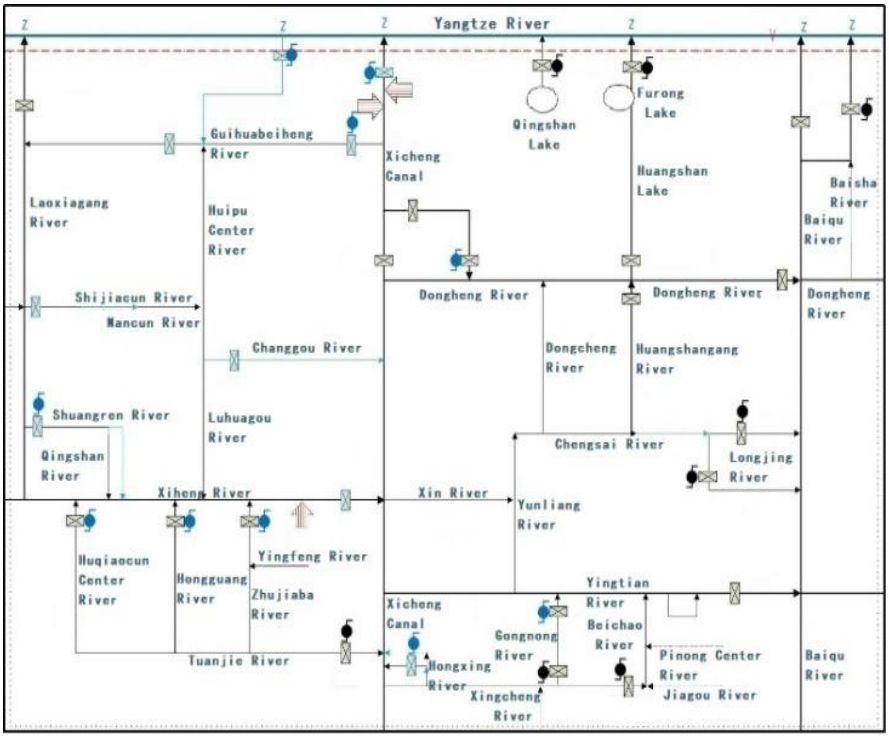

Figure 2. Overview of river network in Jiangyin urban area.

4.2.3. Parameter Selection

According to the characteristics of the main river bed in Jiangyin urban area and the hydraulics manual, the roughness is set to 0.025. The integrated degradation coefficient k is a comprehensive coefficient reflecting the pollution's changes in biodegradation, sedimentation and other physical and chemical changes, and also the pollution's changes itself as well as the pollution's changes from the environment, and it is related to the flow rate of the water body. According to the relevant research results on the decay law of pollutants in various water bodies in the river network area of Taihu Lake Basin, the COD attenuation coefficient value of 0.09-0.12 (1/d) is chosen. The attenuation coefficient of NH_3-N is set between 0.06-0.08 (1/d). And the attenuation coefficient of TP is set between 0.045-0.052 (1/d).

4.2.4. Calibration and Verification

The measured water quantity and water quality data in 2018 are used to calibrate and verify the model. According to the comparison results between the calculated and measured values of the major pollutants, the model can basically reflect the change process of river network water quality in Jiangyin urban area in 2018, providing a reference for the calculation and analysis of river network water quality in Jiangyin urban area.

4.3. Performance Analysis

4.3.1. Goal on Water Quality

The water quality goal of the 28 rivers in the central urban area of Jiangyin is surface water class III.

4.3.2. Evaluation Method

Based on the one-dimensional river network water environment model, we take the hydrological design conditions and the amount of pollutants entering the river in the planning year as the input conditions, and the effect of water quality improvement is predicted. The hydrological design conditions are the measured rainfall and tide level data in dry year 2013, normal year 2012 and rainy year 2018; and the pollution source data is the amount of pollutants entering the river in 2025. Within the evaluation month, if the compliance rate of each water quality index is greater than (including equal to) 80%, the river water quality is considered to be up to standard.

4.3.3. Water Quality Standard Analysis

On the basis of the prediction of pollution load in 2025, the one-dimensional river network water environment model is adopted to calculate and predict the water quality of each river channel based on the measured rainfall process in normal water year 2012, dry year 2013, rainy year 2018 and the pollution load in normal year 2025. The annual water quality compliance is shown in Table 1. According to the model and analysis, only the water quality of Laoshi Fish Port does not meet the standard, and the standard rate of water quality is 96.4%.

Table 1. The goal accessibilities of the water quality of 28 rivers and canals in Jiangyin until 2025.

No.	Water body	Water quality compliance rate of normal year			Water quality compliance rate of dry year			Water quality compliance rate of rainy year			Compliance or not
		COD	NH_3N	TP	COD	NH_3N	TP	COD	NH_3N	TP	
1	Changgou River	82.3	81.6	81.4	83.5	82.2	81.9	83.2	85.7	84.3	Yes
2	Puhui Center River	80.3	82.8	82.9	80.7	83.7	86.4	80.3	81.7	86.1	Yes
3	Nanxin River	84.4	82.3	87.5	87.9	80.4	85.2	88.1	80.1	84.2	Yes
4	Longjing River	96.4	96.4	96.2	98.9	98.9	98.6	98.4	98.6	97.8	Yes
5	Shuangren River	100	100	100	100	100	100	100	100	100	Yes
6	Zhujiaba River	100	100	100	100	100	100	100	100	100	Yes
7	Yingfeng River	100	100	100	100	100	99.2	99.5	99.2	98.9	Yes
8	Luhuagou River	85.2	83.2	81.9	85.4	80.6	82.2	85.1	83.0	80.5	Yes
9	Shijiacun River	82.0	80.9	84.1	85.9	80.5	83.5	85.2	80.2	83.8	Yes
10	Qingshan River	100	100	100	100	100	97.3	95.6	100	87.7	Yes
11	Luqiao Center River	100	100	100	100	97.5	100	100	100	100	Yes
12	Jiangfeng Center River	83	85	82	84	82	81	87	87	86	Yes
13	Chuangxin River	100	100	100	100	100	100	100	100	100	Yes
14	Huangshan River	100	100	100	100	100	100	100	100	100	Yes
15	Qinjing River	100	100	100	100	100	100	100	100	100	Yes
16	Dongheng River	100	100	100	100	100	100	100	100	100	Yes
17	Beichao River	100	100	100	100	100	100	100	100	100	Yes
18	Laoyingtian River	100	100	100	100	100	100	100	100	100	Yes
19	Beiheng River	95.6	95.9	100	96.7	96.7	100	90.7	90.9	100	Yes
20	Laoshi Fish Port	81	76	83	86	87	88	88	89	87	No
21	Dongcheng River	100	100	100	100	100	100	100	99.7	100	Yes
22	Chengsai River	100	100	100	100	100	100	100	100	100	Yes
23	Dongfeng River	100	100	100	100	100	100	100	100	100	Yes
24	Dongzhuan River	100	100	100	100	100	100	100	100	100	Yes
25	Yunliang River	100	100	100	100	100	100	100	100	100	Yes
26	Hongxing River	100	100	100	100	100	100	100	100	100	Yes
27	Xiejing River	84	82	86	88	89	88	100	99	96	Yes
28	Laoying Creek	80	81	85	87	88	87	92	91	88	Yes

5. Conclusions

This paper proposes a study on improving the water quality in Jiangyin central urban area by discussing the ideas and strategies of comprehensive treatment of river and lake water environment in plain river network area, which provides a reference for other plain river network basins and urban water environment treatment. Conclusions are followed:

There are two reasons for the widespread water environment problems in cities in plain river network areas: firstly, the plain river network area is low and flat, with intertwined rivers and lakes, and the gentle slopes coupled with the downstream tidal backwater effect, result in poor water flow, weak hydrodynamics, and limited environmental capacity; secondly, in recent years, with the rapid development of urbanization in plain river network areas, the industry and population density increases, the pollutant emissions sharply increase; more seriously, the dense control buildings such as sluice pumps separate rivers and lakes, resulting in the further weakening of hydrodynamic force, the reduction of environmental capacity and the deterioration of water ecological environment.

Due to the complex causes of the pollution, the water environment treatment in plain river network areas should be carried out synchronously or step by step according to the idea of "systematic implementation of policies and comprehensive treatment", so as to comprehensively improve the quality of water ecological environment; smart management technologies are adopted to ensure the long-term improvement of water ecological environment; Combined with the positioning of urban development, the water landscape in key sections truly achieve the governance goal of "smooth river, clear water, green bank and beautiful scenery".

References

[1] Zhang J. Improvement and application of urban water environment in plain river network areas. Academician Forum of Shanghai Chengtou Research Institute. July 3rd 2019. (in Chinese)
[2] Wang H, Shen Z, Zeng, et al., Connection between anthropogenic water diversion and hydrodynamic condition in Plain River Y network. Water. 2022;13(24).
[3] Cai B, Meng C, Wang X, et al. Application of a fuzzy two-stage chance constrained stochastic programming model for optimization of the ecological services value of the interconnected river system network project in the western Jilin province, China. Water. 2019;11(1).
[4] Montalvo-Cedillo C, Jerves-Cobo R, Dominguez-Granda L. Determination of pollution loads in spillways of the combined sewage network of the City of Cuenca, Ecuador. Water. 2020;12(9).
[5] Stanko S. Reconstruction and rehabilitation of sewer systems in Slovakia. Damgerous Pollutants in Urban Water Cycle. 2008: 61-70
[6] Jaskuła J, Sojka M, Fiedler M, et al. Analysis of spatial variability of river bottom sediment pollution with heavy metals and assessment of potential ecological hazard for the Warta River, Poland. Minerals. 2021;11(3): 327-327.
[7] Zhang S, Tian K, Jiang S, et al. Preventing the release of Cu2+ and 4-CP from contaminated sediments by employing a biochar capping treatment. Industrial and Engineering Chemistry Research. 2017;56(27): 7730-7738.
[8] Bhattacharya T, Chakraborty S. Eco-Restoration potential of vegetation for contaminated water bodies, Phytomanagement of Polluted Sites: Market Opportunities in Sustainable Phytoremediation. 2019: 425-446.
[9] Koenig F, Nafikova E, Lehmann B, et al. River restoration in Moscow – Experiences. Wasserwirtschaft. 2011;101(4): 26-32.
[10] Xu G, He B, Li F. History and experience of Danube River treatment. Foreign Theoretical Trends. 2016(12):123-128. (in Chinese)
[11] Guan F, Zhang C, Bao J, et al. Dredging sludge treatment model of Seine River in France and its reference to China. Proceedings of 2014 Academic Annual Meeting of China Hydraulic Society (Volume II). 2014:387-393. (in Chinese)
[12] Wang S, Zhang T, Gao Y, et al. Comprehensive management of the Rhine River Basin and its experiences. Resources and Environment in the Yangtze Basin. 2018;27(01):215-224. (in Chinese)
[13] Cheng F. Study on ecological restoration of Qingxichuan in South Korea and its enlightenment. Water Resources Planning and Design. 2022(03):67-70. (in Chinese)
[14] Tang Y, Chen W. Discussion on the application of water environment treatment and three-water separation project in Shenzhen, Pearl River. 2022;43(03):37-44. (in Chinese)

[15] Tang Y, Guo Z. Green water and green mountains are the overall and systematic management of Jinshan Yinshan Basin -- The four step-by-step treatment of the comprehensive improvement project of water environment in Maozhou River Basin. Construction Enterprise Management. 2022(03):110-114. (in Chinese)
[16] Zhao Y. General idea and measures for comprehensive management of river water environment in small watershed of Fuxin city. Ground Water. 2022;44(01):254-255. (in Chinese)
[17] Xu W, Guo Z, Zhou X. Study on water environment treatment and pollution control of Shima River Basin in Dongguan City. Zhong Guo Gao Xin Ke Ji. 2021(23):127-128. (in Chinese)
[18] Ma F, Chen Y, Jiang S. Thoughts on coordinated management of water ecological environment in Yangtze River Delta region. Yangtze River. 2022;53(02):48-53. (in Chinese)