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Application Research of Logistics-Optimization MIKE Model in Urban Water Pollution Control and Management

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Abstract: With the continuous utilization and development of water resources, the problem of water pollution has become increasingly serious, and the ecological environment of river water has been gradually destroyed. Therefore, the control and protection of water pollution has gradually become the research focus of various research institutions. The study of the water environmental capacity of water bodies is of great significance for the prevention and control of water pollution. MIKEll, MIKE sHE and EC0 Lab were used to construct the coupling model of watershed hydrology, hydrodynamics, and water quality, to explore the migration and transformation of pollutants, and to further evaluate the effectiveness of river water quality improvement under different control measures. The research shows that the coupling model has good adaptability in the study area, the accuracy of hydrodynamic simulation is good, and the PBIAs of water quality simulation are all less than 40%. It is an improvement to reduce point source pollution of human rivers by improving the treatment rate of residents' domestic sewage and intercepting sewage at outlets. The key to the water quality of assessment sections, under the total control measures, 3 assessment sections c0D. NH, a N and TP annual average concentrations were reduced by 6.9l ~ 22.82, O. 66~2.70, O. 09—0.30 mg·L~, the decline rate is obvious, and gradually meet the water quality assessment standard of class V, and finally reach the level of class III~IV.

Keywords: Logistics-Optimization ; MIKE Model; Urban Water Pollution; Control and Management

1. INTRODUCTION

The Shending River Basin is in the central and western part of Shiyan City, Hubei Province, and its downstream directly flows into the Danjiangkou Reservoir, which bears an important responsibility for water environment security. The comprehensive simulation of water quantity and quality based on the hydrology and drainage system of the basin is an important measure to ensure the water quality of the section and the verification of pollutant reduction targets. Due to the special terrain and complex river network density in the Shending River Basin, the traditional section-by-section test algorithm has been difficult to meet the actual needs of the project in terms of comprehensiveness, accuracy, and rationality of calculation , so it needs to be combined with professional software simulation, actual investigation, etc. A variety of methods are used to calculate the quantity and quality of river water. Gu Juerong (2002) used MIKEll to establish a numerical model of the Shanghai plain river network, which is used for water quantity regulation and non-point source pollution analysis of the water system. Ma Qiang et al. (2011) used the EcOLab module to simulate the water quality of the Liangtan River Basin.

The spatio-temporal process of river water quality was analyzed. And the improvement effect of water body under different working conditions was simulated. Zheng et al. (2014) coupled surface water and groundwater to explore the hydrological response of the basin and proposed the feasibility of applying MIKEsHE and MIKEll to simulate the process of water quality change in the basin. Another foreign scholar used MIKESHE to simulate the process of leaching and loss of nitrate nitrogen in the agricultural monitoring area to achieve the purpose of reducing the nitrate load in the agricultural area. Up to now, the research and development of water quality models in various countries in the world have tended to be perfect, and the construction methods have also diversified, and the main application directions have their own characteristics, such as multi-media box models, aquatic food chain accumulation, fugacity models, etc.

The water quality model has been developed to the present. Compared with the previous ones, the biggest feature is that most of the models currently used are optimized and improved based on the original water quality model, mainly for the scope of application of the model. Adaptive water quality model. Qian Haiping (2013) used MIKE11 to establish a hydrodynamic and water quality model of the tidal river network in the plain of Pinghu City, and calculated the pollution load that should be reduced to achieve the goal of water quality improvement. Yu Xiao et al. (2011) used the MIKE11 model to simulate the maximum submerged area of the Ergun River flood, which provided a scientific basis for flood control on both sides of the river. The above studies mainly provide scientific basis for water dispatching, flood control and load reduction by simulating river hydrology and water quality. Relying on the simulation prediction of the model, there are few reports on the auxiliary decision-making function of comprehensive river management projects.

According to the water quality monitoring data of 11 sections of the three main tributaries of the basin in 2018: the water quality of the main streams of Nansha River, Beisha River and Dongsha River is generally between Class III and inferior V, and the main pollutant exceeding the standard factor is CODmNH, N and TP. Among them, the water quality

compliance rate of Dongsha River Sluice, Beisha River Chaozong Bridge and Nansha River Yuhe Rubber Dam (the assessment standard is V category) is only 4% in non-flood season and 26% in flood season, which is far from meeting the assessment requirements. The sources of pollution in the watershed mainly include unconventional water source replenishment, direct discharge and overflow discharge, domestic pollution of urban and rural residents, and agricultural non-point sources. The MIKE model is a model developed by the Danish Institute for Water Resources and the Environment (DHI). DHI's professional software has achieved good simulation results in many practical engineering applications. The functions of the software cover a wide range, including MIKE11 for one-dimensional river networks, MIKE21 for two-dimensional estuaries and surface water bodies, MIKE3 for three-dimensional deep sea, MIKEBASIN for water resource assessment and management, etc.

2. THE PROPOSED METHODOLOGY

2.1 Water Quality Modeling Based on MIKE11

Point source pollution such as direct discharge along main and tributary streams, overflow discharge outlets and residential discharges are relatively prominent. The MIKE11 model is suitable for professional engineering software for estuaries, rivers, irrigation channels and other water bodies to simulate one-dimensional hydrodynamics, water quality and sediment transport, including hydrodynamic module (HD), hydraulic structure module (SO), dam failure module (DB), rainfall-runoff module (RR), convection-diffusion module (AD), water quality ecology module (ECOLab), non-cohesive sediment transport module (ST) and flood forecast module (FF)/data assimilation module (DA) module. In this study, the hydrodynamic and convective-diffusion models of MIKE11 were used, combined with the rainfall-runoff model, to establish a water quality model for the Wohe section of the "Diverting the Yangtze River to the Huaihe River" project. To effectively control the pollution of the water body, the water environmental capacity of the water body must be effectively utilized to protect the self-purification ability of the water body from damage. And this requires finding out the migration and transformation rules of pollutants in different water bodies, to calculate the water environmental capacity of water bodies. The core of water environmental capacity estimation is to use numerical simulation methods to analyze the water volume and water quality changes of water bodies, and to establish suitable hydrodynamic and water quality models, to accurately simulate and predict changes in water volume and water quality.

A comprehensive understanding of the water environment of the water body and a thorough eradication of water pollution will inevitably bring about a huge workload. The water quality model is mainly used to numerically simulate the migration and transformation of pollutants in the water body. By establishing the water quality model of the regional water body, the water environment status of the regional water body can be grasped macroscopically, to propose a reasonable regional water environment treatment plan and Environmental engineering measures.

The modeling data in this study include watershed DEM, rainfall evaporation, river network sections, water T buildings, point and non-point source pollution, and cross-section measured water quantity and quality data. Among them, the basic data such as hydrology come from the Beijing Water Affairs Bureau and its subordinate hydrological stations, and the water quality and pollution data come from the actual measurement in 2018 and the statistical yearbook of water affairs in Beijing, Haidian, and Changping districts. By simulating the cleaning and sewage mixing flow ratio of 15 branch ditches, the variation range of the cleaning and sewage mixing flow ratio in the sewage pipes in sunny days is basically consistent with the survey value, and the actual survey values of 10 branch ditches are all within the simulated value range. The actual investigation values of 3 tributaries were higher than the simulated maximum value, and the actual survey values of 2 tributaries were lower than the simulated minimum value. The measured results are in good agreement with the overall simulation results.

2.2 Urban Water Pollution Solution Based on MIKE11 Water Quality Modeling

Mixed flow ratio of cleaning and sewage the higher the mixed flow ratio, the higher the proportion of clean water in the pipeline, and the water flow load of the pipeline network and the treatment load of the downstream sewage treatment plant will also increase accordingly. Accurate simulation of clean-sewage mixed-flow ratio can predict the clean water content in the pipeline, thereby providing data support for the water quality control plan of the basin. Through measures such as expanding the capacity of the sewage treatment plant, improving the sewage treatment capacity during the rainy period, and optimizing the sewage dispatching during the rainy period, the initial stage of the pipeline network can be increased. Rainwater collection and treatment rate. To improve the accuracy of river channel hydraulic calculation, the NAM module is divided into several regions according to the topography to simulate the rainfall and runoff process. Since the time of confluence in different regions is different, and this paper mainly collects data from three rainfall stations (Dasi Gate, Guoyang Gate, and Mengcheng Gate) and two evaporation stations (Dasi Gate and Mengcheng Gate), therefore, each the region uses the daily rainfall and evaporation of the nearest rainfall station within or around the subregion to calculate the daily average rainfall and evaporation of the subregion.

According to the environmental statistical data of Anhui Province in 2013 and other supplementary data, the non-point source COD and ammonia nitrogen that flowed into the river section of the study area with the surface runoff in 2013 were 4146.2 and 417.9 tons, respectively, including rural domestic pollution and agricultural non-point sources. pollution, urban runoff pollution, etc. The model is set according to distributed pollution sources with the daily average values of flow and pollutant concentration. There are 13 generalized point source sewage outlets along the line, among which, 10.002 million tons of direct sewage from industrial enterprises, 1022.9 tons of COD, and 258.4 tons of ammonia nitrogen, 44.79 million tons of direct sewage from urban life, 2136.8 tons of COD, and 213 tons of ammonia nitrogen. .7t, 31.535 million tons of sewage, 957.0t of COD, and 97.2t of ammonia nitrogen discharged from the outfalls of five sewage plants. The grid is divided into 30m×30m.

The rainfall data of 9 rainfall stations in 2018 are used, and the Thiessen polygon is used to divide the control area. Evapotranspiration refers to the monthly average crop reference evapotranspiration distribution map in Beijing calculated by Duan Yonghong et al. (2004) based on the Penman-Monteith formula. The annual reference evapotranspiration of the watershed is 1184.50 mm through ArcGIs vector interpolation. Leaf area index refers to the

research results of monthly variation and spatial distribution characteristics of vegetation LAI in Beijing (Xie Junfei et al., 2014).

Slope Manning Coefficient refers to the recommended value of different land uses by Engman (1986) and the research results of flood control effect evaluation of water and soil conservation measures in Zhaojiatai small watershed. Satisfies the target water quality Mingyang Community to Kangning Estuary. Class V, Kangning Estuary to Ruyujiang Estuary. IV The predicted concentration of COD in the Liangqing River is between 40 and 60 mg/l, which does not meet the requirements of the target water quality category IV; the predicted concentration of COD in the Bachi River is between 15 and 20 mg/l, which meets the target water quality of Fengting From the dam site of the Nayue River Reservoir to the mouth of the Nayue River, and from the mouth of the Nayue River to the mouth of the Bachi River, the requirements of the Class IV; the predicted concentration of COD in the Pinghua River, the left tributary of the Bachi River, is between 20 and 30 mg/l, which meets the requirements of the target water quality of the IV class. Requirements: the predicted concentration of COD in the Natan River, the right tributary of the Bachi River, is between 40 and 60 mg/l, which does not meet the requirements of the target water quality category V.

3. CONCLUSION

The MIKE11 model was used to build a model that can objectively reflect the temporal and spatial distribution of COD and ammonia nitrogen concentrations in the Guohe River of the "Diverting the Yangtze River to the Huaihe River" project, and the model was calibrated by the measured values of hydrology and water quality. The Re, R2 and Ens of the water depth are 3.30%, 0.990 and 0.984 respectively, the Re, R2 and Ens of the flow rate are 9.8%, 0.969 and 0.997 respectively, and the error of the COD simulation value is 14 .2%, and the error of the simulated value of ammonia nitrogen is 16.1%, which shows that the simulation accuracy of the model is high, and it can reasonably describe the control effectiveness of different treatment measures for influent water pollution sources. The water quality model of Nanning City was established by using Mikell hydrodynamic module and AD module, and the model was calibrated and verified at the same time. After comparing and analyzing the simulated value and the measured value, it can be found that the simulated value and the measured value fit well, and the model can basically reflect the water quality change law of the Yongjiang River and inland rivers. It can be used for subsequent calculation of water environment capacity and verification of scenario models.

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