Available online at www.sciencedirect.com
SCIENCE DIRECT
Journal of Hydrodynamics
Ser.B, 2006,18(3): 253-261
sdlj.chinajournal.net.cn

WATER QUALITY MODELING AND POLLUTION CONTROL FOR THE EASTERN ROUTE OF SOUTH TO NORTH WATER TRANSFER PROJECT IN CHINA*

WANG Chao, WANG Yan-ying,WANG Pei-fang
Key Laboratory of Integrated Regulation and Resource Development on Shallow Lakes, College of Environmental Science and Engineering, Hohai University, Nanjing 210098, China,
E-mail: cwang@mailsvr.hhu.edu.cn

(Received Oct. 14, 2005)

ABSTRACT: South to North Water Transfer Project in China is the largest project over centuries to solve the water shortage problem in vast areas of northern China. It comprises of three routes: the eastern, central and western route and this study mainly focused on the eastern route. As water quality is the key factor for the eastern route, this paper examined the main factors influencing water quality of the main route south of the Yellow River, by investigating the point source, non-point source (diffusive source) and internal source pollutions along the main eastern route and in its drainage basins, and assessing the current water quality in the waterways. According to the complicated and combined systems of rivers and lakes in this route, one-dimensional water quantity and quality model for rivers and two-dimensional model for lakes were developed to simulate the hydrodynamic and pollutant transport processes. The numerical method and model algorithm were described. The values of model parameters were estimated by using field-monitoring data along the main route and the inverse modeling technique. Established models were employed to predict the degradations of COD_{Mn} and NH_4^+-N in the main stream, under the conditions of current pollution loads and different hydrologic conditions. Schemes were present for controlling total quantities of pollutants from point source and non-point source along the main route to secure water quality for the eastern route.

KEY WORDS: South to North Water Transfer, Eastern Route Project, water quality, pollution loads, pollution control

1. INTRODUCTION

South to North Water Transfer Project in China is designed to solve water shortage problem and support sustainable social and economic development in northern China. Eastern Route Project (ERP) is one of the three components of the water transfer project. Pumping water from the Yangtze River in Yangzhou, Jiangsu Province, ERP utilizes the Grand Canal and its parallel rivers to transfer water from south to north. It also employs Hongze Lake, Huoma Lake, Nansi Lake and Dongping Lake for flood regulation. There are two water transfer ways after Dongping Lake. One way is northward: water goes through the Yellow River in tunnels near Weishan Hill, enters Nan Canal and finally flows to Tianjing City. The total length of this route is 1156 km, of which 646 km are south of Yellow River, 17 km through the Yellow River and 493 km north of Yellow River. The other way is eastward: water is transferred to Yantai City and Weihai City through 704 km long rivers in the Jiaodong area. Thirteen levels of pumping stations are set from Yangtze River to Dongping Lake with a total delivery head of 65 m. The main route for ERP is shown in Fig. 1.

The design flow rate for ERP is 600 m^3/s. As South to North Water Transfer Project spans 23 municipalities and 105 counties, it is excessive of the total quantity of pollutants from point sources in these areas, the non-point sources in the basins, and the internal sources from watercrafts, resulting in very

* Project supported by the National Basic Research Program of China (Grant No: 2002CB412303) and the National Natrual Science Foundation of China (Grant No: 50379012).
Biography: WANG Chao (1958-), Male, Ph.D., Professor

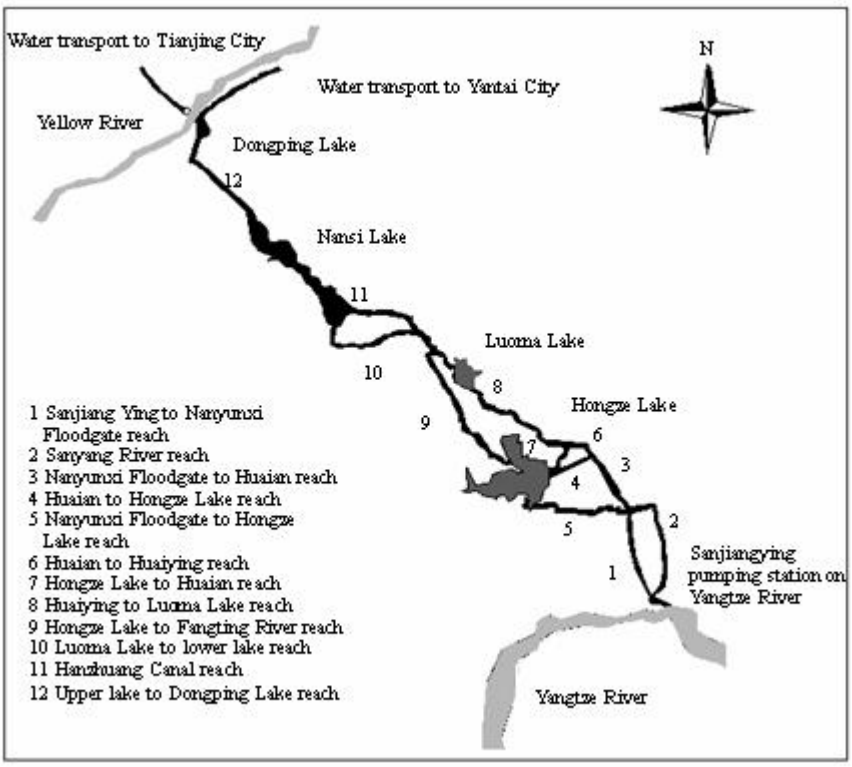

Fig. 1 The main route for water transfer in ERP

bad water quality in main rivers. So water pollution control is vital for the success of the ERP. According to investigations and analysis on pollution loads of the main waterways for water transfer, one-dimensional and two-dimensional water quantity and quality models were developed to simulate water quality in ERP. And the allowable quantities of pollutants discharged into the rivers were analyzed and calculated based on water quality targets designed for water transfer. Then pollution control and pollutant abatement scheme were established along the main route. These results provided scientific support for pollution control and water environment protection in ERP.

2. THE POLLUTION LOADS ALONG THE MAIN ROUTE OF WATER TRANSFER

According to the characteristics of their spacial distribution, the pollution sources are classified as point sources, non-point sources and internal sources discharged into rivers and lakes in ERP [1, 2]. Point pollution sources mainly include industrial and domestic wastewater from urban areas. Non-point pollution sources comprise of the pollutants from surface runoff from agriculture lands, town lands, woodlands, meadows and so on. Internal sources are commonly caused by shipping and released from riverbed mud and so on.

The pollution loads of urban point sources, non-point sources, and shipping internal sources discharged into the main route in ERP were assessed by corresponding methods, of which non-point sources assessment referred to Jeffrey [3]. It indicates that the amount of COD from urban point sources is about 78.5% of the total COD. So point sources are overwhelmingly and should be the priority for control and abatement. Non-point pollution sources should also be paid adequate attention, because the NH_4^+-N from these sources accounts for 34.5% of the total NH_4^+-N, and for COD, it accounts for 20.9%.

3. MODELS OF WATER QUANTITY AND QUALITY SIMULATION

3.1 *Mathematical formulation for calculating water quantity and quality in rivers*

Flow dynamics and changes of the chemical composition of water in rivers and their tributaries can be adequately described by a system of nonlinear partial differential equations as listed below [4, 5].

$$B\frac{\partial h}{\partial t}+\frac{\partial Q}{\partial s}=d \tag{1}$$