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POLLUTION TREND IN THE TUMEN RIVER AND ITS INFLUENCE ON REGIONAL DEVELOPMENT

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ABSTRACT: The Tumen River had failed to meet Grade Ⅲ and Ⅳ levels in the environmental quality standard for surface water, and had exceeded Grade Ⅴ level. Surface water pollution is serious. The major excessive standard pollutants were COD_{Mn} and SS. After taking effective treatment steps, the worsening trend of water pollution will be basically under control. But the change of runoff in the Tumen River is large in a year, especially during as long as five-month freezing period, smaller flow and lower temperature of river waters led to weak dilution and self-purification capacity. The water quality of the Tumen River will not reach the appoint functional water quality standards, even if sewage meets discharge standard, which will influence water resources utilization in the lower reaches of the Tumen River and regional economic development. Therefore water pollution has become the major restrictive factor of the development of the Tumen River area.

KEY WORDS: water pollution, environmental capacity, permissible amount of wastewater discharge, the Tumen River

1 INTRODUCTION

Severe water pollution and water resources shortages have become two key obstructions to realize sustainable utilization of water resources in China(SPC *et al.*, 1994). The Tumen River area will be an interested region in Northeast Asia economy development in the 21st century. According to the water quality monitoring data, environmental capacity of water, and allowable quantity of wastewater discharge, this paper analyses the restrictive influence of water pollution on regional development. The measurement and suggestions for prevention and control are proposed.

2 THE HYDROGRAPHICAL CHARACTERISTICS OF THE TUMEN RIVER

The Tumen River is a border river of China and the Democratic People's Republic of Korea(DPRK). It originates in the east slope of the main peak of the Changbai Mountain and flows into the Sea of Japan. The whole river is 505.4 km long, the total drainage area is 33 168 km^2, the first tributaries in China side are mainly the Gaya River and the Hunchun River. The mean annual flow is 215 m^3/s in Quanhe Hydrographic Station in the lower reaches of the Tumen River, which belongs to a large river with flow above 150 m^3/s, and there is a great dilution capacity to pollutants in the water. The river freezes at the end of November and thaws at the beginning of April, with a five-month freezing period. The monthly river flow and its percentage in a year in Quanhe Hydrographic Station is shown in Fig. 1(He *et al.*, 1997). It shows that the runoff of five months from November to March next year is only 9.1% of a year, but that of July and August is 38.2%. The seasonal change of runoff is large. As river flow is a main

factor to influence environmental capacity of water, and monthly flow of the Tumen River is greatly different, the distribution of monthly environmental capacity is very uneven. That will influence and restrict the amount of wastewater discharge.

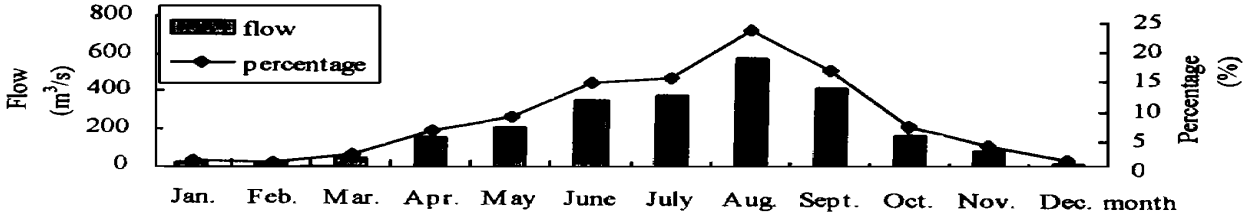

Fig. 1 Distribution of monthly river flow and its percentage in Quanhe Hydrographical Station

3 PRESENT WATER QUALITY AND POLLUTION TREND OF THE TUMEN RIVER

There are not pollution sources in the upper reaches of about 115 km from the riverhead of the Tumen River to Nanping. The water quality is good. Tailing sand within wastewater discharged from Maoshan iron-mine of DPRK has severely polluted the river water of the middle and lower reaches of about 400 km of the Tumen River. SS concentration in the river is very high and the river is in turbid state. The river section from Nanping to Kaishantun is about 172 km long. The sewage, especially papermaking and sugar-refining wastewater from Huining City of DPRK discharges into the Tumen River, so that the water is polluted by organic compounds. Wastewater pollution sources in the river section below Kaishantun come from China. Sewage from Kaishantun Town and Tumen City discharges directly into the Tumen River. Sewage from Yanji City, Longjing City, Shixian Town and Hunchun City discharges into the Tumen River through the Burhatong River, the Hailan River, the Gaya River and the Hunchun River respectively. Main pollutants in the sewage are COD and SS(Zhu *et al.*, 1996).

In recent eight years(1988–1995), the change of industrial wastewater discharge and discharge of COD in industrial wastewater in the Tumen River area in China is shown in Fig. 2. It shows that industrial wastewater discharge reduced 34% in the eight years. Discharge of COD decreased gradually from 1988 to 1992 and increased from 1992 to 1995, the discharge of COD reduced by 15% in the eight years.

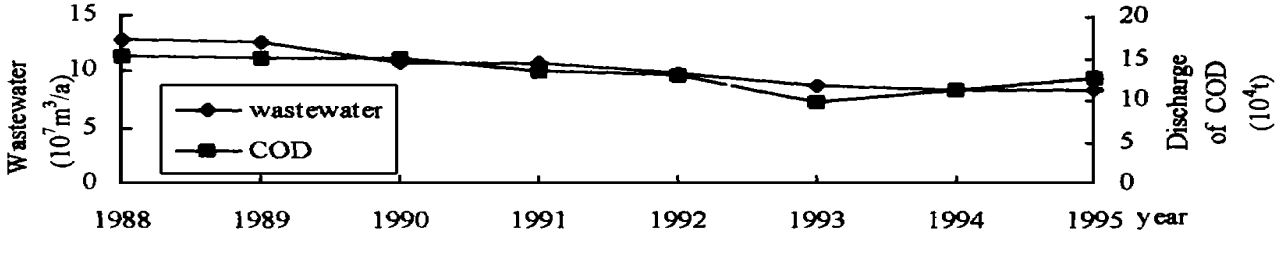

Fig. 2 The change of industrial wastewater discharge and discharge of COD in Tumen River area

The change of mean annual concentrations of permanganate demand (COD_{Mn}) and SS in Quanhe section of the lower reaches of the Tumen River in recent eight years (1988–1995) is shown in Fig. 3. The concentrations of COD_{Mn} exceeded 6 mg/L, based on the Grade Ⅲ level in environmental quality

standard for surface water (GB3838- 88), exceeding 1.78- 4.50 times. The concentrations of SS exceeded 150 mg/L of environmental quality standard (expect 1990 and 1992), the maximum exceeding 1.33 times. In addition, The concentrations of COD_{Mn} also exceeded Grade Ⅴ levels of 10 mg/L. Surface water pollution was serious. The main reason is that industrial wastewater and domestic sewage discharged into the Tumen River basin were not treated effectively, which exceeded discharge standard. Main industrial wastewater pollution sources were Maoshan Iron-mine of DPRK, Kaishantun Chemical Fibers Plant and Shixian Papermaking Plant of China.

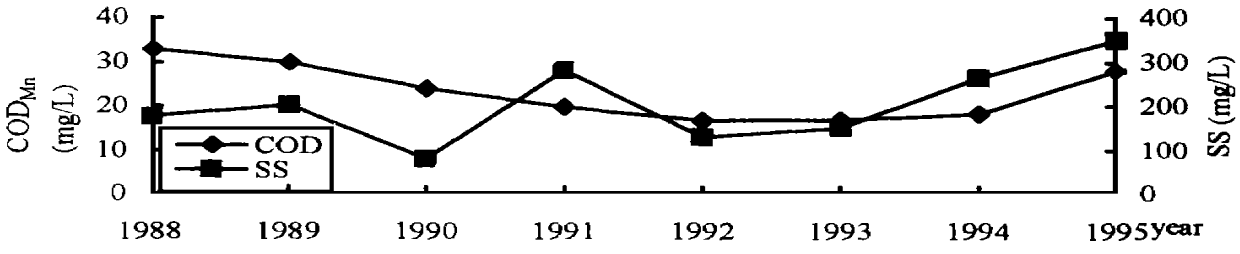

Fig. 3 The change of mean annual concentration of COD_{Mn} and SS in Quanhe section

There is a great dilution and self-purification capacity to organic pollutants in the Tumen River, but the main factor, the seasonal change of river flow greatly influences the environmental capacity of water, so that there is a great difference in monthly environmental capacity, especially during the five-month freezing period, smaller flow and lower temperature of the river water led to weak dilution and self-purification capacity, the environmental capacity was less than 10% of the year. Environmental capacity of usable COD (W) and permissible discharge amount (Q_P) of sewage which reaches discharge standard discharge concentration of COD (paper making wastewater is 350 mg/L and that in other wastewater is 150 mg/L) in cities and towns in China both in freezing and non-freezing periods are showed in Table 1(Tian *et al.*, 1998). In Table 1, q stands for sewage discharge in 1995.

Table 1 Environmental capacity of usable COD and permissible amount of wastewater discharge of cities and towns in China

Cities and towns	Freezing period		Non-freezing period		q
	W(t/d)	Q_p(10^4 m^3/d)	W(t/d)	Q_p(10^4 m^3/d)	(10^4 m^3/d)
Kaishantun Town	5.84	1.8	38.48	11.6	9.96
Tumen proper	17.75	13.5	85.86	71.0	2.25
Hunchun proper	6.04	4.5	35.72	26.4	5.19
Jingxin area	4.94	3.7	15.30	11.3	0
Shixian Town	1.48	0.5	15.05	4.5	8.23
Yanji proper	1.95	1.6	30.71	24.3	5.66
Longjing proper	0.80	0.6	5.38	4.9	3.88
Total	38.80	26.2	226.5	154.0	35.88

The results in Table 1 show that sewage discharge amount in 1995 exceeded permissible amount of wastewater discharge in freezing period. Water quality of the Tumen River didn't reach the prescript

functional water quality standards even if sewage met discharge standard, so there was not environmental capacity to use in freezing period. However industrial wastewater and domestic sewage discharges will obviously increase with the development and construction in the Tumen River area. Although the worsening trend of surface water pollution will be basically under control after taking effective treatment steps, if sewage discharge exceeds 154×10^4 m^3/d, not only water pollution in freezing period will be aggravated, but also the river will not meet standards in non-freezing period.

4 RESTRICTION OF WATER POLLUTION ON REGIONAL DEVELOPMENT

4.1 Influencing on Utilization of Water Resources in the Lower Reaches

Jingxin area will be one of the main areas in the regional development. But the water quality of the Tumen River didn't meet Grade Ⅲ level in "Environmental Quality Standard for Surface Water" GB3838-88 and "Water Quality for Scenery and Recreation Area" GB12941-91, the concentration of SS in the river exceeded the standard values in "Standards for Irrigation Water Quality" GB5084-94, the Tumen River could not be taken as drinking water source, natural bathing field, general scenery water body and recreation water, irrigation water of Jingxin area. Therefore, the water quality pollution of the river influence water resources utilization of this area.

4.2 Restricting Regional Economic Development

Based on the Trans-Century Green Project Plan of Jilin Province, the water quality of the Tumen River will meet functional standards by the year 2010. According to environmental capacity of water, in order to realize the goal, it is necessary to discharge sewage which reach discharge standards, and control the sewage discharge amount. As the wastewater discharge in 1995 in the Tumen River basin(not including North Korea) exceeded the permissible amount of wastewater discharge in freezing period, the sewage discharge is not increased, and the sewage in 1995 should be reduced by 27%, that is, 9.68×10^4 m^3/d. The sewage discharge in non-freezing period should be controlled to a level of 154×10^4 m^3/d. In addition, as the water quality of the upper and middle reaches of the Tumen River has exceeded the standards, in principle, wastewater from Jingxin area in the lower reaches of the Tumen River can't discharge sewage into the Tumen River. Therefore the water quality pollution of the river and small environmental capacity of water in freezing period have restricted regional economic development.

5 MEASUREMENT AND SUGGESTIONS FOR PREVENTING AND CONTROLLING POLLUTION

In order to promote the coordinated development of environment and economy, the measurements and suggestions for preventing and controlling pollution are proposed as follows.

1) To raise technical starting point of construction projects, to adopt clean production techniques, so as to make pollutants amount minimum.

2) The treatment of industrial wastewater pollution sources should be accelerated, meet discharge standards. The municipal sewage disposal ponds must be constructed in the main cities.

3) As environmental capacity of the river is smaller in freezing period, wastewater discharge and river runoff should be coordinated, in order to reduce wastewater discharge and increase flow and environmental capacity in freezing period. Specific steps are as follows: part effluent of sewage disposal ponds should be completely treated and recycled; the oxidation pond should be built with fully utilizing physical condition, so that part of sewage can be stored in the pond in winter and discharge in spring; reservoirs should be built in Kaishantun of the Tumen River and Laolongkou of the Hunchun River, so as to control and store flood, increase flow in freezing period.

4) The dilution and self-purification capacity to pollutants of the sea is far bigger than that of the river. If sewage discharge obviously increases with regional development at a high speed, in order to protect water quality of the Tumen River and the Hunchun River from pollution, and protect the function of waters from damage, it is the suggested that sewage from Hunchun City and Jingxin area discharge into the Sea of Japan through pipes or open channels.

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