Journal of Environmental Sciences Vol. 7, No. 3, pp. 317－324, 1995 ISSN 1001－0742

Eco - environmental problems and protection in Tumen River development

Ye Changming, Yan Hai, Ding Mei

Research Center for Eco - Environmental Sciences, Chinese Academy of Sciences, Beijing 100085, China

Abstract—The eco - environmental problems and protection in Tumen River development were studied. The background of the catchment which is at the juncture of China, Korea and Russia was described. The eco - environmental characteristics and major problems, and regional eco - environment impact and tendency were analyzed. Eco - environment of Tumen River catchment was divided into four function and protection zones.

Keywords: regional ecology; ecological division; Tumen River; China.

1 Introduction

Experiences of industrialized countries development have shown that economic development has brought unprecedented material wealth to the society, but the ecologic balance and human living environment have been seriously damaged with the process in exploiting natural resources blindly and developing economy without environmental protection measures. At the present time, we have to face a serious eco - environmental crisis which has become an important restricting factor of curbing further development of the economy. Since 1980s, many countries in the world have paid great attention to solve eco - environmental problems, and have invested heavily in the environmental protection including environmental assessment, planning, pollution control, vegetation recovery, water and soil conservation, desert control and rebuilding of ecology and environment. In developing countries, while economy, eco - environmental planning and pollution prevention is being developed, the inadvisable policy of pollution first and treatment afterwards in developed countries should be avoided.

On the basis of available basic data of social, economic, ecological and environmental pollution situation of Tumen River catchment, the literal description, diagram illustration and model computation are used to analyze the ecological and environmental characteristics and existing main problems, and to predict impact on eco - environment. The purpose is to improve the operability of the research results in this study.

2 Background of the catchment

Tumen River is at the bordering area of China, Korea and Russia, running through Helong, Yanji and Huichun cities of Yanbian Korean Autonomous Prefecture. It has a length of 490.4

km and a catchment area of 33168.4 km^2, and blows into the Japanese Sea finally (Fig. 1). The catchment lies in mesotherm humid and semi-humid climate zone, and has a temperate and rainy summer, a pleasant cool autumn, but a long and cold winter, with a yearly average temperature of 2—5°C, and a forstless season of 80—150 days. The region has abundant natural resources, nice and fine environment and perfect ecology, and has a very important strategic situation for development of Northeast Asia area. In this study we pay attention only to Yabian region of the Tumen River catchment.

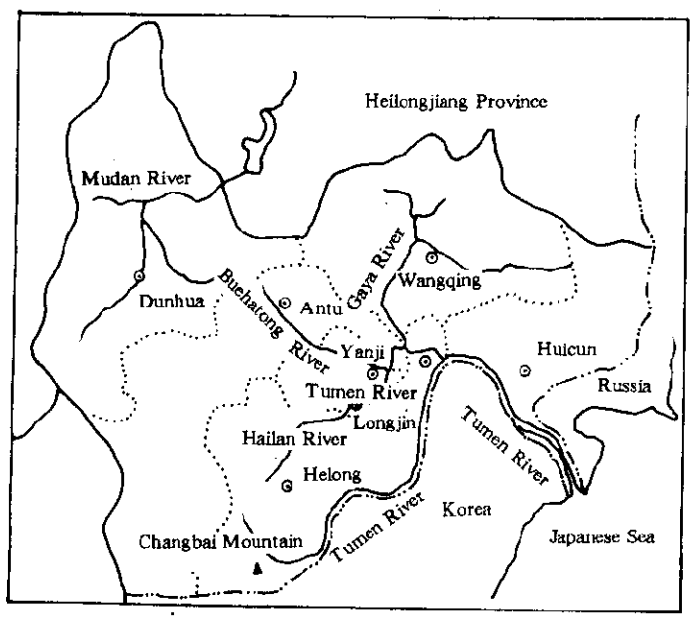

Fig. 1 The Tumen River catchment

3 Analysis of eco-environmental characteristics and major problems

3.1 Eco-environmental characteristics

3.1.1 Abundant natural resources

Yanbian region has abundant natural resources, in the first place land resources. The whole area is 42700 km^2 in which forestland amounts to 81.3%, cultivated land 5.5%, grassland 5.4%, water area 1.2%, garden plot 0.4%, and others 6.2%. The per capita land area is 2.4 ha which is greater than the per capita area of the whole province (0.8 ha) and of the whole nation (1.0 ha). The region has population density of 48.7 people per square kilometer.

There is abundant water resource in the region. Surface and ground water are 113.8 and 12.8 hundred million m^3, respectively. Each person has 6100 m^3 of water. The runoff of river is the difference between the spring and summer floods which is very changeable. The rivers have also a long period of freezing (about 130 days per year).

Yanbian region has large potentialities in resource exploitation and it has abundant biological

resources. There is a vegetation coverage of 78.2% and a timber accumulation of 3.25 hundred million m^3, the whole region has 1592 species of wild economic plants which belong to 152 families. There are 200 economic animals in which more valuable ones are sika, lynx, sable, otters, leopard, tiger in northeast of China and so on. Especially, the Changbai Mountain area has favorable conditions for building a gene pool, and it has been determined by the United Nations as an international biosphere protection zone.

Yanbian region has a good natural landscape and abundant tourism resources. Especially the Changbai Mountain area has dense forest and various tree species. The climate, biota and soil have clear vertical distribution. The natural ecosystem is more complete. On the basis of protection, the area can be built into a tourist scenic spot which combines northern scenery, national character and scientific investigation into one.

3.1.2 **Mountainous topography and landform**

Yanbian region belongs to the Changbai Mountains, and has complex and varied geographic units. It has more mountain and less plain, and great relative height. These topography and landforms determine the specific pattern of land use and the transport situation of pollutants in the environment.

3.1.3 **Mainly forested vegetation form**

Yanbian region has a vegetation area of 3793362 ha and a coverage of 87.2%. The forestland is 3548897 ha which is 93.56% of the total vegetation area. The area of fruit trees is 8666 ha which is 0.23%. The area of grassland is 235597 ha which is 6.21%. The above - mentioned data indicated that vegetation form in the region is mainly forest which decides the structure and distribution of agriculture.

3.1.4 **Integrated environmental quality in no bad**

At the present time, except for suspended particulate, the quality of atmosphere in the region has essentially been maintained at a national standard of 2.5 grade, and the water quality at a national surface water standard of 3rd grade, source water at 2nd grade. Under the plan of environmental goal, there are still allowances for receiving certain amount of pollutants.

3.2 **Existing major problems**

3.2.1 **Destruction of forest resources and decrease in valuable animals and plants**

Owing to the lagging behind of management, excessive cutting, imbalance of cut and nursery and unreasonable structure of age of stand and species of tree, the forest resources have continually been destroyed, thus leading the valuable animals and plants to decrease both in amount and species. Function of conserve water is lower, water quality deteriorates day by day. According to statistics between 1975 and 1985, the proportion of high - quality coniferous tree reduced by 0.62%, Korean pine 1.91%, dragon spruce 0.68%, valuable Chinese northeast tiger is on the verge of extinction.

3.2.2 **Serious water and soil loss**

According to statistic data of 1984, the area of water and soil loss in the whole prefecture is about 259197 ha which is 6.07% of the total area of the region. The total year mean loss amount is 1.03 million tons, loss ratio 7%. At the catchment of Buerhatong and Hailan Rivers, owing to

high density of population, low coverage of forest and grass and large area of cultivated land, the area of water and soil loss in the catchment is 39%—49% of the total loss area, and total loss amount is 47% of whole prefecture loss area. The serious water and soil loss leads to poor soil, silting up and shallow of rivers, increase of sand quantity in river water, agricultural ecological degeneration, which affects on the good cycle of eco-environment.

3.2.3 **Atmosphere quality is tending to deteriorate**

At the present, the major problems causing deterioration of atmosphere environment quality are pollution from precipitation of dust and particles. The former is the main pollutant and has commonly been behind the standard in every grade. The latter is the second main pollutant and has frequently been behind a standard of 32.5%—60%. The third is sulphur dioxide and nitrogen oxides.

The atmosphere pollution in Yanbian region is mainly from fuel combustion, such as power plants, industrial boilers, stove for civil use and automobile exhaust gas.

3.2.4 **Serious water quality pollution of Tumen River**

Owing to the loss of water and soil, and the untreated industrial waste water and the direct discharge of sewage, water of local river reaches has been polluted seriously. For example, Tumen River reach of 30 km from Maoshan to the place where the river leaves China has been polluted seriously with SS which is mainly from Maoshan Iron Ore of Korea. The BOD and COD in the reaches behind Tumen City have been behind dozens of surface water standards in 5th grade. These organic pollutants are mainly from Kaishantun Chemical Fibre Plant and Shiyan Paper Mill.

4 The regional eco-environment impact analysis and tendency prediction

4.1 Impact analysis and prediction of the atmosphere quality

Due to limits of available data and information, we can only use simplified method to give a relative change tendency.

4.1.1 The establishment of prediction model

Using seven year data from 1985 to 1991, we can obtain the prediction model for generation quantity of air pollutants by the linear regression analysis as follows:

$$Y_1 = (1577.6 + 724.19X)(1-\alpha), \quad r = 0.96, \tag{1}$$

$$Y_2 = (1758.2 + 839.58X)(1-\alpha), \quad r = 0.84, \tag{2}$$

$$Y_3 = (-64471 - 6979.9X)(1-\alpha), \quad r = 0.98, \tag{3}$$

where X is the industrial output value, 100 million Yuan; Y_1, Y_2 and Y_3 are the generation quantity of SO_2, NO_x and dust, respectively, t/a; r is correlation coefficient; α is the technological progress factor, with development of social economy, the value varies between 0 and 1. In this work, the value was taken as follows (Table 1).

According to actual conditions of Yanbian region, we have established the following rough

calculation model for determining remaining air environmental capacity:

Table 1 A value in different industrial output

100 million Yuan

X	40	50	60	70	80	90	100	110	120	130	140
a	0.1	0.1	0.15	0.20	0.23	0.25	0.32	0.37	0.41	0.44	0.45

$$Ac = Bc - M; \tag{4}$$

$$Bc = C \times V \times 10^{-6}; \tag{5}$$

$$V = Mg/Cg, \tag{6}$$

where Ac is the remaining air environmental capacity, t/a; M is the generation quantity of air pollutants, t/a; Bc is the background capacity, t/a; C is the environmental quality standard of air pollutants, g/m^3; V is the hypothesized space volume, m^3; Mg is generation quantity of pollutants in the reference year, t/a; Cg is the environmental concentration of pollutants in reference year, g/m^3; 10^{-6} is the unit conversion factor.

4.1.2 Prediction results

The quality standards of air pollutants in this study are shown in Table 2 and the environmental capacity of sulfur dioxide (SO_2), nitrogen oxides (NO_x) and suspended particle (SP) in Table 3.

Table 2 Environmental standards used GB 3095-82,

Unit: mgN/m^3

Pollutants	SO_2	NO_x	SP
1st grade value	0.02	0.05	0.15
2nd grade value	0.06	0.10	0.30
3rd grade value	0.10	0.15	0.50

Table 3 Background environmental capacity of air pollutants

Unit: t/a

SO_2		NO_x		SP	
2nd grade	3rd grade	2nd grade	3rd grade	2nd grade	3rd grade
83700	140000	94600	142000	101000	168000

In order to carry out the analysis of impact of air pollutants on atmosphere quality, the generation quantities of SO_2, NO_x and SP during above three years are predicted by Equation (1), (2) and (3). Table 4 shows that with the expansion of Huichun Power Generation Plant and industrial development of other cities and towns, the dominant generation quantities of air pollutants are still suspended particles, next are sulfur dioxide and nitrogen oxides. The generation quantities of suspended particle in the years 1995, 2000 and 2010 will be 1.3, 1.7 and 2.1 times that in the year 1991, respectively. Those of sulfur dioxide will be 1.3, 1.8 and 2.2 times and those of nitrogen oxides will be 1.4, 2.0 and 2.7 times, respectively.

Table 4 Prediction results of air pollutant generation quantity in different years

Prediction year	Pollutant quantity, t/a		
	Sulfur dioxide	Nitrogen oxides	SP
1995	33700	39000	255000
2000	45400	52500	379000
2010	56100	65000	500000

Here the difference between air background capacity and generation quantity of air pollutant is defined as remaining environmental capacity of air pollutants (Equation 4). This physical dimension was used to represent the degree of impact on atmosphere quality. It is easy to understand that the smaller the remaining capacity is, the larger will be the impact on atmosphere quality. On the contrary, the larger the remaining capacity, the smaller the impact on atmosphere quality. Equation (4) is used to calculate remaining capacity of air environment of SO_2, NO_x and SP in the three different years, which satisfied with the national second and third grade standards. The results are shown in Table 5, which indicate that main air environmental problem during the future 20 years in Yanbian region is still suspended particle pollution. Compared with suspended particle, the pollution of SO_2, NO_x are not so serious.

Table 5 The prediction results of remaining air environmental capacity

Prediction year	Sulfur dioxide		Nitrogen oxides		Suspended particle	
	2 grade	3 grade	2 grade	3 grade	2 grade	3 grade
1995	50000	102000	57000	103000	−154000	−86600
2000	38400	951000	42000	89400	−278000	−261000
2010	18800	84400	29600	76900	−399000	−332000

4.2 Impact analysis and prediction of water environmental quality

4.2.1 Prediction of generation quantity of water pollutants

Water pollutants are mainly from industrial wastewater, domestic sewage and emission from hospital. When wastewater enters natural water bodies, water pollution occurs. So the prediction of pollutant generation quantity is mainly based on the industrial and agricultural output and increase of population in the urban and rural areas. The prediction model are given as follows:

$$W=\frac{Q}{Q_0}W_0, \tag{7}$$

$$Q = Q_1+Q_2, \tag{8}$$

$$Q_1 = 0.365 \times N \times Rt \times (1-a), \tag{9}$$

$$Q_2 = Q_{20} \times (1+\alpha\beta)^t, \tag{10}$$

where W is the water pollutant in the prediction year, t/a; W_0 is the water pollutant in the reference year, t/a; Q is the discharge of wastewater in the prediction year, t/a; Q_1 is the discharge of domestic sewage in the prediction year, t/a; Q_2 is the discharge of industrial wastewater in the prediction year, t/a; N is the population in the reference year (in 10 thousands); a is the loss rate of domestic water use, generally as 30%; Q_{20} is the discharge of industrial wastewater in the reference year, t/a; α is the average increase rate of industrial output; β is the elastic coefficient, 1, 0.75, 0.5; Rt is the natural increase rate of population; t is the time, year.

From the economic development and population increase as well as Equation (7) to (10), we can predict the generation quantities of suspended solids (SS), chemical oxygen demand (COD), biochemical oxygen demand (BOD) and volatile phenol in different years (1995, 2000, 2010). The results are shown in Table 6. From the table, we can find that the COD, BOD and SS should be the focus point of treatment in the future.

Table 6 Prediction results of main water pollutants in Yanbian region

Prediction year	SS, t/a	COD, t/a	BOD, t/a	Volatile phenol, t/a
1995	110720	177910	44240	14.19
2000	136290	244500	58650	17.74
2010	273200	572000	137000	37.14

4.2.2 Calculation of water environmental capacity

Water environmental capacity can be predicted by using the following model:

$$G = 86.4\ (B-b)\ Q\ , \tag{11}$$

$$B = Bt \times \exp\ ((K_1+K_2)\ X/u). \tag{12}$$

where G is water environmental capacity in a river reach, kg/d; B is BOD concentration in the beginning section of a river, mg/L; Bt is BOD concentration of water quality standard in the control section of a river, m^3/s; b is BOD concentration from upstream of a river, mg/L; Q is design volume rate of a river, m^3/s; K_1, K_2 are the BOD reducing coefficients due to the biodegradation and precipitation respectively, L/d; X is distance of the river, km; u is flow rate of the river, km/d.

The water environmental capacity of COD was calculated indirectly from the capacity of BOD by the BOD - COD conversion model. The prediction results of BOD and COD are shown in Table 7 on the second grade.

Table 7 The usable water environmental capacity of BOD and COD

Unit: t/m^2

Time	1991—1995		1996—2000		2001—2010	
Warrant rate, %	75	90	75	90	75	90
BOD	1788	2264	1649	2038	990	1262
COD	7285	9242	6718	8275	4030	4965

4.3 Impact analysis and tendency of agriculture and forest ecosystem

The analysis results show that because proportion of artificial forest increases year by year, which will cause following effects on forest ecosystem: (1) sideline production by collecting mainly wild plants will reduce; (2) biological diversity will reduce; (3) loss of water and soil will become more and more serious; (4) timber quality will be degraded.

5 Eo - environmental division of Yanbian region

By using the methods of combination of quantitative and qualitative analysis, the eco - environment of Yanbian region is divided into four parts (Fig. 2).

The first is the zone of tourist development and nature protection; the second is the zone of water resource protection and soil erosion control; the third is the zone of ecological agriculture construction at valleys and plains between mountains; the forth is Tumen River economic development and pollution control district with Huichun City, Yanji City and Tumen City as center. On the basis of the function and the protection goal of each zone, appropriate protection measures are put forward.

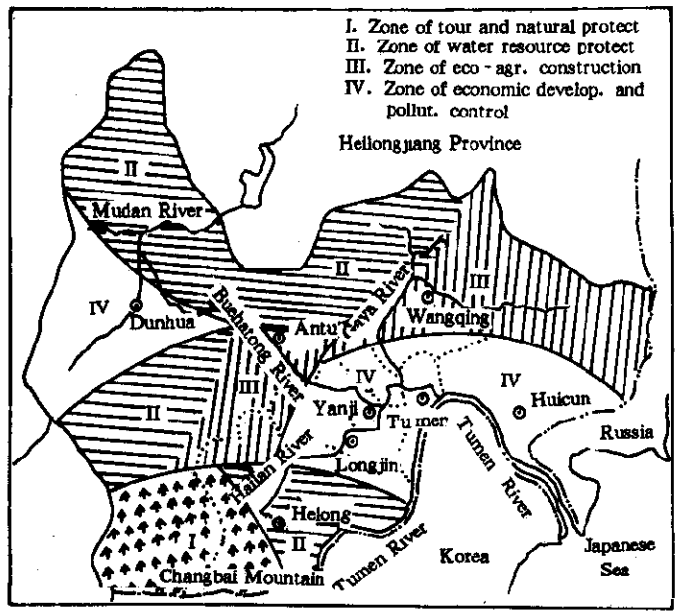

Fig. 2 Division of eco - environment of Yanbian region

6 Conclusion

On the basis of the analytical study of the eco - environmental problems and protection in Tumen River development, several protection measures for Yanbian regional eco - environment are suggested: (1) when the projects are newly built, extended and rebuilt, the high clean technologies are made widest use of; (2) we must reject persistently projects of low - grade technologies, unrational arrangements and serious pollution; (3) prompt comprehensive regional treatment and development of environmental protection industries in accordance with characteristics of regional resources; (4) spreading advanced pollution treatment technologies; (5) on the basis of "Using Resources for Charge", making a system of resource use compensation fee and environmental taxes, putting natural resource and environmental investment into national economic budget; (6) amplifying and strengthening further governmental , environmental administrative, supervisional and legal functions, and promotion of education of national environmental consciousness.

Reference

Barbier EB. Environmental Conservation, 1987; 13:1

Goodland RJA. The Geog J, 1990; 156(2):149

Ye CM, Wei AX, Huang YY, Zhang XF, Chen QH, Liu JF. Journal of Environmental Sciences (China), 1991; 3(2):103

(Received December 9, 1994)