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Conference Title

Study on the Self-purification of Juma River

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Abstract

The capacity of river self-purification is an important indicator for the river health. The organic and inorganic pollutants in most of the rivers in China are beyond the self-purification capacity of the river, which has caused the serious pollution to the water body. The capacity of the self-purification of the river may act as one of the indicators in regulating the discharge standards. Three reaches in Juma River were selected including serious polluted, light polluted and clear reach. The samples of water and aquatic plants were taken for the pollutant test. The results indicate that the Juma River has a great ability to purify the organic pollutants such as TN and TP, but little ability to the heavy metal ions. By analyzing the pollutant absorption ability of the three aquatic plants, Myriophyllum spicatum has greatest ability to absorb the organic pollutants.

Keywords: Self-purication, Juma river, Aquatic plants, Pollution

1. Introduction

As the social and economic development, the exploitation of the water resources is intensifying. At the same time, the water resources protection is not paid enough attention to, which results in many pollution events in the rivers and lakes in China. According to statistics, 21 thousands of chemical plants are located in the riverside and coastal areas, more than 70% of the water areas are polluted, and the ground water in 90% of the cities in China has been contaminated. The Yangtze River flows through 186 cities and 40% of the sewerage in China is discharged into it, 80% of which is untreated. There are 126 species in the Yangtze River in the mid-1980s, but only 52 species in 2002 due to the water pollution. The Lipotes vexillifer is extinct in 2006. In the Yellow River, 60% of the water resources is undrinkable. The garbage dumped into the Yellow River has an acceleration with 0.08 billion tons per year. Only in 2006, the Yellow River absorbed 4.35biilion tons of wastewater (Guo, 2007). Hence, the study on the self-purification of the river is becoming more and more important.

When the water body is contaminated, the river can purify itself by some physical and chemical action such as flowing, dilution, deposition and adsorption, which is called the self-purification (Gu, 1985). The

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capacity of the self-purification is closely related with the characteristics of the river including the flow discharge, flow rate, sediment-load and creatures in the rivers. For a certain river, the capacity of the self-purification is determined. When the total amount of pollutants is beyond the self-purification capacity of the river, the river will be polluted. The self-purification is an index to estimate the pollution accommodation of the river.

Juma River originates from the Laiyuan county, Hebei Province, the North side of Taihang Mountain. It's a tributary of Daqinghe River, belong to the Haihe River watershed. Juma River flows into Beijing city in Shidu village, Fangshan district, and finally flows into the Haihe River. The total length of Juma River is 254km and 61km of which is in Beijing city.

Juma River flows through Yesanpo senic spot in Hebei province. In some reaches, much sewage and garbage from the restaurants and villages along the river is discharged into the river. In addition, the farmers draw water from the river for irrigation and discharge them into it without any treatment. The water of these reaches is contaminated and the water quality is bad. However, several kilometers downstream of the contaminated reach, the river is clear and the water quality is good. In Juma River, the contaminated reach and the clear reach exits alternately, which means the large capacity of the self-purification of Juma River. An experiment was carried to study the self-purification capacity of Juma River and the relations of the river characteristics to the self-purification.

2. Experiment

2.1 Method

In order to quantify the self-purification capacity of Juma River, three typical reaches were selected and some parameters were measured. The selected reaches are composed of serious polluted reach, light polluted reach and clear reach. There is no tributary flowing into the river along the selected reach. In these reaches, flow rate, width and depth are measured for the flow discharge estimation. Other contamination indices as DO and temperature are recorded, too. Water samples and aquatic plants samples are also taken for the pollutant test. The sample spots are shown in Fig.1. The total length of the experiment reach is 5km.

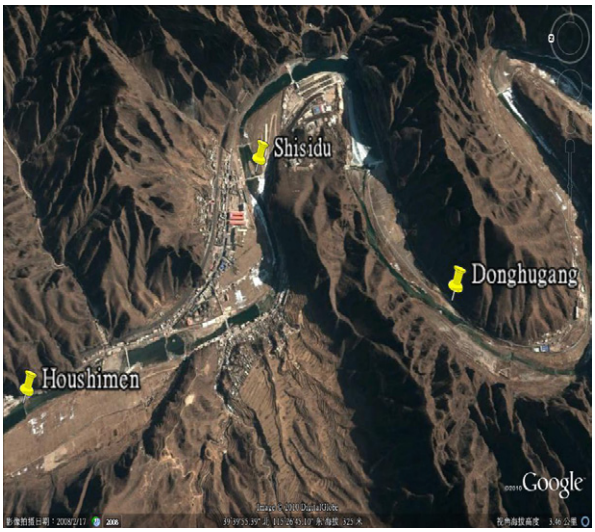

Figure 1. Location of the three sample spots: Houshimen, Shisidu and Donghugang

The aquatic plants are abundant in Juma River, but the usual species are Potamogeton malaianus, Myriophyllum spicatum, Potamogeton perfoliatus and Chara, as shown in Fig.2. The later three species are taken in serious polluted reach, light polluted reach and clear reach respectively. The samples of water and aquatic plants were taken back to the laboratory for pollutant test. The main indices of the pollutants are total nitrogen (TN), total phosphorus (TP) and mercury (Hg).

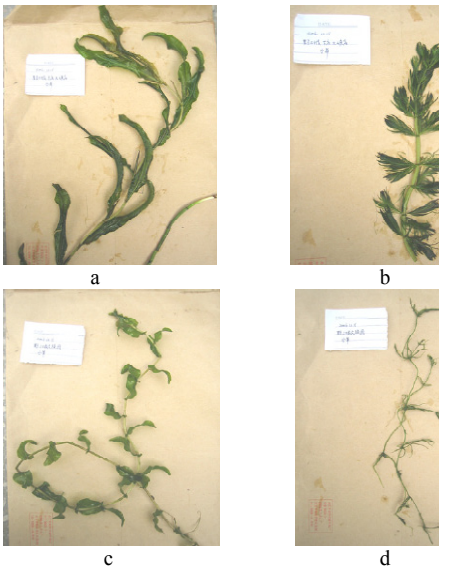

Figure 2. Aquatic plants in the Juma River: a. Potamogeton malaianus; b: Myriophyllum spicatum; c. Potamogeton perfoliatus; d. Chara

2.2 Results

- Measured discharge.

The discharges are gained in the three weirs by the product of the width of the weirs, the length of the weirs, the head on weirs and the mean velocity, as shown in Table.1. The discharges in Shisidu weirs and Donghugang weirs are less than that in Houshimen weirs, because there are diversion ditches aside the former two weirs, whose total discharge containing the diversion ditches is about 2.5 m3/s. Hence, the discharge in Juma River is 2-2.5 m3/s.

Table 1 The Measured Discharge in the Juma River

Place	Head on Weirs （cm）	The Width of the Weirs (m)	The Length of the Weirs (m)	Mean Velocity (m/s)	Discharge (m^3/s)
Houshimen weirs	4.3	3.2	120	0.399	2.06
Shisidu weirs	2.9	2.0	250	0.253	1.83
Donghugang weirs	4.6	2.0	120	0.305	1.68

- The values of DO

In the three sample spots the values of DO are recorded as the contamination index. In each spot, the values of DO in three points are measured. Table 2 indicates that the value of DO ascends from the first reach to the third reach, which means the degree of contamination reduces.

Table 2 The Values of DO in the Three Sample Spots

Spots	Points	%	°C	mg/L
Spot 1	*Point 1*	59.4	16.9	5.6
	Point 2	60.7	16.6	5.8
	Point 3	62.6	16.5	6.0
Spot 2	*Point 1*	85.7	16.6	8.1
	Point 2	103.5	16.5	9.8
	Point 3	103.7	16.5	9.9
Spot 3	*Point 1*	114.2	17.4	10.7
	Point 2	114.2	17.1	10.7
	Point 3	114.1	17.1	10.7

- The values of contamination indices

The samples of water and aquatic plants were taken to the analysis centre in Tsinghua University for the pollutants test. The contents of TN, TP and Hg are detected, as shown in Table 3 and Table 4.

Table 3 The Contents of Contamination Indices in Water Samples (mg/L)

Contamination indices	TP	TN	Hg
Water sample in the first reach	0.0092	2.11	0.0001
Water sample in the second reach	0.0081	1.96	0.00012
Water sample in the third reach	0.0079	1.73	0.00011

The contents of TN and TP in the water samples decrease progressively, which indicates that the water body is becoming cleaning. The contents of the contamination indices in the aquatic plants are in consistent with that in the water body. The contents of TN and TP in aquatic plants are high in the serious polluted reach and low in the clean water. The reduction of the content of the TN and TP in the water body is most due to the absorption of the aquatic plants because there are no tributaries in the experimented reach and the sediment-laden is very low.

Table 4 The Contents of Contamination Indices in the Samples of Aquatic Plants

Places	Contamination Indices	TP(%)	TN(%)
Place 1	*Potamogeton malaianus*	0.36	3.96
	Myriophyllum spicatum	0.41	2.56
Place 2	*Potamogeton perfoliatus*	0.26	2.64
	Chara	0.06	0.96
Place 3	*Myriophyllum spicatum*	0.15	1.94
	Chara	0.11	1.16
	Potamogeton perfoliatus	0.26	2.4

3. Analysis

3.1 The Self-purification of the River

In order to quantify the self-purification of Juma River, the capacity of the self-purification per unit length (CSUL) is introduced. It can be defined that the total amount of the reduction of a certain contamination index in the water body through the unit river length. It can be represented by the parameter P. According to this, the CSUL of TN and TP in Juma River can be calculated as shown in Table 5. In Table 5, L_{i-j} represents the distance between sample spot *i* and sample spot *j*.

Table 5 The capacity of the self-purification per unit length of Juma River

Distance	Reduction of TN(mg/L)	Reduction of TP(mg/L)	River Length (km)	P_{TN} mg/(L·km)	P_{TP} mg/(L·km)
L_{1-2}	0.15	0.0011	L_{1-2}=2	0.075	0.00055
L_{2-3}	0.23	0.0002	L_{2-3}=3.5	0.0657	0.000057
L_{1-3}	0.38	0.0013	L_{1-3}=5.5	0.0691	0.000236

The CSUL of TN and TP in Juma River are PTN = 0.0691 mg/(L•km) and PTP = 0.000234 mg/(L•km).Table 3 shows that there is little change of the content of Hg in the three reaches, indicating that the Juma River has no purification capacity to the heavy metal pollution. So the factories with high heavy metal pollution should not be set up along the river.

In the status quo, the Juma River has an ability to purify the organic pollution such as TN and TP, but has no purification capacity to the heavy metal ions such as Hg. To maintain the health of Juma River, the heavy metal pollution must be forbidden and the organic pollution should be limited in the capacity of the self-purification of the river.

3.1 The Purification Capacity of the Aquatic Plants

Table 6 lists the sample spots and the content of TN and TP in water body and aquatic plants. When the pollution doesn't affect the vigor of the aquatic plants, the content of the TN and TP in aquatic plants is consistent with that in the water body. But if the pollution has damaged the vitality of the aquatic plants, the content of TN and TP in aquatic plants will decrease instead of increment (Carballo and Romano, 2002; Wu, et al., 2005).

Table 6 The Purification Capacity of the Aquatic Plants

Aquatic plants	Sample Spot	Water Body	Aquatic Plants	Water Body	Aquatic Plants
		TP(mg/l)	*TP(%)*	*TN(mg/l)*	*TN(%)*
Myriophyllum spicatum	Serious polluted water	0.0092	0.41	2.11	2.56
	Clean water	0.0079	0.15	1.73	1.94
Potamogeton perfoliatus	Light polluted water	0.0081	0.26	1.96	2.64
	Clean water	0.0079	0.26	1.73	2.4
Chara	Light polluted water	0.0081	0.06	1.96	0.96
	Clean water	0.0079	0.11	1.73	1.16

Table 6 shows that Myriophyllum spicatum can purify the water by absorbing TN and TP well. Potamogeton perfoliatus has a low capacity to absorb TP and a little capacity to absorb TN. For the Chara, the content of TN and TP is low in the water body with high concentration of TN and TP and high in the

water body with low concentration of TN and TP. Maybe the vitality of Potamogeton perfoliatus has been damaged or it's due to the measurement errors. For the Juma River, more Myriophyllum spicatum may be helpful for the river self-purification.

4. Conclusions

The river has ability to purify the pollution and the degree of ability is an indicator of the river health. Juma River has a great ability to purify the organic pollution. The CSUL of TN and TP in Juma River are PTN = 0.0691 mg/(L•km) and PTP = 0.000234 mg/(L•km), which can be used to draw up the discharge standard for the total amount control of the pollutants. But there is little ability for the Juma River to purify the heavy metal pollution. It suggests that it's not suitable to set up the factories with much heavy metals pollution. In the three aquatic plants, Myriophyllum spicatum has a great ability to absorb the organic pollutants and more this species may be helpful for the capacity of the self-purification of Juma River. The river has ability to purify the pollution and the degree of ability is an indicator of the river health. Juma River has a great ability to purify the organic pollution. The CSUL of TN and TP in Juma River are PTN = 0.0691 mg/(L•km) and PTP = 0.000234 mg/(L•km), which can be used to draw up the discharge standard for the total amount control of the pollutants. But there is little ability for the Juma River to purify the heavy metal pollution. It suggests that it's not suitable to set up the factories with much heavy metals pollution. In the three aquatic plants, Myriophyllum spicatum has a great ability to absorb the organic pollutants and more this species may be helpful for the capacity of the self-purification of Juma River.

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