Desalination and Water Treatment
www.deswater.com

doi: 10.5004/dwt.2021.26770

215 (2021) 250–258
March

Diversity comparison of water quality between the Mopanshan Reservoir and Songhuajiang Reservoir – northeast China

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Received 25 May 2020; Accepted 7 October 2020

ABSTRACT

This work aims to appraise the water quality diversity from the Mopanshan Reservoir and the Songhuajiang River between 2016 and 2018, which are the primary drinking water sources of the Harbin City in China's northern cold regions. Results revealed that the Mopanshan Reservoir and the Songhuajiang River waters both could reach the Case III standard of the "Environmental Quality Standards for Surface Water" (GB3838-2002). The characteristic pollutants of the two drinking water sources both had a characteristic of seasonal variation. The COD_{Mn}, TN, and TP values of the Mopanshan Reservoir and COD_{Mn} value of the Songhuajiang River all increased during the rainy season, whereas they decreased during the icebound season. The NH_4^+–N variation of the Songhuajiang River was contrast to such findings. Furthermore, the finished water quality indices of the Mopanshan Reservoir all could meet the "Standards for drinking water quality" (GB5749-2006), except for the chloral exceeding 20% of the limit after the conventional treatment. Only the NH_4^+–N value in the Songhuajiang River's icebound season exceeded the drinking water standard. It indicated that the Songhuajiang River is more suitable for drinking water after 10 years of restoration management.

Keywords: Mopanshan Reservoir; Songhuajiang River; Seasonal variation; Water quality

1. Introduction

Harbin is located in the northernmost region of China. Here, water is equipped with a low-temperature feature. This develops other complex water quality characteristics, such as turbidity, potassium permanganate index (COD_{Mn}), and ammonia nitrogen (NH_4^+–N) [1]. However, high-quality drinking water safeguards people's lives and health [2,3]. In China, lake reservoirs and river reservoirs are major water sources for domestic drinking water in urban areas [4,5]. Therefore, appraising the water quality diversity between the lake reservoirs and river reservoirs is vital for the health and economic development of humans.

For Harbin City, the typical lake reservoir is the Mopanshan Reservoir. Meanwhile, the typical river reservoir is the Songhuajiang River. Among them, the Songhuajiang River was originally the main water source for living and production. However, a nitrobenzene pollution event occurred in 2005. Consequently, the Mopanshan Reservoir became the main water supply for Harbin City in 2007 [6,7]. Until 2010, water from the Mopanshan Reservoir

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has supplied the entire south urban area of Harbin City. Meanwhile, the Songhuajiang River was withdrawn as a water source for Harbin City. Currently, the city's drinking water is mainly drawn from the Mopanshan Reservoir. However, the disadvantages of the Mopanshan Reservoir as Harbin City's only water source have become increasingly clear. Li et al. [8] showed that the Mopanshan Reservoir has a seasonal variability of the organic pollution. Liu et al. [9] found similar results through their study. On the one hand, the Mopanshan Reservoir's water quality has suffered eutrophication. On the other hand, as the Mopanshan Reservoir is far away (180 km) from the urban area of Harbin City. Therefore, two gravity pipelines are used for water transport. Any failure of these pipelines will affect the water supply necessary for maintaining the life and productivity of residents and enterprises in Harbin City. This would adversely impact society. The government of Harbin decided to reinstate the Songhuajiang River as a water source for the city in 2015. The water source project of the Songhuajiang River came into operation. Therefore, evaluating the water quality of the Mopanshan Reservoir and the Songhuajiang River is crucial to carry out the government's decisions.

In this study, the waterbody classification, characteristic pollutants of raw water and the finished water quality of the Mopanshan Reservoir and the Songhuajiang River were compared and analyzed. The researchers monitored data over 3 years. Ultimately, this research will lead to the development of both effective management and conservation strategies for the two drinking water sources of the Harbin City.

2. Materials and methods

2.1. Study area

2.1.1. Mopanshan Reservoir

The Mopanshan Reservoir is located in the upper part of the mainstream of the Lalin River, Wuchang City, and Heilongjiang Province, which is about 180 km away from the urban area of Harbin City (Fig. 1). The longitude and latitude of the reservoir are 127°41′20″ E, 44°23′40″ N, respectively. The drainage area above the reservoir dam site is 1,151 km^2, with a total storage capacity of 5.23 billion m^3. The normal water storage of the reservoir is 318 m. It has a total water storage capacity of 3.56 billion m^3. The reservoir has a dead water level of 304.5 m and a dead storage capacity of 0.91 billion m^3. Meanwhile, the annual average runoff amount of the reservoir is 5.61 billion m^3/a.

2.1.2. Songhuajiang River

The Songhuajiang River Basin is located between 41°42′–51°38′N and 119°52′–132°31′E. It is at the northernmost end of the seven major river basins in China (Fig. 2). It has two major fountainheads. The north one is the Nen River, which originates from the Ilehuli Mountain and Daxing'an Mountains. Meanwhile, the south one is the second Songhuajiang River, which originates from the heavenly Lake in Changbaishan. The two rivers converge at the Sancha River, known as the Songhuajiang River. The Songhuajiang River's mainstream is nearly one thousand kilometers long, with an interval catchment area of 18.64 ten thousand km^2. The annual average runoff amount is 321.8 billion m^3.

2.2. Sampling and data

All water samples were obtained monthly below 0.5 m from the water surface over 3 years (2016–2018). The sampling site of the Mopanshan Reservoir is at the center of the lake. The sampling site of the Songhuajiang River is at the Zhushuntun monitoring section. A 5-L acid-treated high-density polyethylene bottle was used to collect water samples at a time interval. The samples were transported and stored for further analysis after the field parameters were determined (pH, temperature, etc.) [10,11].

To assess the water quality diversity of the Mopanshan Reservoir and Songhuajiang River, the potassium permanganate index (COD_{Mn}), total phosphorus (TP), total nitrogen (TN), ammonia nitrogen (NH_4^+–N), and routine ion were available from the Ministry of Environmental Protection

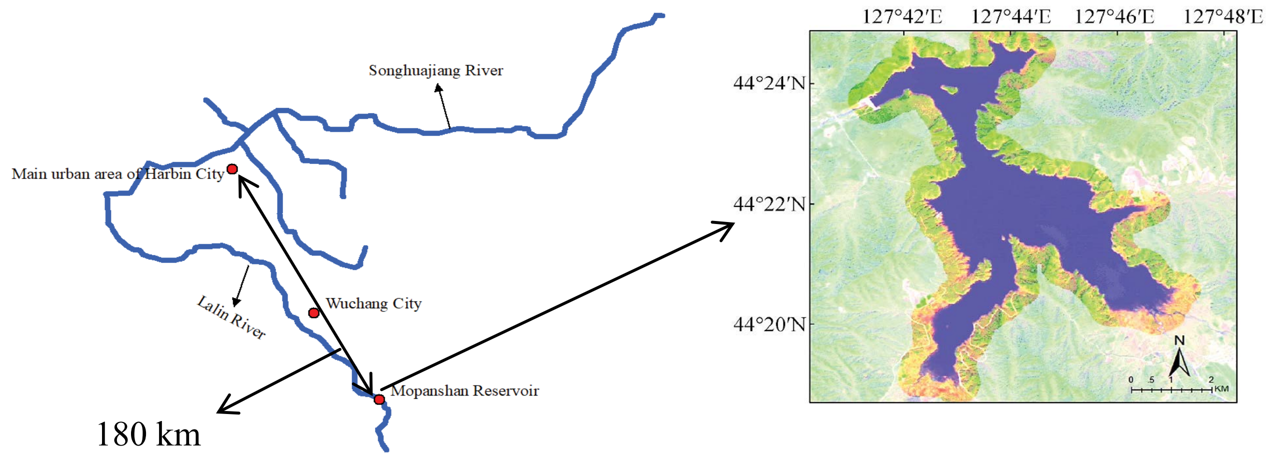

Fig. 1. Location map of Mopanshan Reservoir.

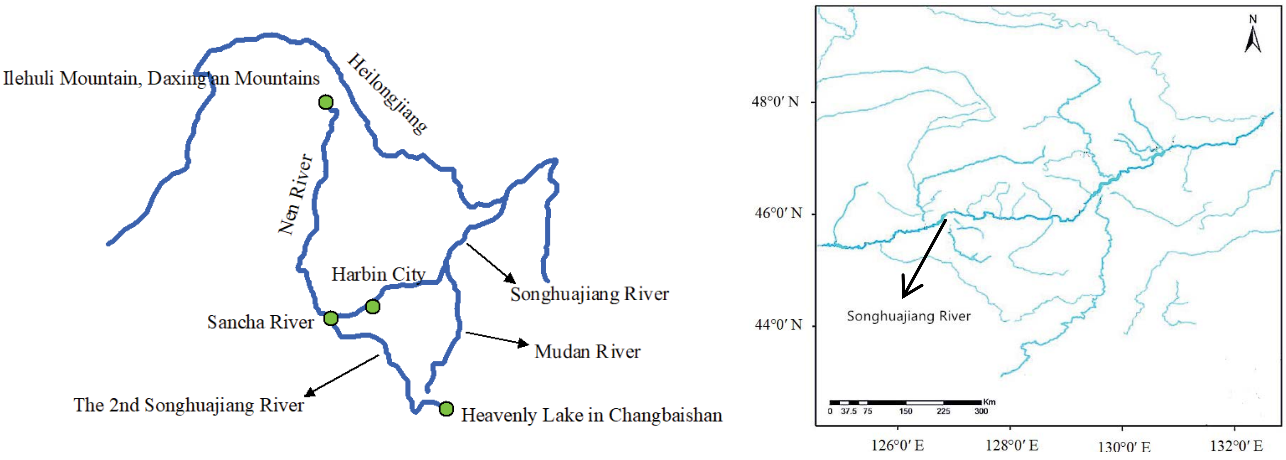

Fig. 2. Location map of Songhuajiang River.

of the People's Republic of China or determined according to the Chinese National Standard Methods [12,13]. The disinfection by-products (DBPs) were measured with a gas chromatograph-mass spectrometer coupled with an electron capture detector (Agilent 7890B-5977, USA). The detection methods of major indices are as follows: TP by GB11893-1989, TN by GB11894-1989, NH_4^+–N by HJ/T 195-2005, COD_{Mn} by GB 11892-1989, typical DBPs by GB/T 17130-1997 [14].

3. Results and discussion

3.1. Comparative analysis of the waterbody classification

The "Environmental Quality Standards for Surface Water" (GB3838-2002) suggest that the surface waterbody is divided into five categories. They are labeled as Case I, Case II, Case III, Case IV, and Case V. Among them, Case I, Case II, and Case III waterbody are suitable for drinking water. In this section, the waterbody classification of the Mopanshan Reservoir and the Songhuajiang River in 2014–2018 is analyzed to reveal the water overview preliminarily.

3.1.1. Waterbody classification of the Mopanshan Reservoir

The waterbody classification of the Mopanshan Reservoir from 2014 to 2018 is listed in Table 1. It can be seen that the rates of reaching the Case III standard are 83.33%, 91.67%, 100%, 58.33%, and 83.33% from 2014 to 2018. Especially in 2016, the Mopanshan Reservoir's water reached the Case III, exhibiting a preferable water quality. However, the water was presented as poor in 2017, especially in the summer. The abundant rainfall caused the organic matter flowing into the reservoir through the surface water runoff. Meanwhile, several researchers showed that the reservoir had a trend of eutrophication in the summer, which was another reason for the worsened water quality [15,16]. On the whole, the water quality was presented as poor from May to July compared with the other months. Also, it was poor in 2017 and 2018 compared with the previous years. Therefore, some enhanced measures should be applied to ensure the water supply security, especially in the summer.

3.1.2. Waterbody classification of the Songhuajiang River

Table 2 shows the waterbody classification of the Songhuajiang River. The rate of reaching the Case III standard accounted for 50%, 58.33%, 91.67%, 91.67%, and 100% from 2014 to 2018. The water quality demonstrated an improving trend year by year. Therefore, the Songhuajiang River Harbin section has consistently realized the Case III water quality standards after the implementation of a series of protection measures since the nitrobenzene pollution event in 2005. Interestingly, the water quality exhibited poor from November to June. This is mainly due to the enclosed environment in the icebound season

Table 1
Waterbody classification of the Mopanshan Reservoir

Year	Month											
	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
2014	III	III	III	III	IV	IV	III	III	III	III	III	III
2015	III	III	III	III	III	III	III	III	III	IV	III	III
2016	III	III	III	III	III	III	III	III	III	III	III	III
2017	III	III	III	IV	III	IV	IV	III	III	III	IV	IV
2018	III	III	III	III	III	IV	IV	III	III	III	III	III

Table 2
Waterbody classification of the Songhuajiang River

Year	Month											
	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
2014	V	IV	III	IV	III	IV	III	III	III	III	IV	IV
2015	IV	III	IV	IV	IV	III	III	III	III	III	IV	III
2016	III	III	III	IV	III	III	III	III	III	III	III	III
2017	III	IV	III	III	III	III	III	III	III	III	III	III
2018	III	III	III	III	III	III	III	III	III	III	III	III

(November–April) and surface water runoff in the rainy season (May–June). However, the rate of reaching the Case III standard can reach up to 100% in 2018. This implies that the Songhuajiang River water is suitable for the drinking water at present.

The water quality of the Songhuajiang River was determined as preferable to that of the Mopanshan Reservoir through the analysis of the waterbody classification. The water quality of the Songhuajiang River increases year by year whereas the water quality decreases in the case of Mopanshan Reservoir year by year.

3.2. Comparative analysis of characteristic pollutants of raw water

3.2.1. Analysis of characteristic pollutants of the Mopanshan Reservoir

According to the "Environmental Quality Standards for Surface Water" (GB3838-2002), 109 indices were measured to evaluate the water quality of the Mopanshan Reservoir. The majority of the indices were undetected or close to the limit of detection (LOD) for years, aside from the permanganate index (COD_{Mn}), total nitrogen (TN), and total phosphorus (TP). Thus, the COD_{Mn}, TN, and TP were considered as the characteristic pollutants in the Mopanshan Reservoir. A detailed analysis is shown in Fig. 3.

Fig. 3a shows that the value of COD_{Mn} exceeded the Case III standard (6 mg/L) in July–September of 2016 and September of 2017. It was in accordance with the Case III standard for the rest of the monitoring period. Moreover, the COD_{Mn} value has a characteristic of seasonal variation. There are higher values of COD_{Mn} in the rainy season and lower values in the icebound season. It is probably because surface runoff carries organic pollutants from soils into the reservoir with increased precipitation in summer and autumn. This results in the increase of COD_{Mn}. In contrast, the reservoir is enclosed in the icebound season, which reduces the exogenous input of pollutants. Generally speaking, the concentration of COD_{Mn} declined year by year. Especially in 2018, the COD_{Mn} value was controlled effectively for all the monitoring ones being below the Case III standard.

The variation of TN in the Mopanshan Reservoir from 2016 to 2018 is presented in Fig. 3b. The value of TN in the Mopanshan Reservoir exceeded the Case III standard (1.0 mg/L) and was even higher than the inferior Case V standard (2.0 mg/L). Specifically, the value of TN was at a high level from April to September every year and reached a peak during June and July (2.5 mg/L). The agricultural production period usually occurs from April to September. Therefore, the value of TN increased with the nitrogen-containing fertilizers entering into the reservoir through surface runoff. In general, there exists a potential risk of water eutrophication in the Mopanshan Reservoir with the increasing TN value year by year. Furthermore, the TN variation also has a characteristic of seasonal variation, with higher values in the rainy season and lower values in the icebound season.

The variation of TP in the Mopanshan Reservoir from 2016 to 2018 is illustrated in Fig. 3c. The value of TP was lower than 0.05 mg/L in 2018. Meanwhile, it exceeded the Case III standard (0.05 mg/L) in March and June of 2016 and April and May of 2017. The value of TP was close to the Case III standard in the monitoring years, implying a risk of eutrophication. Meanwhile, the high value of TP and TN both occurred in the agricultural production period. The value of TP increased sharply in June probably due to the phosphorus fertilizer used in agricultural production entering the reservoir along with the surface runoff.

In general, the characteristic pollutants in the Mopanshan Reservoir all have a characteristic of seasonal variation. The COD_{Mn}, TN, and TP are the crucial control indicators to guarantee the water quality of the reservoir, especially in the rainy season.

3.2.2. Analysis of characteristic pollutants of the Songhuajiang River

The majority of the referred 109 indices in the Songhuajiang River was similar to that in the Mopanshan Reservoir. They are all in accordance with the Case III standard, aside from the COD_{Mn} and ammonia nitrogen (NH_4^+–N). Thus, the COD_{Mn} and NH_4^+–N were considered the characteristic pollutants in the Songhuajiang River. Since the nitrobenzene pollution event in 2005, the Songhuajiang River has suffered a serious defeat and undergone a series of repairs. Some special years (2005, 2006, 2010, 2015 and 2017) are selected to monitor the variation of COD_{Mn} and NH_4^+–N roundly. The detailed results are shown in Fig. 4.

Fig. 4a shows the variation trend of COD_{Mn} in the Songhuajiang River in the special years. Evidently, the variation of COD_{Mn} also has a characteristic of seasonal variation. In the rainy season, the COD_{Mn} has a high value with an average of 7.03 mg/L. It was mainly because of the increase of precipitation causing the surface water runoff

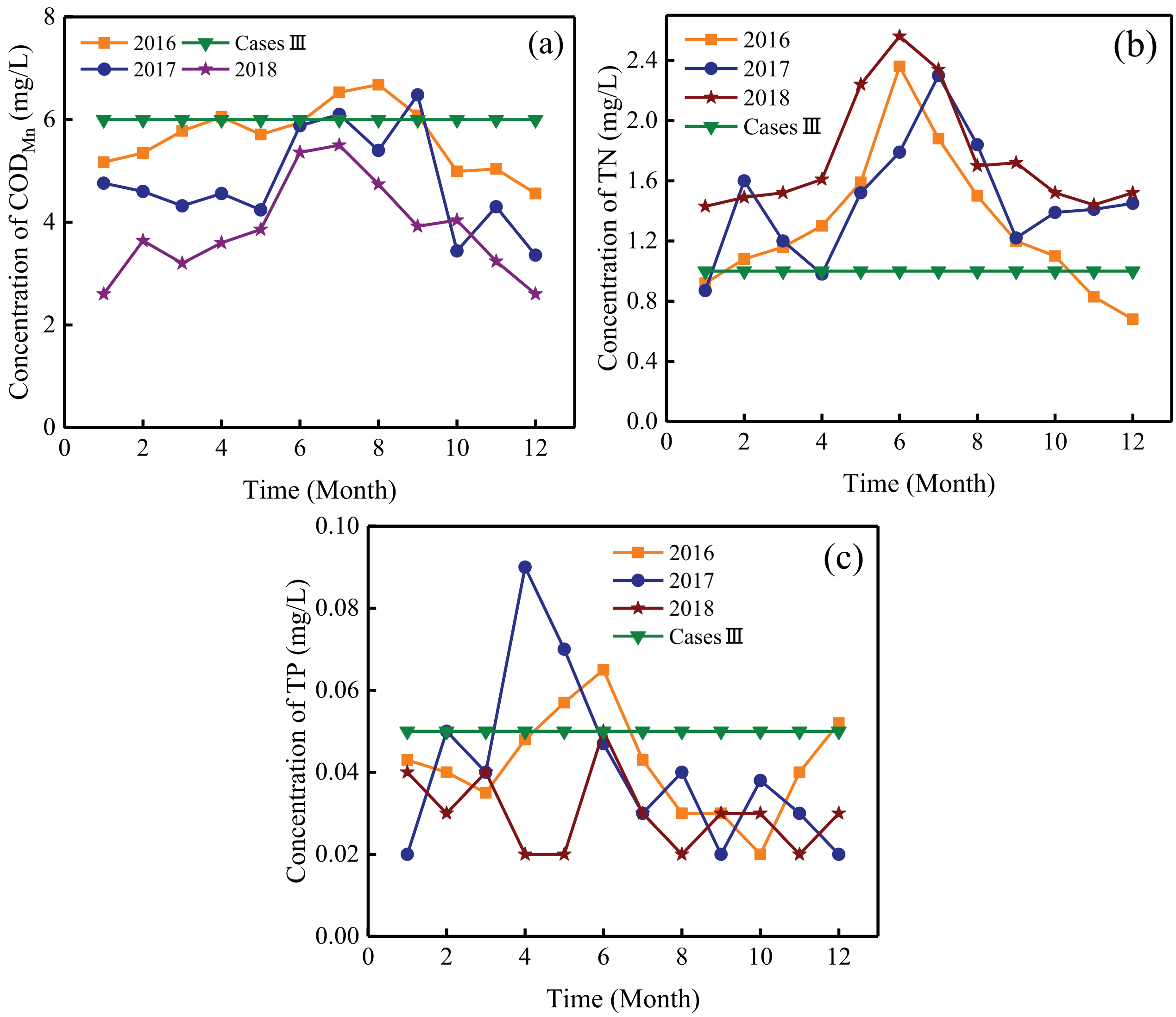

Fig. 3. Variation of (a) COD$_{Mn}$, (b) TN and (c) TP in the Mopanshan Reservoir from 2016 to 2018.

carrying organic pollutants into the river. Meanwhile, there are many industries on both sides of the river. They discharge large quantities of sewage into the river. Thus, the Songhuajiang River carries a huge pollution load in the rainy season. This was the primary reason for the COD$_{Mn}$ exceeding the standard. However, the COD$_{Mn}$ value declined in the icebound season. It is mainly due to a decreased input of exogenous pollutants for the frozen river. The contribution of the COD$_{Mn}$ value mainly depends on the release of the bottom sludge. Furthermore, the content of COD$_{Mn}$ declined year by year over a decade of governance. Especially in 2017, the COD$_{Mn}$ values are all below the Case III standard, with an average of 5.28 mg/L. This reveals that the Songhuajiang River possessed reduced organic contamination after treatment in the past decade.

The variation of NH_4^+–N in the Songhuajiang River is presented in Fig. 4b. Evidence shows that the variation of NH_4^+–N also has a characteristic of seasonal variation. However, the variation is different from that of COD$_{Mn}$. The content of NH_4^+–N has a high value in the icebound season, while it dramatically declines in the rainy season. The average values of NH_4^+–N in the icebound season of 2005, 2006, 2010, 2015, and 2017 are 2.14, 1.81, 1.27, 1.18, and 0.88 mg/L, respectively. They are 0.37, 0.32, 0.28, 0.17, and 0.26 mg/L in the rainy season, respectively. This may be due to several factors in the icebound season, including low water temperature and precipitation in winter, a relaxed standard of NH_4^+–N standard discharge from the municipal sewage treatment plant, the poor activity of the bacteria and the reduced self-purification capacity of the water. However, the content of NH_4^+–N can be reduced in the rainy season for the dilution of precipitation and increase of the self-purification capacity. Furthermore, the content of NH_4^+–N in the Songhuajiang River has declined over the recent 10 years for its continuous expansion of management. For example, in 2005, the content of ammonia nitrogen reached 3.44 mg/L, which far exceeded the poor level V (2 mg/L). However, in 2017, the highest content of

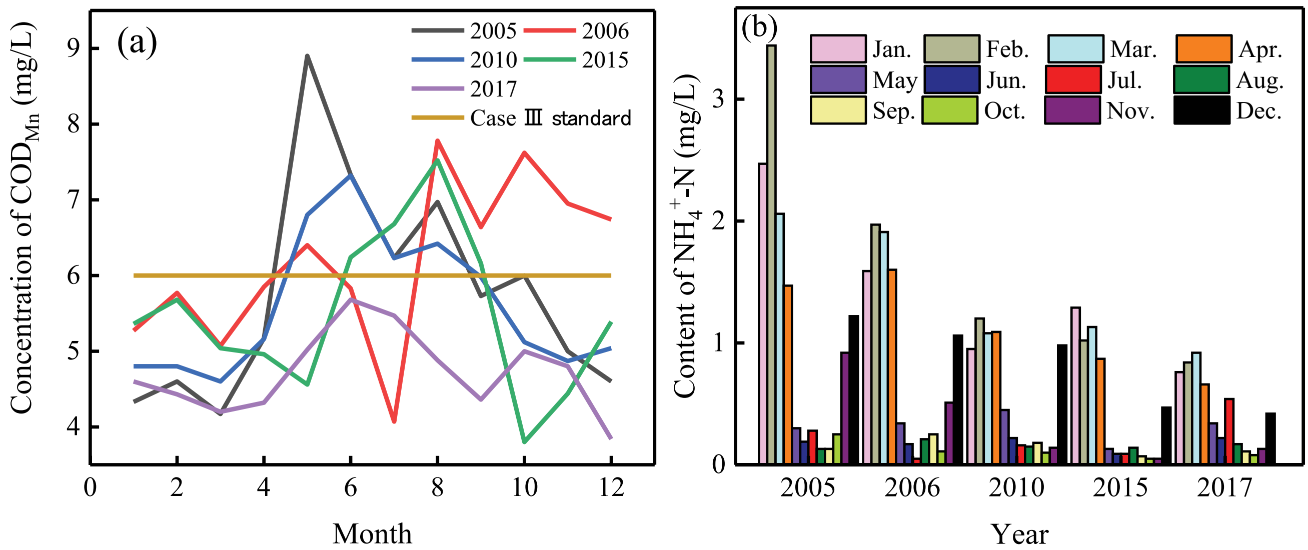

Fig. 4. Variation of (a) COD$_{Mn}$ and (b) NH_4^+–N in the Songhuajiang River.

NH_4^+–N was observed from January to April. It measured lower than 1 mg/L, meeting the Case III standard.

The above results showed that the characteristic pollutants of the Mopanshan Reservoir are the COD$_{Mn}$, TN, and TP. Meanwhile, they are COD$_{Mn}$ and NH_4^+–N in the Songhuajiang River. These characteristic pollutants all have a characteristic of seasonal variation. However, the water quality of the Mopanshan Reservoir and Songhuajiang River both reached the Case III standard in 2017. The types of characteristic pollutants are not exactly the same. The only common one was the COD$_{Mn}$. The above analysis indicated that the value of COD$_{Mn}$ in the Songhuajiang River was higher than that in the Mopanshan Reservoir. However, the referred pollutants can be removed excellently through water purification treatment. Meanwhile, the content of NH_4^+–N in the Songhuajiang River has decreased gradually year by year, while the Mopanshan Reservoir has a trend of eutrophication. The water quality of the Songhuajiang River can meet the Case III water standard, which indicates that the water can reach the requirements for drinking water sources.

3.3. Finished water quality

Based on the above comparative analysis of the water quality, the main pollutants in the Mopanshan Reservoir were the COD$_{Mn}$, TN, and TP. Meanwhile, they were COD$_{Mn}$ and NH_4^+–N in the Songhuajiang River. A conventional treatment (coagulation–precipitation–filtering–disinfection) was applied based on a water plant in Harbin City to analyze the finished water quality of the two drinking water sources. The water quality of the effluent was appraised by the "Standards for drinking water quality" (GB5749-2006).

3.3.1. Finished water quality in the Mopanshan Reservoir

The national drinking water standard involves 106 water quality indices. The major common water quality indices of the finished water from 2016 to 2018 are presented in Table 3, while the other indices are below the LOD. Clearly, all the values of detectable indices can reach or be inferior to the national standard. The point to make here is that the excessive COD$_{Mn}$ and TN in raw water can be removed by the conventional treatment effectively. The effluent can completely meet the national drinking water standard. For example, the COD$_{Mn}$ and TN value in 2018 averagely are 1.47 and 0.075 mg/L on average, which are evidently 51% and 85% inferior to the threshold value of the national drinking water standard.

Due to the high content of natural macro-molecule organic matter in the Mopanshan Reservoir water, it is easy to produce the DBP exceeding the drinking water standard after the use of liquid chlorine disinfection [17–19]. Hence, a detailed statistical analysis of DBPs was performed. The sterilization indicators of the finished water from 2016 to 2018 are presented in Table 4. According to the qualitative analysis of organic pollutants in the effluent from the water plant, results showed 10 types of DBPs, 6 of which could be detected. All of these DBPs met the drinking water standard, except for chloral. The average value of chloral was 0.012 mg/L, which exceeded 20% of the limit. Moreover, the content of chloral in the rainy season was evidently higher than that in the icebound season. It indicated that chloral was another crucial control indicator in the rainy season for the Mopanshan Reservoir, other than the COD$_{Mn}$, TN, and TP.

3.3.2. Finished water quality in the Songhuajiang River

The monitoring values in 2017 were collected to analyze the finished water quality of the Songhuajiang River after conventional treatment. The values of major common water quality indices are shown in Table 5. All the referred water quality indices meet the drinking water standard, except for the NH_4^+–N. The average value of NH_4^+–N was 1.01 mg/L, exceeding 2.02 times than the threshold value of the national drinking water standard. In the icebound

Table 3
Major common water quality indices of the finished water in the Mopanshan Reservoir

Index	Threshold value	2016		2017		2018	
		Rainy season	Icebound season	Rainy season	Icebound season	Rainy season	Icebound season
pH	6.5–8.5	7.0	7.0	6.8	6.81	6.80	6.83
Chloride (mg/L)	250	6.73	6.35	8.20	7.724	9.17	8.84
Sulfate (mg/L)	250	8.54	8.12	10.33	7.657	9.16	8.17
Total hardness (mg/L)	450	30	38	34	38	36	40
TN (mg/L)	0.5	<0.025	0.04	<0.025	0.03	0.07	0.08
Fluoride (mg/L)	1.0	0.05	0.02	0.08	0.017	0.02	0.01
COD_{Mn} (mg/L)	3	1.84	1.04	1.76	2.32	1.36	1.58

Table 4
Monitoring value of DBPs of the finished water in the Mopanshan Reservoir

Index	Threshold value (mg/L)	2016		2017		2018	
		Rainy season	Icebound season	Rainy season	Icebound season	Rainy season	Icebound season
Trichloromethane	1	0.0253	0.0244	0.0207	0.0073	0.0052	0.0032
Chloral	0.01	0.021	0.011	0.005	0.016	0.012	0.006
Trichloroacetic acid	0.1	0.019	0.018	0.012	0.010	0.013	0.01
Dichloroacetic acid	0.05	0.011	0.006	0.004	<0.001	0.015	<0.001
Bromodichloromethane solution	0.06	0.0023	0.003	0.001	<0.001	<0.001	<0.001
Dichloromethane	0.02	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Tribromethane	0.1	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Dibromochloromethane	0.1	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cyanochloride	0.07	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
2,4,6-Trichlorophenol	0.2	<0.02	<0.02	<0.02	<0.001	<0.001	<0.001

Table 5
Major common water quality indices of the finished water in the Songhuajiang River

Monitoring time	Index						
	pH	COD_{Mn} (mg/L)	NH_4^+–N (mg/L)	Total hardness (mg/L)	Fluoride (mg/L)	Chloride (mg/L)	Sulfate (mg/L)
Rainy season	7.01	2.82	0.05	66.4	0.25	16.57	17.93
Icebound season	7.01	2.66	1.96	90.4	0.26	16.93	28.84

season, the monitoring value of NH_4^+–N was 1.96 mg/L, exceeding 3.92 times than the limit value. It indicated that the conventional treatment was ineffective in eliminating NH_4^+–N in the icebound season. The average value of COD_{Mn} was 2.74 mg/L, which was 8.7% lower than the limit value. That is to say, the COD_{Mn} of the Songhuajiang River water after the conventional treatment can reach the national drinking water standard, while the NH_4^+–N cannot be eliminated efficiently. However, numerous researchers suggest that ozone/activated carbon process is effective to eliminate the NH_4^+–N [7,20]. For example, Fan et al. [21] found that when the concentration of NH_4^+–N in raw water was 1 mg/L, the value in the effluent after the process of ozone/activated carbon was 0.3 mg/L, which distinctly reached the drinking water standard.

The sterilization indicators of the Songhuajiang River' finished water in 2017 are listed in Table 6. It can be seen that there were ten types of DBPs in the finished water, four of which were detected. All the detected DBPs met the drinking water standard. For example, the average value of chloral was 0.004 mg/L, which was obviously below the limit value. That is to say, the conventional treatment is effective in removing the DBPs of the Songhuajiang River water.

Table 6
Monitoring value of disinfection by-products of finished water in the Songhuajiang River in 2017

Index	Threshold value (mg/L)	Monitoring value (mg/L)	
		Rainy season	Icebound season
Trichloromethane	1	0.0027	0.0072
Chloral	0.01	0.003	0.005
Trichloroacetic acid	0.1	0.002	0.011
Dichloroacetic acid	0.05	0.005	0.020
Bromodichloromethane solution	0.06	<0.001	<0.001
Dichloromethane	0.02	<0.0001	<0.0001
Tribromethane	0.1	<0.001	<0.001
Dibromochloromethane	0.1	<0.001	<0.001
Cyanochloride	0.07	<0.01	<0.01
2,4,6-Trichlorophenol	0.2	<0.001	<0.001

Given the comprehensive analysis of water quality indices, it can be concluded that the Mopanshan Reservoir water can reach the Case III standard. However, it has trends of deterioration and eutrophication. Importantly, the finished water of the reservoir existed with exceeding amount of chloral after the conventional treatment, according to "Standards for drinking water quality" (GB5749-2006). This increases the difficulty of subsequent processing. However, after the Songhuajiang River undergoing over a decade of contamination remediation, the water also can reach the Case III standard. Further, the finished water can meet the national drinking water standard after the conventional treatment, apart from the NH_4^+–N in the icebound season. Taken into account the disadvantage of the Mopanshan Reservoir, the Songhuajiang River water is more suitable for the drinking water at present.

4. Conclusion

The waterbody classification, characteristic pollutants of the raw water and finished water quality of the Mopanshan Reservoir and the Songhuajiang River were analyzed in this work. Results showed that the Mopanshan Reservoir and the Songhuajiang River water both could reach the Case III standard. The characteristic pollutants of the Mopanshan Reservoir were COD_{Mn}, TN, and TP. All of them had characteristics of seasonal variation. In addition, the reservoir had a trend of deterioration and eutrophication in recent years. The characteristic pollutants of the Songhuajiang River were COD_{Mn} and NH_4^+–N. Both of them had a characteristic of seasonal variation.

After the conventional treatment of raw water from the Mopanshan Reservoir, only the chloral could not meet the national standard, while all other water quality indices could reach the requirements of "Standards for drinking water quality" (GB5749-2006). For the Songhuajiang River, all the water quality indices and DBPs could meet the national standard after the conventional treatment, apart from the NH_4^+–N in the icebound season. Through contrast and analysis, the Songhuajiang River is more suitable for the drinking water at present. It is suggested to apply a new model of dual-source combined water supply amalgamating the Mopanshan Reservoir and Songhuajiang River. This would alleviate the water supply pressure. Then, we could strengthen water supply safety for the urban area of Harbin City and avoid risks associated with the use of a single-water source.

Acknowledgments

This article was not supported by any foundation. But the authors would like to thank the assistance of Prof. Chong-wei Cui in the water quality of Songhuajiang River and Mopanshan reservoir.

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