



Water quality evaluation based on the water quality index in Lake Bosten: a large brackish inland lake in arid northwest China

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Received 30 June 2019; Accepted 17 November 2019

ABSTRACT

Lake Bosten is a representative lake in the arid area of northwest China and has attracted much attention due to its serious pollution. Using the water quality index (WQI) method, this research offers a vivid and overall understanding of the water quality of Lake Bosten. From 2007 to 2017, 14 sites in Lake Bosten were sampled once each month, and 21 parameters were measured to calculate the WQI. The results show that the water quality of Lake Bosten was “good” overall and showed a trend of improvement on an interannual scale. Seasonally, the water quality during the wet season was better than that during the normal water season. Other parameters usually resolved the WQI values in the evaluation, particularly sulfates (SO_4^{2-}) and chlorides (Cl^-), while the easily treated parameters and toxic metals in Lake Bosten were usually at low safety levels. The water level had an energetic effect on the water quality of Lake Bosten by diluting the environmental parameters, and in practice, it affected the concentration of sulfates (SO_4^{2-}). Our results provide a valuable reference to water management by providing information on the water quality in Lake Bosten.

Keywords: Lake Bosten; Water quality evaluation; WQI method; WL; Mineralization

1. Introduction

An appropriate amount of high-quality water resources is the premise of economic development and ecological construction. Artificial and natural processes degrade surface water and affect its use for drinking, industrial, agricultural, recreational and other purposes [1]. Lakes provide major water resources for families, industry and irrigation; however, with the development of rough and wild industrial and agricultural structures and unreasonable utilization, water bodies have become increasingly unable to meet the requirements as normal drinking water sources for humans. As lakes play a key role in ecological health and sustainable

social development, it is necessary to protect and control the decline in lake water quality. Therefore, effective information on water quality changes must be collected for scientific management. Water quality evaluations are essential to determine the temporal and spatial changes in water quality and its main contributors, which is conducive to water resource management. In addition, according to the information assessed, public administrations can take protective measures to improve the water quality.

Many studies have builded various methods for evaluating water quality, including the multivariate statistical techniques, PoS index and the geochemical indicators and GIS [2–5]. The use of the water quality index (WQI) was

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originally proposed by Horton [6] and Brown et al. [7] and has been further developed by various researchers [8–10]. Although multiple formulas can be used to calculate the WQI, they all effectively convert the relative pollution value of each pollutant into a simple value that reflects water quality, eliminating the differences caused by using single-factor parameters in evaluations. The WQI has been widely used to assess surface water quality. Using the WQI, Wu et al. [11] assessed the effect of water level (WL) changes on the water quality of Lake Panyang on a temporal and spatial scale. Using a combination of the WQI and GIS, Sener et al. [12] evaluated the spatial differences in water quality of the Aksu River in Turkey.

Lake Bosten is a typical representative of lakes in the arid areas of northwest China. This lake provides valuable water resources for the development of industry and agriculture in Bayingol Mongolia Autonomous Prefecture, Xinjiang [13,14]. The salinity of the water in Lake Bosten and eutrophication has been recently observed to be increasing and intensifying, respectively [15]. Hence, a number of studies have been carried out on the water quality of Lake Bosten, including analysis of the distribution of water quality parameters and the evolution of the water quality of Bosten Lake over the past 50 years [16]. Since the 1970s, Lake Bosten has been transformed from the largest freshwater lake in Xinjiang into a brackish water lake. Furthermore, the water quality of Lake Bosten has been assessed before, and the previous results were mainly based on single-factor assessments [17]. Nevertheless, the assessments of water quality in other regions have adopted a more comprehensive approach, taking multiple water quality parameters into account instead of using the most-damaged parameters [18,11]. Consequently, a more dependable way is needed to define the water quality of Lake Bosten. In addition, lake WL is largely influenced by Water level fluctuations [19]. Since Lake Bosten is at the tail of the Kaidu River and the source of the Peacock River, its WL fluctuates greatly on the seasonal scale [20]. Therefore, it is very important to define the impact of the WL on the water quality of Lake Bosten, which could ameliorate the water quality management of Lake Bosten.

In this study, the WQI method was applied to assess the water quality and its temporal-spatial variations in Lake Bosten. Our study was based on a data set of 21 parameters surveyed at 14 sampling points in Lake Bosten six times per year during a 11-year period. The targets of this study were to (1) explain the water quality status and temporal-spatial changes in Lake Bosten and (2) discuss the main parameters resolving the water quality of Lake Bosten. This study supplies an overall understanding of the water quality assessment in Lake Bosten, which is essential for water utilization, and it also strengthens the knowledge base for water quality assessments of plateau lakes around the world.

2. Materials and methods

2.1. Study area

Lake Bosten (86°19′–87°28′E, 41°46′–42°08′N) is located in the center of Eurasia. The Lake Bosten Basin, with Lake Bosten as its water source, spans four counties in North China,

including Bohu County, Hejing County, Heshu County and Yanchi County. It has an inland desert climate with abundant heat, dry air and scarce rainfall. The average annual temperature in the lake area is 8.4°C, the average annual precipitation is 94.7 mm, and the potential annual evapotranspiration is 1,800 mm [21,22]. Lake Bosten is a deep dish with a water area of 1,002.4 km², an average water depth of 8.8 m and a maximum water depth of 17 m. The annual average temperature is approximately 7.9°C, and the lowest is in January (–12.7°C) [23,24]. Located in the Kaidu River-Peacock River system, Lake Bosten is the source of the Kaidu River and the Peacock River. It also has water resources regulation of Kaidu River water supply, farmland irrigation in the Peacock River irrigation area, industrial, urban and rural domestic water use. With the large-scale development of human activities in the Yanqi Basin and the role of global climate change, lakes are becoming degraded, lake mineralization is increasing, eutrophication is intensifying, and the ecological environment is rapidly deteriorating, seriously affecting the stability of ecosystems and ecological services [25].

2.2. Sample collection and laboratory analysis

In 2007–2017, 14 sampling points were carefully selected in Lake Bosten to represent the entire area, and six samplings were conducted each year (May–October, the rest of the year could not be sampled due to the occurrence of the ice-sealing period; Fig. 1). All locations were located in areas without large plants. Site 14 was near the estuary of the Kaidu River. Site 7 was located in brackish waters, and saline and eutrophication irrigation drainage from the Huangshui ditch northwest of Lake Bosten had an effect on site 7 [26]. The pH and dissolved oxygen (DO) were measured in the field using a YSI multi-water quality meter (YSI 6600V2, USA). Then, three copies of mixed water samples were collected at each sampling point with a 500-mL plastic bottle, and the plastic bottle was rinsed with water before sampling. To analyze the heavy metals, 500 mL of the samples were immediately filtered through a 0.45- μ m cellulose acetate membrane that had previously been combusted in a Muffle furnace at 500°C for 5 h and washed with 0.05 M HNO₃. The filtrates (50 mL) were collected in acid-washed polypropylene bottles and acidified to a pH of 1–2 with ultra-clean HNO₃. All bottles were transferred to a laboratory refrigerator and analyzed as quickly as possible. Total nitrogen (TN), total phosphorus (TP), ammonia nitrogen (NH₄⁺-N) and petroleum were analyzed according to Chinese standard methods [27]. The concentrations of inorganic salts such as cyanide (CN⁻), fluoride (F⁻), chloride (Cl⁻), sulfate (SO₄²⁻), and permanganate (KMnO₄) were measured by ion exchange. Selenium (Se), arsenic (As), mercury (Hg), cadmium (Cd), hexavalent chromium (Cr⁶⁺), lead (Pb), copper (Cu), zinc (Zn) were measured by cold atomic fluorescence spectrometry. The concentrations of 5-d biochemical oxygen demand (BOD₅) and fecal coliforms were determined by the dilution and inoculation method and membrane method.

2.3. WQI calculations

The “Surface Water Environmental Quality Standard” GB3838-2002 [28] was selected as the evaluation standard,

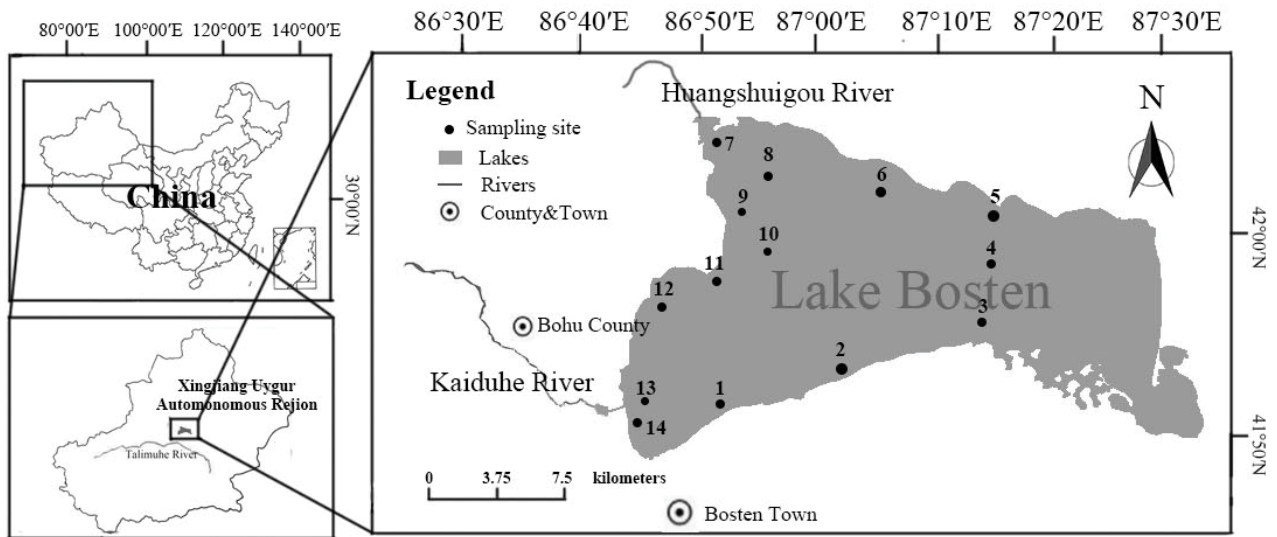


Fig. 1. Sampling site of Lake Bosten.

and the WQI classification is shown in Table 1. The parameters in the evaluation were divided into three groups: the first group of easily treated parameters included $\text{NH}_4\text{-N}$, TP, TN, pH, DO, BOD_5 , permanganate, and fecal coliform, the second group of toxic metals included Se, As, Hg, Cd, Cr^{6+} , Pb, and CN^- , and the third group of other parameters included Cu, Zn, F^- , SO_4^{2-} , Cl^- , and petroleum. The WQI calculation formula for the evaluation parameters is as follows: when $C_{iok} \leq C_i < C_{iok+1}$

$$I_i = \left(\frac{C_i - C_{iok}}{C_{iok} + C_{iok+1}} \right) \times 20n + I_{iok} \tag{1}$$

where C_i is the measured concentration of the i th evaluation parameter, C_{iok} and C_{iok+1} are the standard concentrations of the K and $K + 1$ levels of the i th parameter, respectively; n is the number of identical standard values of the i th parameter in GB3838-2002; I_{iok} is the K -level index value of the i th parameter, and the values of the I, II, III, IV, and V classes are 20, 40, 60, 80, and 100, respectively. It is easiest to purify the first and third groups of pollutants, so the average of each individual index is taken separately. Toxic metals must be strictly controlled, so W (2) takes the highest single index. Finally, the WQI for each water source takes the highest of the above three categories of classification indices, that is, $\text{WQI} = \max(W(1, 2, 3))$. Some parameters, such as SO_4^{2-} , Cl^- , and Cu, have only one standard value. Therefore, the WQI of these parameters is expressed as

$$\text{WQI} = \frac{C_i}{C_{oi}} \times 60 \tag{2}$$

Table 1
Water quality index table

Water quality evaluation	Excellent	Good	Moderate	Poor	Low	Bad
WQI	<20	21–40	41–60	61–80	81–100	>100

When the pH value is in the 6–9 range, the individual index value is recorded as 0; when the pH is not in this range, its single index is recorded as 100. Finally, the water quality of Lake Bosten is evaluated based on the calculated WQI value and WQI table.

2.4. Data analysis

All data were $\log(x + 1)$ transformed before analysis to satisfy normal and variation conditions. The relationship between the WL and WQI was analyzed by SPSS22.0 statistical software. Using the one-way analysis of variance (ANOVA) of the general linear model, an LSD test was performed at a 5% significance level to determine significant differences in lake location and season for each indicator.

3. Results

3.1. Results of WQI water quality evaluation

According to all WQI calculations, from 2007 to 2017, the WQI value of Lake Bosten was 36.02, and the water quality rating was “good”. Only three observations had WQI values higher than 40, which were 43.1, 41.4, and 40.4. The overall water quality was “good”. Based on the itemized WQI levels, the water quality statuses of portions of Lake Bosten were “good” and “moderate”, accounting for 68% and 32% of all samples, respectively. Spatially, site 7 (43.69) had the highest average WQI, while the lowest (26.68) was at site 14 (Fig. 2). On the interannual scale, the average WQI values in 2008, 2009, and 2012 were all higher than 40, with values of 43.1, 41.4, and 40.5, respectively. In 2008, the WQI

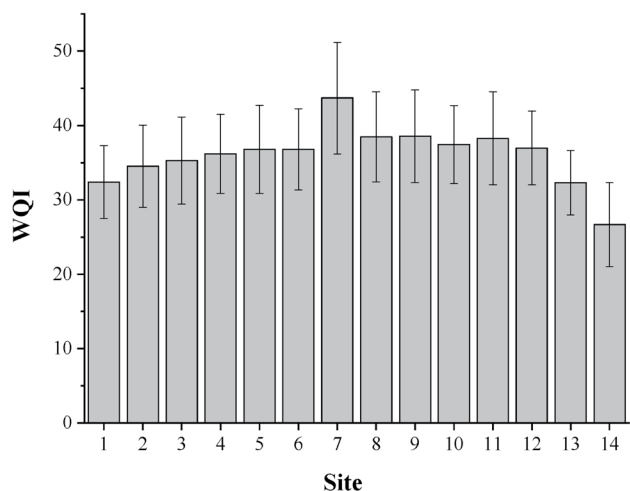


Fig. 2. Spatial distribution of water quality index of Lake Bosten from 2007–2017. Results were expressed as mean ± standard deviation (SD) based on WQI values.

reached the highest value, and the proportion represented by the “moderate” status was relatively high (Fig. 3b). The average WQI values in 2007, 2010, 2013, 2014, 2015, 2016, and 2017 were all lower than 40, with values of 35.4, 39.2, 36.4, 39.1, 33.8, 27, and 26.2, respectively, and the lowest was recorded in 2017 (Fig. 3a). Overall, the WQI value increased between 2007 and 2008 because the percentage of “good” stations changed. From 2008 to 2017, the WQI value showed a downward trend, and the “moderate” percentage gradually increased. Thus, the 11-year study indicated that the water quality in Lake Bosten was “good” or “moderate”, and the water quality exhibited an overall trend of improvement. Seasonally, there were also changes in the WQI value (Fig. 3c). The average WQI value during the wet season was 42.61, which was lower than the average WQI value of the normal water season (43.03). The percentage of “good” water quality samples during the wet season was greater than the percentage of “good” water quality during the normal water season (Fig. 3d). The results showed that the water quality of Lake Bosten reached a “good” water quality level during the wet season, and the percentage of

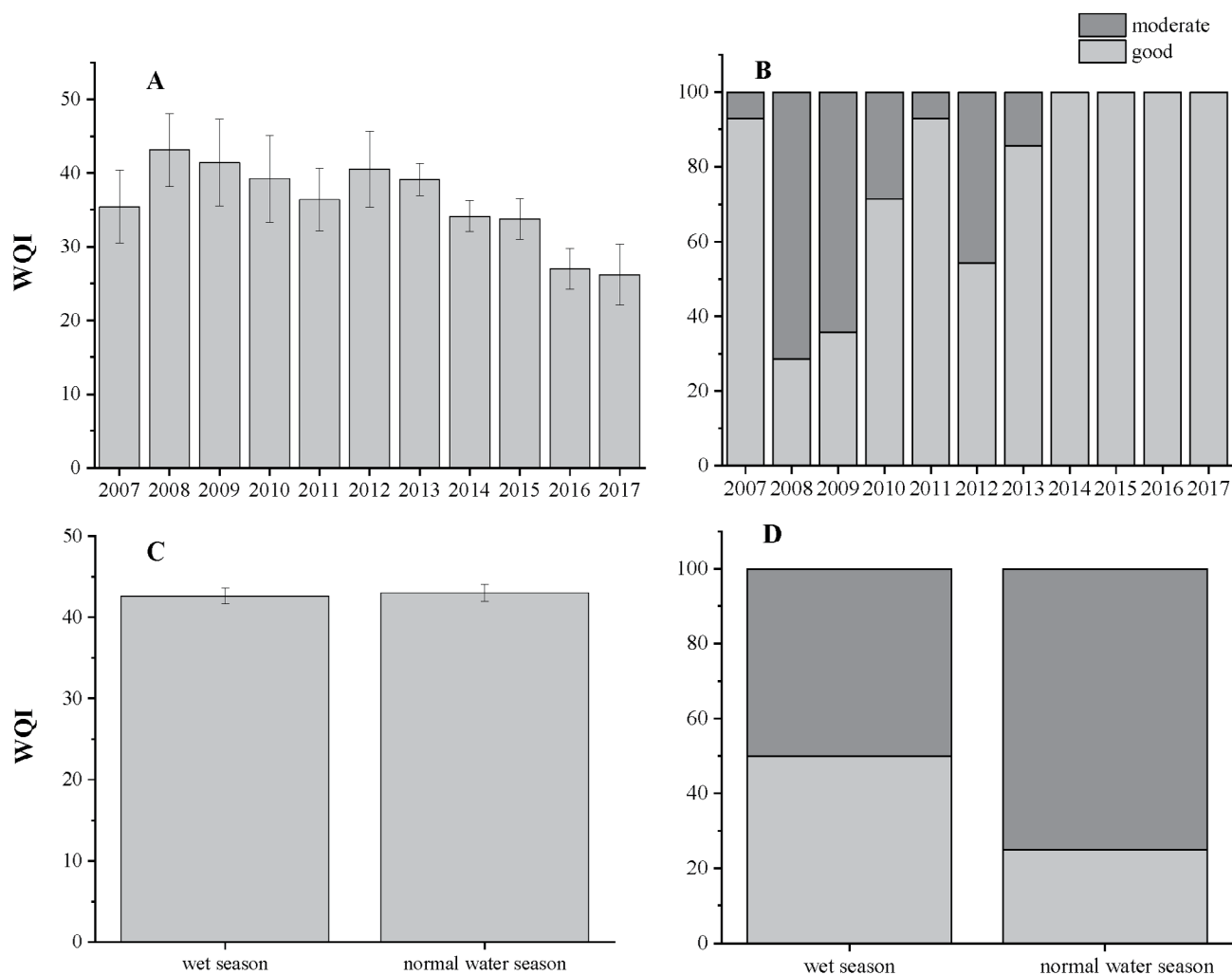


Fig. 3. Time distribution of WQI value and relative composition of water quality grade of Lake Bosten from 2007–2017. Results were expressed as mean ± SD based on WQI values.

“moderate” water quality grades during the normal water season was high.

3.2. Main influencing factor of the WQI

In the three types of classification, other parameters played a leading role in the WQI. The WQI values of the other parameters (W (3)) were defined by the individual indices of copper (Cu), zinc (Zn), fluoride (F⁻), chlorides (Cl⁻), sulfates (SO₄²⁻), and petroleum. On the one hand, based on all of the data, the average W (3) was 39.01, which was almost equivalent to the average WQI of Lake Bosten (41.4). The average WQI values for W (1) and W (2), which represent the easily treated parameters and toxic metals, were 20.1 and 10, respectively, which were far lower than the W (3) values and maintained relatively low levels on the intertemporal scale (Table 2). Specifically, total nitrogen (TN), total phosphorus (TP), 5-d biochemical oxygen demand (BOD₅), ammonia nitrogen (NH₄⁺-N), permanganate (KMnO₄), dissolved oxygen (DO), fecal coliforms and pH were classified as easily treated parameters in this study. The average WQI values of those parameters were 47.1, 21.69, 7.34, 9.67, 48.17, 21.55, 3.66 and 0. For the toxic metals, that is selenium (Se), arsenic (As), mercury (Hg), cadmium (Cd), hexavalent chromium (Cr⁶⁺), lead (Pb), and cyanide (CN⁻), the WQI value of each parameter was no more than 10, all of which were characterized by “moderate” water quality. On the other hand, the final WQI values of 94.23% of the samples were defined by W (3), while W (1) and W (2) were determined by only 3.85% and 1.92% of the total WQI samples, respectively. In addition, the related coefficient between the WQI and W (3) was 0.9961, which was closer than the correlation coefficients between the WQI and W (1) and W (2), which were 0.07 and 0.025, respectively.

Mineralization, particularly sulfates and chlorides, contributed the most to the WQI value of the third group (Table 3). The average WQI value of sulfates was 111.90, which was more than three times that of W (3). The average WQI value of chlorides was 70.19, which is also the reason for the high WQI value in W (3). In addition, the results of the

calibration analysis showed that the correlation coefficients between sulfates and W (3) and the WQI were the largest, and the related coefficients were 0.9992 and 0.9930 (Table 3). Chlorides also played a key role in the assessment, with a related coefficient of 0.9954 with the WQI. Thus, the other parameters usually defined the WQI value in the evaluation when the easily treated parameters and toxic metals were at a low enough level for safe drinking water in Lake Bosten. Spatially, the mean WQI values of sulfates were higher than those of chlorides at 14 sites, and the mean WQI values of sulfates and chlorides were significantly higher than those of W (3) (Fig. 4a). The mean WQI values of sulfates ranged from 50.4 to 150.9 at each point, and the maximum value occurred at site 7. The minimum average WQI value for sulfates occurred at site 14, which is where the minimum average WQI value for chlorides also occurred. On an inter-annual scale, the average WQI values for sulfates from 2007 to 2017 ranged from 83.31 to 142.18, and the average WQI value for sulfates was more than three times the W (3) value per year (Fig. 4b). The average value for sulfates showed great differences throughout the 11-year study. In 2012, the average WQI value of sulfates was very high, followed by that in 2008. The average WQI value of sulfates in the 11 years showed a general downward trend, and the decline

Table 3
Distribution of other parameters after normalization and their Pearson correlation relationships with W (3)/WQI

Parameter	Mean (range)	Coefficient		n
		WQI (3)	WQI	
SO ₄ ²⁻	111.9 (50.4–150.9)	0.9992	0.9930	66
Cl ⁻	70.19 (36.9–90.59)	0.9971	0.9954	66
F ⁻	11.2 (8.4–12.24)	0.9040	0.8500	66
Cu	2 (0–2)	0.0042	0.0032	66
Zn	4 (0–4)	0.0850	0.0830	66
Petroleum	2 (0–2)	0.0026	0.0012	66

Table 2
Changes of water quality index (WQI) among the three groups of Lake Bosten from 2007–2017

		W (1)	W (2)	W (3)
Seasonal	Wet season	23.87 (21.3–26.3)	10 (0–10)	42.61 (38.5–43.5)
	Normal water season	25.19 (24.9–26.1)	10 (0–10)	43.03 (40.9–43.2)
Interannual	2007	19.89 (17.8–24.6)	10 (0–10)	35.32 (22.9–49.5)
	2008	24.46 (19.4–35)	10 (0–10)	43.14 (35.6–56.8)
	2009	24.83 (20.7–28.7)	10 (0–10)	41.29 (23.8–49.5)
	2010	24.76 (22.5–26.3)	10 (0–10)	38.89 (19.4–46.4)
	2011	23.82 (22.8–25.1)	10 (0–10)	36.43 (25.3–42.9)
	2012	24.25 (22.8–25.2)	10 (0–10)	40.51 (26.2–42.8)
	2013	22.85 (21.3–24.6)	10 (0–10)	39.12 (34.4–45.5)
	2014	23.64 (21.9–25.5)	10 (0–10)	36.18 (30.6–38.7)
	2015	20.44 (19.4–21.6)	10 (0–10)	33.83 (28.3–37.2)
	2016	19.88 (18.6–21.4)	8 (0–8)	26.60 (15.5–31)
2017	13.88 (11.6–16.5)	8 (0–8)	25.54 (6.8–34.5)	

from 2012 to 2017 was greater than that from 2008 to 2011 (Fig. 4b).

3.3. Relationships between WL and WQI/minerals

The WL show great temporal-spatial differences in Lake Bosten. The highest mean WL (14.2 m) appeared in the wet season, and its range was 2–14.2 m. The lowest mean WL (0.8 m) occurred in the normal water season, with a range of 0.8–11.4 m. During the study period, the average WL value was 5.3 m, and in 2010, the maximum WL was 15 m. In 2012, the minimum WL was 0.8 m. Spatially, the maximum WL (15 m) was observed at site 4, and the lowest WL (0.7 m) was observed at site 7. The correlation analysis results showed that the WL was negatively correlated with the WQI ($R^2 = 0.059$, $p = -0.24$) (Fig. 5a). The coherence levels between W (1), W (2), W (3) and the WL were analyzed. The WL had a notable adverse impact on W (3) (Fig. 5b). In particular, of the six parameters affecting W (3), SO_4^{2-} was significant ($p < 0.001$) and inversely proportional to the WL, $R^2 = 0.059$ (Fig. 5c). In addition, Cl^- showed a close relationship with the WL ($R^2 = 0.056$, $p = -0.23$; Fig. 5d). However, no notable relativity was observed between the WL and pH, DO or BOD_5 .

4. Discussion

4.1. Water quality status of Lake Bosten

Based on the WQI classification criteria, the general water quality of Lake Bosten was “moderate”, and the average was approximately “good”. The studies showed that the water quality of Lake Bosten still satisfied the demands for living and irrigation and that the water quality of Lake Bosten improved year by year. Although there are many ways to assess water quality, little is known about the water quality of Lake Bosten. Studies have shown that the water quality

of Lake Bosten has been “poor” over the past decade [29]. This condition is worse than the condition determined by this study. However, recent research on the dynamic changes in water and salt in Lake Bosten from 1951 to 2011 noted that the water quality status of the lake was “moderate” [30]. Subsequently, the overall water quality of Lake Bosten was “good” or “moderate”. A single-factor evaluation was the most commonly used method for previous water quality evaluations of Lake Bosten. Regardless of whether the single-factor method provides count information, the results based on maximum damage parameters cannot effectively reflect the water quality status. In contrast, a large number of parameters can be effectively used to assess the water quality, and these methods have been widely used [31]. This 11-year study used the WQI and evaluated 21 parameters, including easily treated parameters, toxic metals, and other parameters. Consequently, the outcomes of this research were carried out in a more comprehensive manner, which resulted in a more acceptable assessment of the water quality of Lake Bosten. On the interannual scale, the water quality of Lake Bosten is generally improving. This improvement may be due to the improvement of the water quality of the inflow rivers, including the Kaidu and Qingshui Rivers. The two rivers are the main inflow rivers to the lake. This condition indicates that the improvement of the water quality in the rivers has also improved the water quality in the lake [32]. Changes in WQI levels were observed at all 14 sites, probably due to the changes in water flow in Lake Bosten. As Lake Bosten is connected to the Kaidu River and the Peacock River, the exchange of lake water is rapid. For this reason, high maneuverability and rapid water changes reduced the spatial diversities in water quality [33]. In addition, the water flowing into Lake Bosten may affect the spatial variation in the water quality to some extent. The maximum and minimum values of the WQI were viewed at sites 7 and 14, respectively. Site 7 was in the northwest corner of the lake, which was the main drainage area in the Great Lakes region

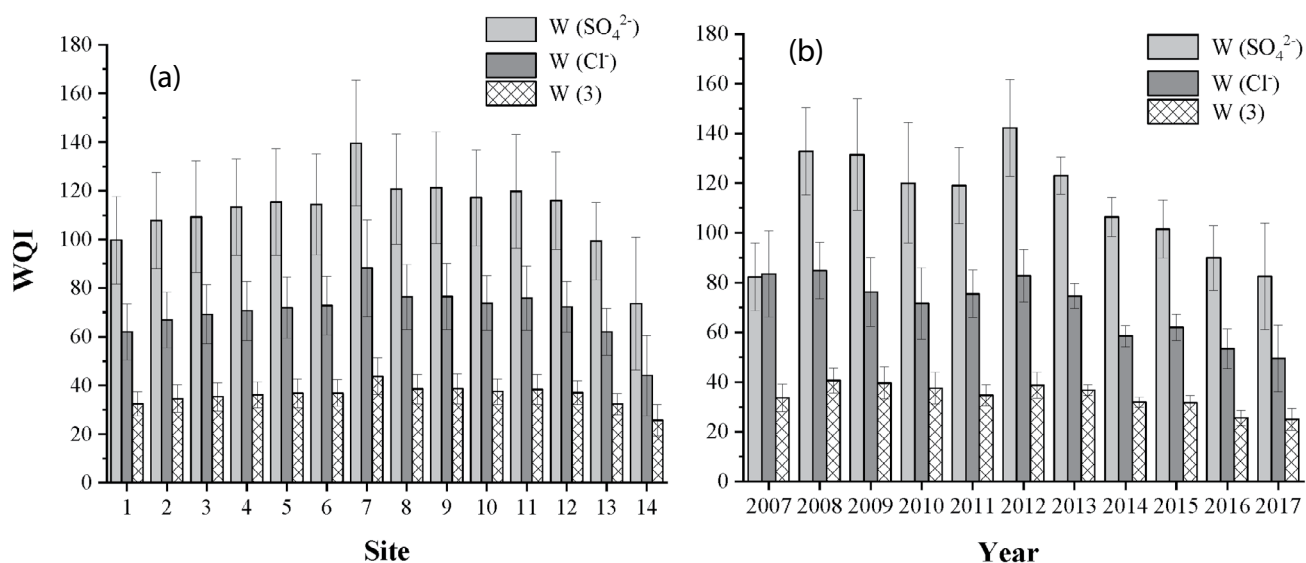


Fig. 4. Spatial variation (a) and interannual variation (b) of water quality indexes of sulfate, chloride and W (3) in Lake Bosten from 2007 to 2017. Results were expressed as mean \pm SD based on WQI values.

of Lake Bosten. Large amounts of industrial, agricultural and domestic sewage from the four counties of Lake Bosten have been deposited in this region [34,35]. Although pollutants are intercepted and purified by the lakeside reed wetland, high concentrations still enter the lake [36,37]. Site 14 was in the Dahekou-West pump station area, which was the direct recharge area of fresh water from the Kaidu River, so it had the lowest average WQI value.

4.2. Dominant role of other parameters

The water quality evaluation results of Lake Bosten were mainly based on other parameters, while the water quality indicators such as toxic metals were generally at low safety levels. The WQI values of other parameters in this study were calculated based on copper (Cu), zinc (Zn), fluoride (F^-), chlorides (Cl^-), sulfates (SO_4^{2-}) and petroleum to determine the WQI value of Lake Bosten. In particular, sulfates and chlorides played a crucial role, and their WQI values were significantly higher than the values for W (3). Since the 1960s, due to the rapid development of agriculture development in the Yanqi Basin, salt washing and improvements to soil alkalinity have increased the amount of high-salinity farmland water entering Lake Bosten, resulting in a continuous increase in the salinity of the lake [15,38]. The Huangshuigou have received large amounts of industrial, agricultural and domestic sewage

from the four counties of Lake Bosten [34,35]. The results of this paper are consistent with those of Li and Yuna [15], who noted that minerals were the main parameters affecting the water quality of Lake Bosten. During 2007–2017, the concentrations of chlorides and sulfates decreased from 628.8 and 378 mg/L to 263 and 151 mg/L, respectively. The decrease in the Cl^- and SO_4^{2-} concentrations was the main reason for the improvement of the water quality in the interannual range. In addition, the average concentrations of Cl^- and SO_4^{2-} in Lake Bosten were high in the normal water season and low in the wet season, which was consistent with the seasonal changes in the WQI value of Lake Bosten.

Mineral pollution is a common problem in the lakes of Xinjiang. According to the monitoring data from other lakes in Xinjiang (Brentory Sea, Yankekule Lake and Reservoir), the salinity of the Brentory Sea increased from 2.4 to 6.59 g/L over 30 years, and the salinity of the Yankekule Lake and Reservoir also increased from 0.64 to 1.88 g/L; the chemical types were SO_4^{2-} , Cl^-Na [39]. Zhang et al. [40] analyzed the pollution levels, sources and changing trends of heavy metals in Lake Bosten. The results showed that the geological accumulation indices of Pb, Zn and Cu in Lake Bosten were less than 0.5; therefore, heavy metals were not the main parameters affecting the water quality of Lake Bosten. Instead, mineralization may be a key parameter in determining the water quality of Lake Bosten.

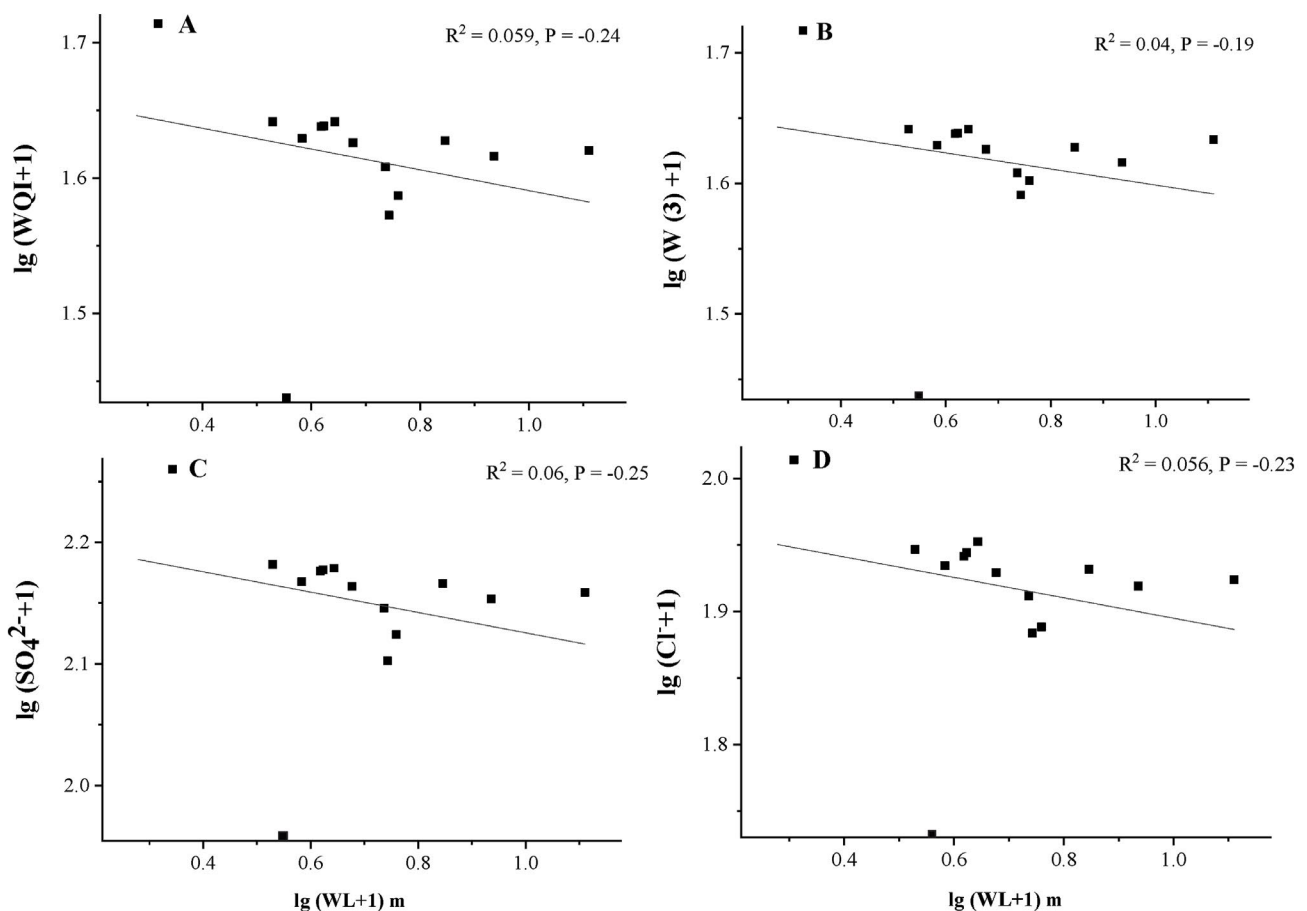


Fig. 5. Variation characteristics of WL, W (3), SO_4^{2-} and Cl^- on the seasonal scale of Lake Bosten from 2007 to 2017.

4.3. Effect of WL on water quality

The WL affects the water quality of Lake Bosten mainly by the dilution of mineral concentrations on seasonal scales. Studies have shown that an increase in the WL results in significant improvement in the water quality of Lake Bosten on the seasonal scale. Studies have indicated that the WL is a key parameter for measuring the construction of lake ecosystems [41]. In addition, due to the input of the melt water from the Tianshan glaciers and the water pumping effect of the pumping station, Lake Bosten experiences high WL fluctuations. Studies have shown that the WL is an important factor affecting the total dissolved solids of the Lake Bosten [16]. In this study, the relationship between the WL and the WQI and W (3), especially SO_4^{2-} , exhibited an inverse ratio. SO_4^{2-} was one of the main contributors to the WQI in Lake Bosten. A similar phenomenon has occurred in two eutrophic lakes connected to the Yangtze River in China. According to 15 years of data, the concentrations of TN and COD_{Mn} increased with the decrease in the WL [42]. On the one hand, the dilution from precipitation may play a key role in this reciprocal relationship in Lake Bosten. Wu et al. [11] certificated that the variations in pollutant concentrations are likely to be affected by the dilution effect of WL fluctuations. On the other hand, the WL caused sediment resuspension and nutrient release [43], which caused the water quality to deteriorate over time. Negative effects of a low WL on water quality have also been discovered in other regions. For example, regardless of the nutritional status, the water quality of the Mediterranean aquatic ecosystem generally declines during low tide [44].

5. Conclusions

In this research, the water quality of Lake Bosten was evaluated by the WQI method. Based on the classification of the WQI, the results showed that the overall water quality of Lake Bosten was “moderate” during the study period. The water quality differed among the 14 sampling sites, and site 7 (43.69) exhibited the highest average WQI, while the lowest (26.68) was at site 14. Moreover, the water quality presented distinct seasonal variations, and the WQI value in the normal water season was higher than that in the wet season. The water quality was the worst in 2012 and the best in 2017. The overall trend of water quality improved. The results of this study are acceptable compared with those of previous studies in Lake Bosten. The results showed that the WQI water quality assessment method has high applicability in the lake. Linear regression analysis showed that sulfate and chloride were the main factors affecting the water quality of Lake Bosten, and their correlations were 0.9930 and 0.9954, respectively. In addition, the WL mainly had a positive impact on the water quality of Lake Bosten through changes to the mineral concentration on the seasonal scale. It is easy to measure these parameters for WQI calculations, which is beneficial for the rapid and low-cost water quality assessments of Lake Bosten. Consequently, our results are very important for the management of water resources in Lake Bosten.

Acknowledgments

This work was supported by the National Science Foundation of China (41601573), the Key University Science Research Project of Anhui Province (KJ2019A0641), the Linkage Project of Anhui Public Welfare Technology Application Research (1704f0804053) and the Science and the Technology Innovation Strategy and Soft Science Research Special Project of Anhui Province (1706a02020048). Anonymous reviewers are acknowledged for their constructive comments and helpful suggestions.

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