Desalination and Water Treatment
www.deswater.com

doi: 10.5004/dwt.2021.27572

242 (2021) 195–202
December

Water quality evaluation and guarantee treatment of outdoor landscape water

Zhongping Liu

Department of Civil Engineering, Anhui Communications Vocational and Technical College, Hefei, 230051, China, email: zhongpingliu009@163.com

Received 29 June 2021; Accepted 23 September 2021

ABSTRACT

The evaluation of landscape water quality is conducted as the breakthrough point to solve the increasingly serious pollution problem of outdoor landscape water. Firstly, pollution indicators are monitored, including phosphorus, chemical oxygen demand, nitrogen, ammonia nitrogen, biochemical oxygen demand, algae, and the cyanobacteria used in the experiment are cultivated in the laboratory. Secondly, on this basis, a model is constructed by the grey clustering method. Finally, the water quality guarantee is studied according to the specific water situation. The evaluation results of the model show that the No. 1 landscape water in the study area is Class IV, and the No. 2 landscape water is Class II. A study on the water quality guarantee of No. 1 landscape water shows that when the zeta potential reaches the maximum of 2 millivolts, or when the concentration of polymeric ferric sulfate is 38 mg/L, the removal efficiency of cyanobacteria reaches the maximum. When the pH value of water is 7, the removal rate of cyanobacteria reaches the maximum value of 98%, and the removal rate of turbidity is 80%. When the water temperature is between 15°C and 20°C, the phenomenon of cyanobacteria re-floating gradually increases. When the water temperature is higher than 34°C, the phenomenon of cyanobacteria re-floating weakens. After the treatment of a multi-media filtration system, the algae concentration in water decreases significantly in 2020. The highest algae content is 275,000 mL in 2019 and 50,000 mL in 2020, decreased by 82%. The turbidity of water in 2020 is far lower than that in the previous year. The turbidity of No. 1 landscape water decreases by 76.5%. In the two landscape waters selected in the experiment, the water quality of No. 1 landscape water is poor as Class IV, while the water quality of No. 2 landscape water is good as Class II. The water quality guarantee scheme for No. 1 landscape water is given, showing a good effect on the water quality guarantee.

Keywords: Landscape water; Water quality evaluation; Water quality guarantee; Algae concentration

1. Introduction

With the further improvement of people's living standards, people in cities choose to arrange outdoor landscapes to improve the quality of life [1]. More and more urban landscapes choose water layouts to simulate the natural landscape [2], such as artificial lakes and rivers, outdoor landscape fountains, and landscape ponds [3]. Landscape water plays a certain role in urban construction, especially in alleviating the "urban heat land effect" [4]. The urban heat land effect refers to the urban high temperature caused by many artificial heat sources, artificial regenerators such as roads and buildings, and the reduction of green space.

In recent years, China has increased economic investment in environmental governance [5], and water pollution has improved year by year [6]. In the 2020 China Ecological Environment Bulletin [7], among surface water, excellent, mild, moderate, and severe water quality accounted for 74.9%, 17.5%, 4.2%, and 3.4%, respectively. The main pollution indicators in 2019 were chemical oxygen demand (COD), potassium permanganate and ammonia nitrogen. Landscape water is mostly from surface water [8], so landscape water quality is also affected. The treatment technologies for outdoor water quality in China mainly consist of physical treatment, chemical treatment and biological treatment. However, a set of mature standards have not yet been formed [9], so most of the treatment technologies do not achieve ideal effects for landscape water [10]. The evaluation methods of landscape water quality mainly include the grey clustering method, fuzzy mathematics, analytic hierarchy process, comprehensive index method and expert evaluation method [11].

The water pollution indicators are monitored in the study area, and the grey clustering method is used to construct the model for water quality evaluation [12]. The algae removal test is carried out on the water body to explore the changes in algae concentration and turbidity of the water body after algae removal. Finally, the multi-media filtration system is used to study the water quality guarantee method. The experiment has certain reference significance for future research on landscape water quality.

2. Water quality evaluation and guarantee methods for landscape water

The outdoor landscape water of two buildings in a certain area is selected for experimental analysis, numbered as No. 1 landscape water and No. 2 landscape water [13]. The following indicators are monitored for the two landscape waters: COD, algae concentration, water temperature, pH (Pondus Hydrogenii), nitrogen content, ammonia nitrogen content, etc.

2.1. Chemical reagents and preparation operation in the experiment

The chemical reagents used in the experiment [14] are reagents with the specification of analytical reagent, including sodium hydroxide, hydrochloric acid, Nessler's reagent, concentrated sulfuric acid, nitric acid, stannous chloride, ammonium molybdate, potassium tartrate, potassium iodide, ascorbic acid, mercury iodide, phenol, silver nitrate, ammonia-free water, potassium dichromate and potassium persulfate [15]. The manufacturer is Sinopharm Chemical Reagent Shaanxi Co., Ltd., (China). The test instruments are the GF5000 AAS (atomic absorption spectrograph) manufactured by GBC Scientific Equipment Pty. Ltd., (4 Lakewood Boulevard, Braeside VIC 3195, Australia), the ICS-900 ion chromatograph produced by Dionex Corporation (1228 Titan Way, Sunnyvale, California 94085-3603, U.S.A.), the JZZ1000 Electronic Analytical Balance produced by Xi'an Shuangjie Measurement Plant (Xi'an, China), the PHSJ-4A pH meter produced by Sartorius Group (Sartorius AG, Otto-Brenner-Straße 20, 37079 Göttingen, Germany), the 3K15 Centrifuge produced by Sigma Laborzentrifugen GmbH (An der Unteren Sose 50, 37520 Osterode, Germany), the ZR 4-6 stirrer produced by Zhongrun Water Technology Development Co., Ltd., (Shenzhen, China), the OLYMPUS Optical Microscope produced by Olympus Corporation (Nishi-shinjuku 2-3-1 Shinjuku Monolith, JP, Tokyo, Shinjuku-ku), the DR/4000U Spectrophotometer, the 2100Q Portable Turbidimeter, the 6B-50N ammonia nitrogen tester and the 6B-200A COD detector produced by Hach Company, Inc., (Washington DC, United States), the DY04-13-44-00 vertical pressure steam sterilizer produced by Shanghai DONGYA Pressing Vessel Manufacturing Co., Ltd., (Shanghai, China), the DZKW-4 electronic thermostatic water bath produced by Beijing Zhongxingweiye Instrument Co., Ltd., (Beijing, China), the HI8633 portable conductivity tester produced by Hanna Instruments, Inc., (270 George Washington Hwy, US, Rhode Island, Smithfield, 02917), and the HJ-6 Heating Magnetic Stirrer produced by Changzhou Guohua Electric Appliances Co., Ltd., (Changzhou, China).

This algae culture experiment selects the most common cyanobacteria in the water of the study area [16]. The medium components used are 1.4 mg/L $NaNO_3$, 0.03 mg/L $K_2HPO_4·3H_2O$, 0.73 mg/L $MgSO_4·3H_2O$, 0.35 mg/L $MgSO_4·3H_2O$, 0.002 mg/L $C_{10}H_{14}N_2Na_2O_8·2H_2O$, 0.005 mg/L $C_6H_8O_7$, 0.007 mg/L $C_6H_{10}FeNO_8$, 2.79 mg/L H_3BO_3, 1.80 mg/L H_3BO_3, 0.242 mg/L $ZnSO_4·7H_2O$, 0.08 mg/L $CuSO_4·5H_2O$, 0.005 mg/L $CoCl_2·6H_2O$, and 0.04 mg/L $CoCl_2·6H_2O$. After the medium is prepared according to the formulas, the medium is put into the refrigerator at 5°C for standby. The water samples in the experiment are composed of cyanobacteria and No. 1 landscape water [17].

2.2. Test method for algae removal

Algae removal test: 700 mL landscape water samples are put in a 1 L beaker. After being added with a coagulant, the beaker is placed on the stirrer [18]. The stirring conditions are set as 200 rpm for 3 min, and then as 150 rpm for 25 min [19]. Then, after stirring for 25 min, the supernatant of the sample is taken to determine the various indicators of cyanobacterial polluted water. The optimal reaction conditions are selected by controlling the concentration of polymerized ferrous sulfate and pH value.

Cyanobacteria re-floating test: under different temperatures and light conditions, the liquid from 1.5 to 2.5 cm below the liquid level in the supernatant is taken to study the re-floating of cyanobacteria. Measured indicators include the cyanobacteria concentration, water electric potential. The temperature conditions are 15°C, 20°C and 34°C, respectively.

2.3. Measurement method of water quality indicators

The surface water sampling method is used to collect landscape water in two study areas from May to December 2020, once a month. Monitoring indicators such as COD, algae concentration, water temperature, pH, nitrogen content, and ammonia nitrogen content [20].

2.3.1. Determination of phosphorus content

Firstly, the sample is pre-treated by adding 12 mL water sample, 38 mL water, 7 m 14% potassium persulfate solution, and 2 mL 10% sulfuric acid solution in a 150 mL conical flask. Then, the mixed solution is heated and boiled on an electric furnace for 35 min until the solution volume is 12 mL. After being adjusted to neutral, the solution is moved into a 50 mL colorimetric tube. Secondly, 2 mL 12% ascorbic acid solution and 3 mL molybdic acid solution are added to the colorimetric tube, and the mixture is kept still for 10 min. Finally, the 15 mm colorimetric dish is placed at an 800 mm wavelength to measure the absorbance and calculate the phosphorus content [21]. The calculation method is shown in Eq. (1).

$$\text{TP mg/l} = \frac{m}{v'} \tag{1}$$

where m is the phosphorus content on the calibration curve, and v' is the sample volume obtained.

2.3.2. Determination of the cyanobacteria concentration

The cyanobacterial liquid on the medium is diluted and dropped onto the cover of the blood cell counting plate by a drop tube, and then stands for 10 min. Then, the liquid is observed under a microscope for counting. The cyanobacteria concentration is calculated according to Eq. (2).

$$\text{N/mg} = n \times 400 \times 1000 \times s \tag{2}$$

Eq. (2) is used for a counting plate of 16 × 25 size, where N is the number of cyanobacteria, n is the number of cells in 100 compartments, and s is the dilution ratio of cyanobacteria.

2.3.3. Determination of nitrogen content

A 30 mL colorimetric tube with a 12 mL water sample and 4 mL potassium persulfate solution is put into a grinding mouth bottle. Then, the bottle is heated for an hour in a sterilization pot at the temperature of 120°C. After cooling, the colorimetric tube is taken out and added with 2 mL 10% hydrochloric acid and ammonia-free water to 30 mL. At the wavelengths of 230 and 270 nm of the photometer, the absorbance is measured using a 12 mm colorimetric dish, and the concentration is calculated by Eq. (1), where m is the nitrogen content on the calibration curve.

2.4. Evaluation method of landscape water quality

Pollution indicators are monitored in the study area in the experiment, including the cyanobacteria concentration, water pH, nitrogen content, water temperature, dissolved oxygen, phosphorus content. Three monitoring points are arranged for sampling in the two study areas, and the average value is finally taken as experimental data.

The grey clustering method is adopted to evaluate landscape water in the two study areas since it is widely used in water quality analysis. The modeling function is divided into two parts based on the relationship between indicator concentration and water quality. The first part is the function construction of the dissolved oxygen indicator (the indicator of water quality improvement after concentration increasing).

The sample selection is as follows: clustering indicator $m = 6$, clustering sample $n = 5$, and grey level $h = 5$. In Eq. (3), $i = 1, 2, 3, 4$. $j = 1, 2, 3, 4, 5, 6$. $k = 1, 2, 3, 4, 5$.

$$f_{1j}\left(x_{ij}\right) = \begin{cases} 1, x \in \left[s_{0j1}, \infty\right] \\ \dfrac{x_{ij} - q_{0j2}}{q_{0j2} - q_{0j1}}, x \in \left[s_{0j2}, s_{0j1}\right] \\ 0, x \in \left[\infty, s_{0j2}\right] \end{cases} \tag{3}$$

Eq. (3) is the grey-weighted function of jth indicator of Specified Class l, where x_{ij} is the sample value to be tested, and q_{0kj} is the standard value of the jth indicator.

$$f_{kj}\left(x_{ij}\right) = \begin{cases} 0, x \in \left[s_{0jk-1}, 0\right] \\ \dfrac{q_{0jk-1} - x_{ij}}{q_{0jk-1} - q_{0jk}}, x \in \left[s_{0jk}, s_{0jk-1}\right] \\ 0, x \in \left[\infty, s_{0jk}\right] \end{cases} \tag{4}$$

Eq. (4) is the grey-weighted function of jth indicator of Specified Class k, where q_{kj} is the standard grey number, and other letters represent the same meanings as in Eq. (3).

$$f_{kj}\left(x_{ij}\right) = \begin{cases} \dfrac{q_{0jk-1} - x_{ij}}{q_{0jk} - q_{0jk-1}}, x \in \left[q_{0jk}, q_{0jk-1}\right] \\ \dfrac{x_{ij} - s_{0jk+1}}{q_{0jk} - q_{0jk+1}}, x \in \left[q_{0jk+1}, q_{0jk}\right] \\ 0, x \in \left[\infty, q_{0jk}\right] \end{cases} \tag{5}$$

Eq. (5) expresses the grey-weighted function of jth indicator of Specified Class h.

The second part is the function construction of other pollution indicators except for dissolved oxygen (the indicator of water quality improvement after concentration decreases).

$$f_{1j}\left(x_{ij}\right) = \begin{cases} 1, x \in \left[0, q_{0j1}\right] \\ \dfrac{q_{0j2} - x_{ij}}{q_{0j2} - q_{0j1}}, x \in \left[q_{0j1}, q_{0j2}\right] \\ 0, x \in \left[q_{0j2}, \infty\right] \end{cases} \tag{6}$$

$$f_{kj}\left(x_{ij}\right) = \begin{cases} \dfrac{x_{ij} - q_{0jk-1}}{q_{0jk} - q_{0jk-1}}, x \in \left[q_{0jk-1}, q_{0jk}\right] \\ \dfrac{q_{0jk+1} - x_{ij}}{q_{0jk+1} - q_{0jk}}, x \in \left[q_{0jk}, q_{0jk+1}\right] \\ 0, x \in \left[q_{0jk}, \infty\right] \end{cases} \tag{7}$$

$$f_{kj}\left(x_{ij}\right) = \begin{cases} 0, x \in \left[0, q_{0jk-1}\right] \\ \dfrac{x_{ij} - q_{0jk-1}}{q_{0jk} - q_{0jk-1}}, x \in \left[q_{0jk-1}, q_{0jk}\right] \\ 0, x \in \left[q_{0jk}, \infty\right] \end{cases} \tag{8}$$

In the above three equations, the meaning of the letters are the same as in Eqs. (3)–(5).

The weight value of the clustering is calculated according to Eqs. (9)–(11).

$$\gamma_{ki} = \frac{w_{kj}}{\sum_{j=1}^{m} w_{kj}} \tag{9}$$

$$\delta_{kj} = \frac{q_{kj}}{q_{0jk}} \tag{10}$$

$$\Upsilon_{kj} = \frac{\delta_{kj}}{\sum_{k=1}^{h} \delta_{kj}} \tag{11}$$

where γ_{ki} represents the weight value of the clustering which measures the weight of each indicator to the same grey category. δ_{kj} is the kth grey dimensionless number belonging to the jth test indicator. Υ_{kj} is the grey weight of each indicator.

The calculation of the clustering coefficient is as Eq. (12).

$$\phi_{ki} = \sum_{j=1}^{m} f_{kj}\left(x_{ij}\right) \times \gamma_{ki} \tag{12}$$

In Eq. (12), the clustering coefficient is the amount of affinity between clustering samples.

The clustering vector is calculated according to Eq. (13).

$$\xi_i = \left\{\phi_{1i}, \phi_{2i}, \phi_{3i}, \ldots, \phi_{ki}\right\} \tag{13}$$

2.5. Treatment method of quality guarantee for landscape water

The algae removal by the coagulation method can guarantee water quality to a certain extent. Polyferric sulfate is used for the coagulation experiment in a beaker. The removal efficiency of cyanobacteria at different concentrations and pH values is mainly investigated and characterized by zeta potential changes. On this basis, the re-floating of cyanobacteria is studied under the influence of temperature.

The multi-media filtration system is used as the landscape water quality guarantee technology in the experiment. Then, the water quality guarantee results are analyzed from perspectives of the turbidity and cyanobacteria concentration showing a good effect. The process of the water quality guarantee system is shown in Fig. 1.

In Fig. 1, the water quality guarantee system is mainly composed of the dosing system, sludge removal system and long-term operation system of multi-media cycle. Since the water pollution level of No. 1 landscape water in the study area is V level, and the long-term operation of the multi-media filtration system will not cause secondary pollution to the water body, so the multi-media filtration method is to ensure water quality. The multi-media filtration system is composed of three cylindrical filtration tanks with a diameter of 1.6 m and a height of 1.7 m. The filtration tanks are filled with 8 kinds of quartz sand with diameters from large to small at tat a total of 25 kg from bottom to top, forming a good filter layer.

3. Results analysis of landscape water quality evaluation and guarantee technology

3.1. Analysis of monitoring results of each pollution indicator for water quality

The monitoring data of pollution indicators of water quality in the study area are shown in Table 1.

From Table 1, the water temperatures of No. 1 landscape water and No. 2 landscape water change in the same range from May to December. The highest temperature appears in July, which is 26.1°C, and the lowest temperature appears in December, which is 4.9°C. The ammonia nitrogen content in the two areas decreases from June to October, with a minimum of 0.76 mg/L in October, while increasing from October to December with a maximum of 2 mg/L in December. The monitoring results of phosphorus content show that the phosphorus content increases from May to December ranging between 0.05 and 0.3 mg/L, which is greater than the international standard of water eutrophication with a phosphorus concentration of 0.02 mg/L. Therefore, the landscape water in the two study areas is eutrophic. The COD value increases gradually from May to September, reaching 55.1 mg/L in September. Then, the COD value decreases from September to December. The overall COD value of No. 2 landscape water is higher than that of No. 1 landscape water, but the two areas both show eutrophication. turbidity of the two areas increases from May to October and then decreases from October to December, reaching the maximum of 90 NTU in October. Turbidity is greatly affected by water quality such as ammonia nitrogen and phosphorus content and is most affected by algae concentration. Besides, the water in the study areas is eutrophic. The nitrogen content increases from May to December, reaching the maximum of 5 mg/L, and the nitrogen content in both places

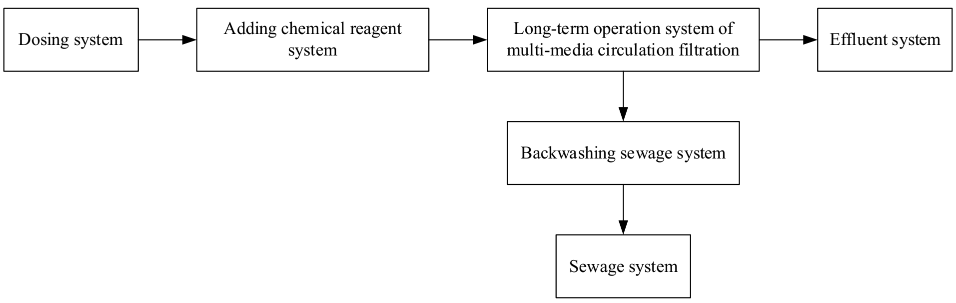

Fig. 1. Process of water quality guarantee.

does not meet the standard of Class V surface water. The dissolved oxygen content in the study areas begins to decrease from May and reaches the minimum value in October, which is 1.9 mg/L. After October, it begins to rise and reaches the maximum value in December, which is 5.6 mg/L. The maximum and minimum dissolved oxygen content correspond to the Class V surface water and Class III surface water, respectively. Algae concentration increases from May to November, with a maximum of 700,000 mL. Algae concentration decreases from November to December, mainly related to temperature. The pH of the two areas increases from May to October, reaching the maximum value of 8.7 in October, and then it decreases from October to December, with a minimum value of 7.4 in December. The water body is weakly alkaline as a whole.

3.2. Results analysis of grey clustering method

Table 2 shows the monitoring results of each pollution indicators of No. 1 landscape and No. 2 landscape.

To calculate the whitening values of the indicators of the two areas, the data of dissolved oxygen content in Table 2 is substituted into Eqs. (3)–(5), while the other indicator data are substituted into Eqs. (6)–(8). The grey standard number q_{kj} is obtained from the surface water quality standard [22]. On this basis, the grey dimensionless number δ_{kj} is calculated according to Eq. (10), and the calculation results are substituted into Eq. (11) to calculate the grey weight Y_{kj} of each indicator. Then, the calculation results are substituted into Eq. (9) to obtain the clustering weight value, and the clustering coefficient is obtained by substituting them into Eq. (12). Finally, the clustering vector is constructed, and the results are as follows: ϕ_{k1} (0,0.012,0.245,0.143,0.501); ϕ_{k2} (0,0.049,0.197,0.670,0.021).

The maximum vector value of the results is taken as the water quality of the study areas: No. 1 landscape water is Class IV water; No. 2 landscape water is Class II water. Therefore, No. 2 has good water quality and No. 1 has poor water quality.

3.3. Results analysis of the water quality guarantee method

Fig. 2 shows the change of cyanobacteria content and turbidity under different polymeric ferric sulfate content.

Table 1
Data of pollution indicators of water quality

	Monitoring location	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
Water temperature (°C)	1#	19.2	22.0	25.3	23.0	18.0	13.4	10.9	4.8
	2#	18.1	21.4	26.1	24.5	19.9	14.2	12.2	4.9
Ammonia nitrogen content (mg/L)	1#	1.95	1.96	1.97	1.52	1.12	0.76	1.52	2.00
	2#	1.82	1.85	1.90	1.92	1.10	0.79	1.53	1.90
Phosphorus content (mg/L)	1#	0.14	0.19	0.18	0.20	0.21	0.25	0.23	0.24
	2#	0.11	0.15	0.14	0.13	0.18	0.19	0.17	0.19
Chemical oxygen demand (mg/L)	1#	19	25	32	40	55.1	50	43	39
	2#	18	20	25	35	46	45	40	32
Turbidity (NTU)	1#	10	15	26	30	55	90	74	65
	2#	12	13	20	24	37	65	53	42
Nitrogen content (mg/L)	1#	2.7	2.9	3.0	3.2	3.7	3.8	4.8	5.0
	2#	2.6	2.8	2.9	3.1	3.4	3.7	4.7	4.9
Dissolved oxygen content (mg/L)	1#	5.8	5.7	5.4	5.0	4.5	1.9	4.7	5.6
	2#	5.5	5.6	4.9	4.7	4.3	2.5	4.5	5.3
Algae concentration ($\times 10^4$/m)	1#	20	34	43	44	57	63	64	51
	2#	20	29	33	38	42	53	70	44
pH	1#	8.0	8.2	8.4	8.5	8.6	8.7	8.4	7.4
	2#	7.9	8.1	8.3	7.9	8.4	8.5	8.3	7.9

Note: 1# represents No. 1 landscape water; 2# represents No. 2 landscape water.

Table 2
Monitoring results of each pollution indicators

Monitoring location	Chemical oxygen demand (mg/L)	Phosphorus content (mg/L)	Biochemical oxygen demand (mg/L)	Number of *Escherichia coli* ($\times 10^4$/mL)	Nitrogen content (mg/L)	Dissolved oxygen content (mg/L)
No. 1 landscape water	40	0.20	9.1	3.5	3.1	4.2
No. 2 landscape water	30	0.15	6.1	2.0	2.1	4.4

From Fig. 2, the zeta potential pressure increases with the increase of polyferric sulfate content, and the removal efficiency of cyanobacteria increases. When the zeta potential reaches the maximum value of 2 millivolts, that is, the concentration of polyferric sulfate is 38 mg/L, the removal efficiency of cyanobacteria reaches the maximum. When the concentration of polyferric sulfate exceeds 38 mg/L, the removal efficiency decreases, which may be related to the porosity of cyanobacteria caused by excessive cations.

Fig. 3 shows the changes of cyanobacteria concentration and turbidity under different pH values at the polyferric sulfate content of 38 mg/L.

In Fig. 3, the change trend of algae concentration is consistent with that of turbidity. When the zeta potential decreases, the electrification of water decreases. With the increase of alkalinity content, the electric neutralization force increases, and the algae removal efficiency increases. The maximum removal rate of algae reaches 98% and the turbidity removal rate reaches 80% at pH 7. After pH > 7, with the decrease of zeta potential, the negative charge in water increases, the forces decrease, the compactness of algae begins to decline, and the algae removal rate starts to weaken.

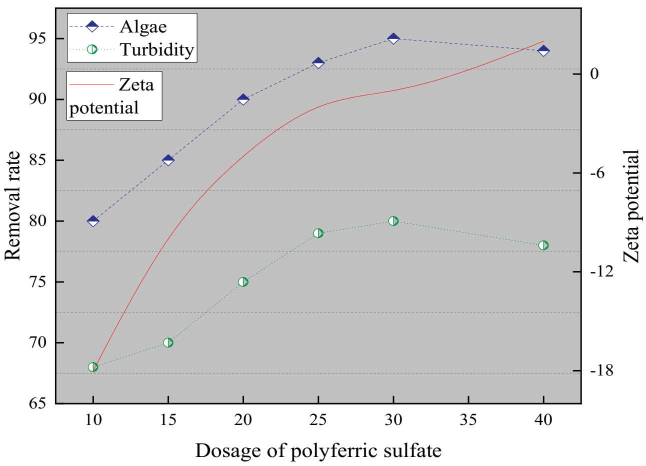

Fig. 2. Effect of different content of polyferric sulfate on the water body.

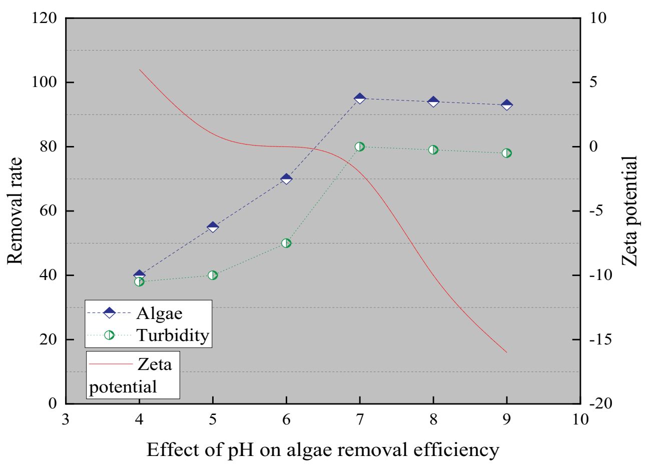

Fig. 3. Effect of different pH values on the water body.

Fig. 4 shows the cyanobacteria re-floating under different temperatures.

According to Fig. 4, under the three kinds of temperatures, the cyanobacteria re-floating gradually increases with the increase of standing time, and the cyanobacteria re-floating at 34°C is less obvious than that at 20°C. The reason may be that 34°C exceeds the optimal temperature for photosynthesis of algae, while 20°C is close to the theoretical optimal temperature of 25°C. Subsequently, the effect of different temperatures is studied on cyanobacteria re-floating under different zeta potentials. Due to length constraints, the research conclusion is given here without the experimental process. The results show that the increase of zeta potential weakens the cyanobacteria re-floating phenomenon, mainly due to the enhancement of cohesion. At the temperature of 20°C, the re-floating phenomenon is the most obvious, mainly due to the enhancement of photosynthesis making bubbles near the algae. After enhanced photosynthesis, cations in water decrease, zeta potential decreases, and cyanobacteria are looser and easier to float.

The data of algae concentration and turbidity after the operation of the multi-media filtration system are taken from the average values of the three monitoring points from May 1 to June 30 in 2019 and 2020. The data is taken every 5 d, with a total of 13 groups of monitoring data.

The variation of algae concentration in No. 1 landscape water is shown in Fig. 5.

From Fig. 5, compared with the algae concentration at the same period in 2019, the algae concentration in the water body decreases significantly in 2020 after treatment. The algae concentration in 2019 is the highest at 275,000 mL, while in 2020 it is 50,000 mL, with a decreased probability of 82%.

The change of turbidity of No. 1 landscape water is shown in Fig. 6.

From Fig. 6, the multi-media filtration system shows an obvious removal effect. The water turbidity in 2020 is far lower than that in the same period in 2019, decreasing by 76.5%.

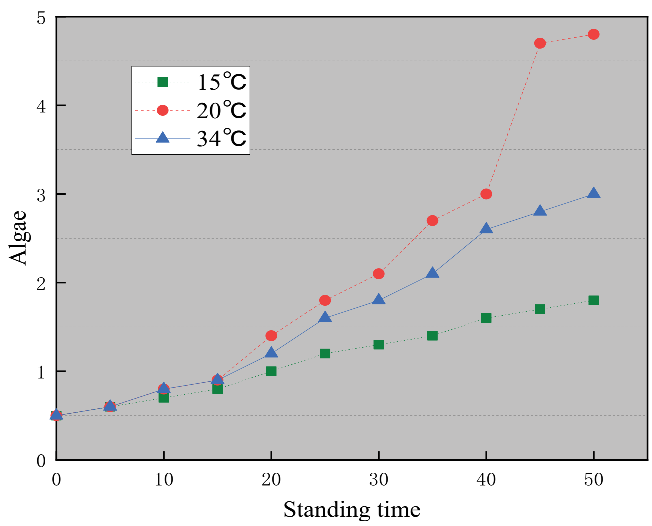

Fig. 4. The curve of cyanobacteria re-floating under different temperatures.

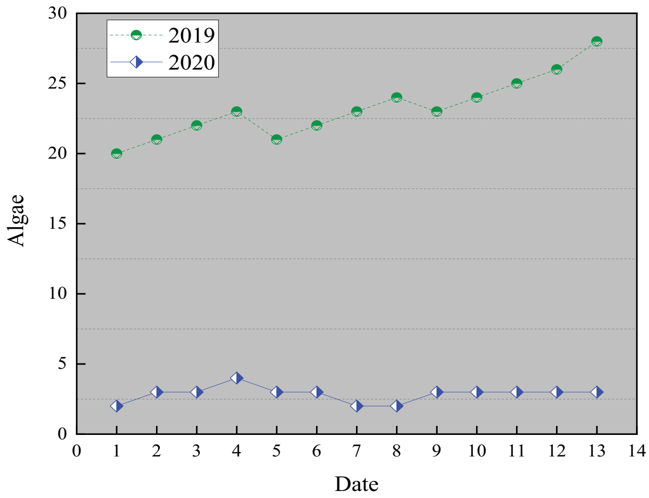

Fig. 5. Variation of algae concentration.

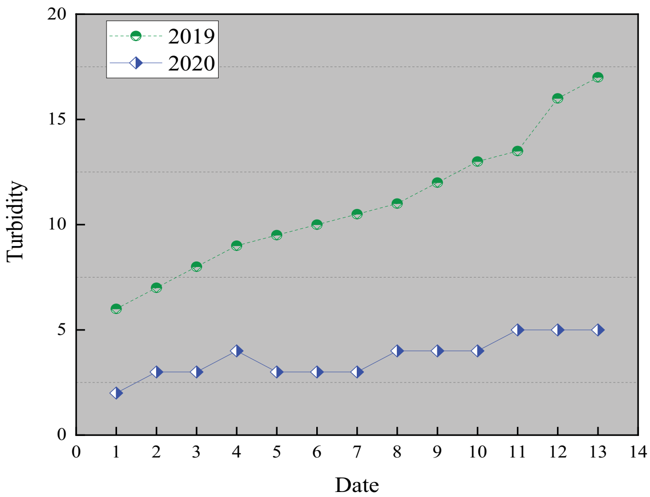

Fig. 6. Change of the turbidity.

4. Conclusions

The study is conducted on the quality evaluation of landscape water in a certain area and on the quality guarantee technology of polluted water. Based on the monitoring of COD, algae concentration, water temperature, pH, nitrogen content, ammonia nitrogen content and other pollution indicators, the grey clustering method is used to construct the model for water quality evaluation. The evaluation results show that No. 1 landscape water is Class IV water, and No. 2 landscape water is Class II water. The optimal conditions for algae removal are as follows: the content of polymeric ferric sulfate is 38 mg/L, the pH is 7, the removal rate of algae is 98%, and the removal rate of turbidity is 80%. In the experiment, the multi-media filtration system is used for water quality guarantee showing a good effect. The experimental process does not involve the discussion of the economic benefits of water quality guarantee technology due to limited energy. Subsequently, the economic benefits of the scheme can be evaluated according to the specific situation, so that the scheme is more suitable for the actual situation.

References

[1] M.C. Morera, P.F. Monaghan, M.D. Dukes, Determinants of landscape irrigation water use in Florida-Friendly Yards, Environ. Manage., 65 (2020) 19–31.

[2] N. Li, J. Wang, W. Yin, H. Jia, J. Xu, R. Hao, Z. Zhong, Z. Shi, Linking water environmental factors and the local watershed landscape to the chlorophyll *a* concentration in reservoir bays, Sci. Total Environ., 758 (2021) 143617, doi: 10.1016/j.scitotenv.2020.143617.

[3] M. Zong, Y. Hu, M. Liu, C. Li, C. Wang, X. Ping, Effects of landscape pattern change on water yield and nonpoint source pollution in the Hun-Taizi river watershed, China, Int. J. Environ. Res. Public Health, 17 (2020) 3060, doi: 10.3390/ijerph17093060.

[4] W.-H. Wang, Y. Wang, L.-Q. Sun, Y.-C. Zheng, J.-C. Zhao, Research and application status of ecological floating bed in eutrophic landscape water restoration, Sci. Total Environ., 704 (2020) 135434, doi: 10.1016/j.scitotenv.2019.135434.

[5] T.M. Maxwell, L.C.R. Silva, A state factor model for ecosystem carbon–water relations, Trends Plant Sci., 25 (2020) 652–660.

[6] A.K. Hohner, C.C. Rhoades, P. Wilkerson, F.L. Rosario-Ortiz, Wildfires Alter Forest watersheds and threaten drinking water quality, Acc. Chem. Res., 52 (2019) 1234–1244.

[7] D. Ellison, C. Ifejika Speranza, From blue to green water and back again: promoting tree, shrub and forest-based landscape resilience in the Sahel, Sci. Total Environ., 739 (2020) 140002, doi: 10.1016/j.scitotenv.2020.140002.

[8] H. Cui, Y. Yang, Y. Ding, D. Li, G. Zhen, X. Lu, M. Huang, X. Huang, A novel pilot-scale tubular bioreactor-enhanced floating treatment wetland for efficient in situ nitrogen removal from urban landscape water: long-term performance and microbial mechanisms, Water Environ. Res., 91 (2019) 1498–1508.

[9] F. Canales-Ide, S. Zubelzu, L. Rodríguez-Sinobas, Irrigation systems in smart cities coping with water scarcity: the case of Valdebebas, Madrid (Spain)., J. Environ. Manage., 247 (2019) 187–195.

[10] D. Abdissa, K. Beyecha, Sugarcane bagasse adsorption evaluation and application on BOD and COD removal from textile wastewater treatment, Water Conserv. Manage., 4 (2021) 30–34.

[11] V. Sheykhi, N. Samani, Assessment of water quality compartments in Kor River, IRAN, Environ. Monit. Assess., 192 (2020) 532, doi: 10.1007/s10661-020-08464-2.

[12] A. Kadam, M. Rajasekhar, B. Umrikar, V. Bhagat, V. Wagh, R.N. Sankua, Land suitability analysis for afforestation in semi-arid watershed of Western Ghat, India: a groundwater recharge perspective, Geol. Ecol. Landscapes, 5 (2021) 136–148.

[13] H. Hc, S. Govindaiah, L. Srikanth, H.J. Surendra, Prioritization of sub-watersheds of the Kanakapura Watershed in the Arkavathi River Basin, Karnataka, India- using Remote sensing and GIS, Geol. Ecol. Landscapes, 5 (2021) 149–160.

[14] C. Acuña-Alonso, X. Álvarez, O. Lorenzo, Á. Cancela, E. Valero, Á. Sánchez, Assessment of water quality in eutrophized water bodies through the application of indexes and toxicity, Sci. Total Environ., 728 (2020) 138775, doi: 10.1016/j.scitotenv.2020.138775.

[15] M.A. Haque, M.K. Hossain, M.A.I. Molla, M. Sarker, S.C. Dey, M. Ashaduzzaman, Facile fabrication of copper oxide nanoparticles for antimicrobial activity, J. Clean WAS, 5 (2021) 27–30.

[16] V.-M. Radu, P. Ionescu, G. Deak, E. Diacu, A.A. Ivanov, S. Zamfir, M.-I. Marcus, Overall assessment of surface water quality in the Lower Danube River, Environ. Monit. Assess., 192 (2020) 135, doi: 10.1007/s10661-020-8086-8.

[17] P. Bhusal, B. Ghimire, S. Khanal, Assessing link between on farm agro-biodiversity and food self- sufficiency in two agro-ecological regions of Nepal, Environ. Ecosyst. Sci., 5 (2021) 78–84.

[18] B. Samuel, O. Temitope, D. Timothy, O. Olayinka, O. Olusegun, B. Emmanuel, Evaluation of the impacts of metals on soil samples, serum creatinine and blood urea nitrogen of residents in selected industrial communities in a developing country, Environ. Contam. Rev., 3 (2020) 40–47.
[19] G.B. McBride, Has water quality improved or been maintained? A quantitative assessment procedure, J. Environ. Qual., 48 (2019) 412–420.
[20] M.L. De Baat, R. Van der Oost, G.H. Van der Lee, N. Wieringa, T. Hamers, P.F.M. Verdonschota, P. De Voogt, M.H.S. Kraak, Advancements in effect-based surface water quality assessment, Water Res., 183 (2020) 116017, doi: 10.1016/j.watres.2020.116017.
[21] N.S. Mohd, R.M. Mohamed, The initial ion effect of heavy metals adsorption by using hydrothermal carbonization banana peels, Environ. Contam. Rev., 3 (2021) 8–10.
[22] D Frau, J. Medrano, C. Calvi, A. Giorgi, Water quality assessment of a neotropical pampean lowland stream using a phytoplankton functional trait approach, Environ. Monit. Assess., 191 (2019) 681, doi: 10.1007/s10661-019-7849-6.