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Exploration on Water Pollution Cloud Monitoring Method Based on Spectral Method

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Abstract: The rapid development of industry, construction and agriculture has played a huge role in promoting social and economic development, but also brought water pollution. The decline in the quality of water resources poses a threat to people's water safety. To ensure the quality and safety of water resources, it is necessary to strengthen the monitoring and control of water resources. In this case, it is of great significance to study an efficient water pollution monitoring method for water pollution control. Based on this, this paper proposed a method of water pollution cloud monitoring through the study of water pollution monitoring, that is, to establish a water pollution cloud monitoring system based on spectral method. At the same time, this paper drew the following conclusions through the research of cloud monitoring system: the average absolute error of the new water pollution cloud monitoring system was 3.28 lower than that of the traditional water pollution monitoring system; the mean square error of the new water pollution cloud monitoring system was 22.17 lower than that of the traditional water pollution monitoring system; the water pollution cloud monitoring system proposed in this paper has better monitoring effect than the traditional water pollution monitoring system. In addition, experts in water pollution monitoring technology also have high evaluation scores for water pollution cloud monitoring system. The water pollution cloud monitoring system based on spectral method has certain practical value.

1. Introduction

With the massive discharge of domestic sewage and industrial wastewater, the environmental quality of natural water bodies is deteriorating. Water pollution monitoring is an important basis for water pollution control. Therefore, ensuring the accuracy of water quality monitoring is the key to

water pollution control and planning. However, although the accuracy of the traditional chemical analysis method can be guaranteed, it has some limitations such as long inspection period, laboratory personnel operation, and easy to cause secondary pollution. In the face of this situation, this paper selected spectral method as the method of water pollution detection, and studied the monitoring of water pollution based on spectral method.

Many scholars have studied water pollution and monitoring. Anwar Gehan M conducted mitotic chromosome aberration and genetic polymorphism research on Nile tilapia and Oreo tilapia collected from five sites in Minia Province, Egypt, which provided support for the research of biological monitors for heavy metal pollutants in water [1]. Hidayah Izhamil believed that the increasing human activities may affect the health and quality of the Cirebon River and its surrounding areas. He detected the water pollution level of the Cirebon River based on the methods of reserves and return and pollution index [2]. Kumar Vinod evaluated the heavy metal status of three different water bodies, namely Indus River, Bis River, Sutraj River and Harik Wetland, through cluster analysis and principal component analysis [3]. Zhi Wei discussed whether the short-term and short-term memory model can monitor dissolved oxygen in water quality, and proved that more data collection at the peak and valley of dissolved oxygen and in areas where monitoring is scarce is essential to overcome the problem of data scarcity [4]. Rahman Mirza collected 20 groundwater samples and tested the acidity and alkalinity, dissolved oxygen, turbidity and heavy metals in the water. The water quality index, pollution degree, heavy metal evaluation index and heavy metal pollution index were proposed [5]. Nour Hamdy El Sayed evaluated the potential ecological risks and pollution of iron, zinc and other metals in the surface sediments along the Red Sea coast of Egypt using environmental pollution indicators and multifactor statistical analysis methods [6].

At the same time, the following scholars have also participated in the research on water pollution and monitoring. He Xiaodong took the surface water, spring water, Quaternary phreatic water, soil and rock in the middle of the Loess Plateau as the research objects, and discussed the main factors affecting surface water pollution in detail [7]. Son Cao Truong carried out water quality analysis for water monitoring points by using water quality index, comprehensive pollution index, organic pollution index, eutrophication index, trace metal pollution index and other different water quality, water pollution index and cluster analysis [8]. Hassan Md Mehedi proposed a machine learning technology for predicting water pollution. Through training and experiments on water quality data sets across India, it was concluded that this method has a high accuracy [9]. Muharemi Fitore described several methods to identify changes or anomalies in water quality time series data, and analyzed the effectiveness and limitations of these methods [10]. Lele Sharachchandra believed that the water pollution problem in India has escalated sharply in the past few decades, but the water pollution regulatory authority has not played its full role. Based on this, he analyzed the problems existing in the water pollution regulatory agencies, including the non-standard environmental water quality standards, poor monitoring and poor pollution law enforcement [11]. The research on water pollution and monitoring is of great significance to people's production and life. This paper studied water pollution monitoring based on spectral method.

In order to solve the problem of water pollution and ensure the health of people's living water, production water and water environment, this paper studied the subject of water pollution monitoring, and proposed a water pollution cloud monitoring system based on spectral method and a water pollution cloud monitoring algorithm. Through the research on the effect of the water pollution cloud monitoring system, this paper drew the conclusion that the water pollution cloud monitoring system has more accurate detection results than the traditional water pollution monitoring system. Compared with other studies, this paper constructed a cloud monitoring system for water pollution monitoring based on spectral method.

2. Contents and Quality Control Methods of Water Pollution Monitoring

2.1. Contents of Water Pollution Monitoring

Water environment monitoring consists of two parts. Surface water: during the monitoring period, the general pollution factors shall be analyzed in detail, and the water quality shall be analyzed according to the data to determine the specific situation of water source pollution [12]. It can strengthen the investigation of pollution factors of water sources, including the material composition in the water environment, the degree of water pollution and the scope of impact. Sampling shall be conducted in sunny days with little water flow and at different time periods to ensure the effectiveness of sampling. Groundwater monitoring: With the rapid development of economy and society, people's demand for groundwater is also increasing. It is necessary to strengthen the monitoring of groundwater to fully understand the quality of groundwater. At present, the monitoring of groundwater is mainly to determine the content of sulfate, fluoride and other elements in sewage through sampling and analysis, so as to determine the local water pollution situation [13].

2.2. Quality Control Methods for Water Pollution Monitoring

In order to obtain accurate monitoring data and results, the quality of water quality monitoring must be strictly controlled. In particular, there are two areas to work on. On the one hand, before conducting water environment monitoring, it is necessary to equip appropriate monitoring instruments and equipment, and repair and maintain them, so as to ensure their proper operation and prevent errors in monitoring data. The collection, transportation, preparation and testing of water quality samples must strictly comply with relevant specifications, standards and procedures to ensure the representativeness of the samples. The samples shall be stored in strict accordance with the specified requirements, and the storage temperature of water samples shall be paid attention to to ensure the stability of the samples. On the other hand, the quality must be strictly controlled during the testing process. The inspectors must have high technical quality, operate the instruments and equipment correctly, and ensure the operating procedures of the test, including sample distribution, standard solution preparation, reagent test, etc., so as to ensure the effectiveness of the monitoring. It is necessary to strictly control the experimental environment, including temperature and humidity. The tester shall have the corresponding qualification certificate and standardize the operation to avoid affecting the test results.

3. Water Pollution Cloud Monitoring System and Algorithm

3.1. Water Pollution Cloud Monitoring System

3.1.1. Overall Architecture of Water Pollution Cloud Monitoring System

The cloud monitoring system built in this paper is composed of three parts: on-site monitoring module, cloud monitoring platform, and user end. The on-site monitoring module includes various monitoring instruments that make up this module. When the monitoring module collects water quality data, it can transmit the monitored information to the cloud monitoring platform. The cloud monitoring platform can store data into relevant databases. Relevant algorithms can be used to analyze and process the monitored water quality data, and the processed water quality monitoring information can be transmitted to the user. The user can monitor the water quality through the wireless network, view the water quality data, download the previous data, and remind the water

quality abnormality. The system can provide users with all-around services. It adopts a number of common technologies and has high reliability. It has the functions of real-time water quality data, query historical data, monitoring and warning.

3.1.2. Functions of Water Pollution Cloud Monitoring System

The system has a good human-computer interaction interface, which can automatically load the database, establish database connection, read real-time data and historical data from the cloud server, and compare the results with the standard results, so as to achieve the purpose of monitoring and warning. The system can mainly realize the following functions, as shown in Figure 1.

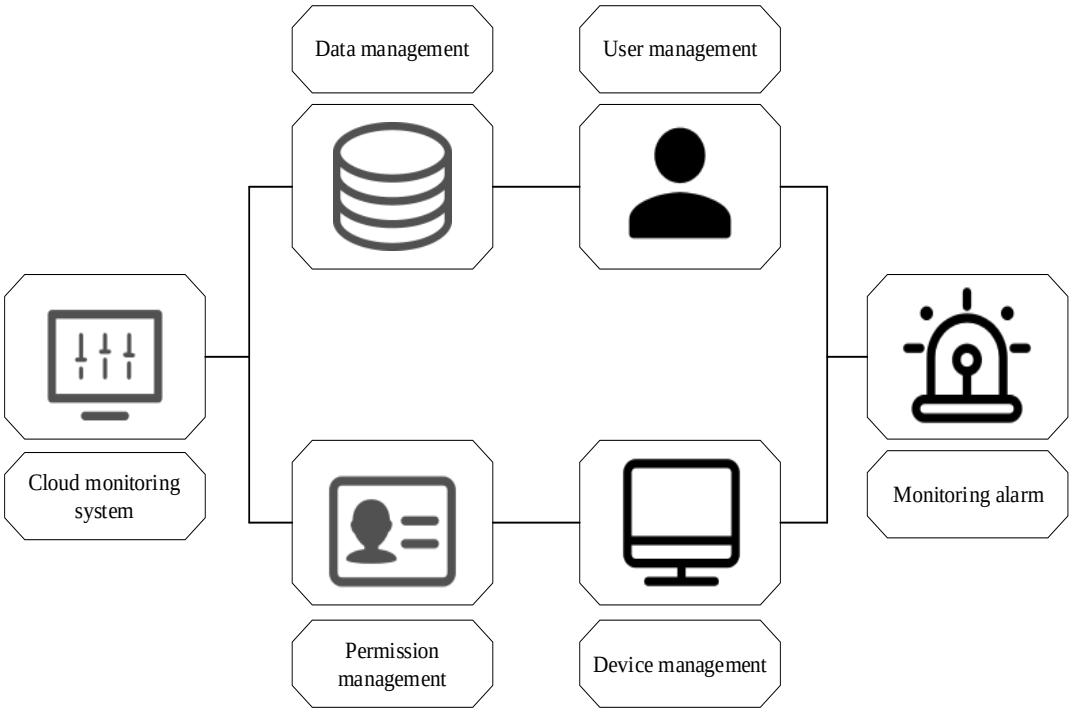


Figure 1. Functions of water pollution cloud monitoring system

Data management: In the whole system, water quality monitoring data is an important part of the whole system. The main work of the system is centered on data operation, so data management is particularly important. The water quality data collected at the site of water pollution is analyzed through the cloud platform, which can quickly read the data in the database, including place, time, chemical oxygen demand (COD), etc., and can perform corresponding data processing according to the user's requirements. At the same time, the water pollution cloud monitoring data can be saved in the cloud database for future use.

Permission management: The water pollution cloud monitoring system has three levels: administrator authority, expert authority and general authority. After logging in, ordinary users can add their own monitoring services. Through the authority of experts and administrators, they can perform basic operation and early warning settings on the equipment. The administrator authority can also update and maintain the system.

User management: Considering that after the water pollution cloud monitoring system is running, there may be many users. In order to better serve customers, customers should be classified according to their requirements, and new registered and invalid users should be managed.

Equipment management: equipment management is an important part of the water pollution cloud monitoring system. After user registration, monitoring equipment should be added; the

equipment of each monitoring station should be sorted, and corresponding data tables should be set for it. On the control platform, the working conditions of each device and the monitoring information of each monitoring device can be seen. By setting the threshold, the purpose of monitoring and warning can be achieved. On the web page, the water pollution cloud monitoring system can display the water quality monitoring data information in a dynamic graphical way.

Monitoring alarm: In the case of abnormal water quality, the real-time collected water quality monitoring results are compared with the standard data. If it exceeds a certain standard, the water pollution cloud monitoring system would give an early warning and notify professionals and users in time, which enables them to take corresponding measures in time to avoid water pollution. In addition, in order to ensure the user's information security, the water pollution cloud monitoring system has a password correction service. The user can change the login password after logging in.

3.2. Utilization Algorithm of Water Pollution Cloud Monitoring System

The measured spectral signal is regarded as the absorption spectrum and turbidity absorption spectrum of COD, that is:

$$b = a + s \tag{1}$$

The model of COD absorption spectrum is established based on the principle of compressed sensing:

$$\arg\min \left\| b - \Phi \Psi t \right\|_2^2, t \geq 0 \tag{2}$$

Among them, Φ is the observation matrix, and Ψ is the sparse base matrix; T is the sparse coefficient.

Φ needs to meet the following conditions:

$$\Phi \in U^{I*J}\left(I \langle\langle J\right) \tag{3}$$

$$\left(1-\varepsilon_C\right)\left\|a'\right\|_2^2 \leq \left\|\Phi a'\right\|_2^2 \leq \left(1+\varepsilon_C\right)\left\|a'\right\|_2^2 \tag{4}$$

Among them, a' is a sparse signal, and a' equals Ψt. If $\varepsilon_C \in [0,1]$, then Φ satisfies the finite isometric property. At the same time, sparse targets in transform domain can be expressed as:

$$\left(1-\varepsilon_C\right)\left\|t\right\|_2^2 \leq \left\|\Phi \Psi t\right\|_2^2 \leq \left(1+\varepsilon_C\right)\left\|t\right\|_2^2 \tag{5}$$

The turbidity absorption spectrum influence matrix is reconstructed:

$$\hat{a}' = \arg\min \left|a'\right|_0 \tag{6}$$

$$s.t.\ s = \Phi \Psi t \tag{7}$$

4. Effect and Evaluation of Water Pollution Cloud Monitoring System

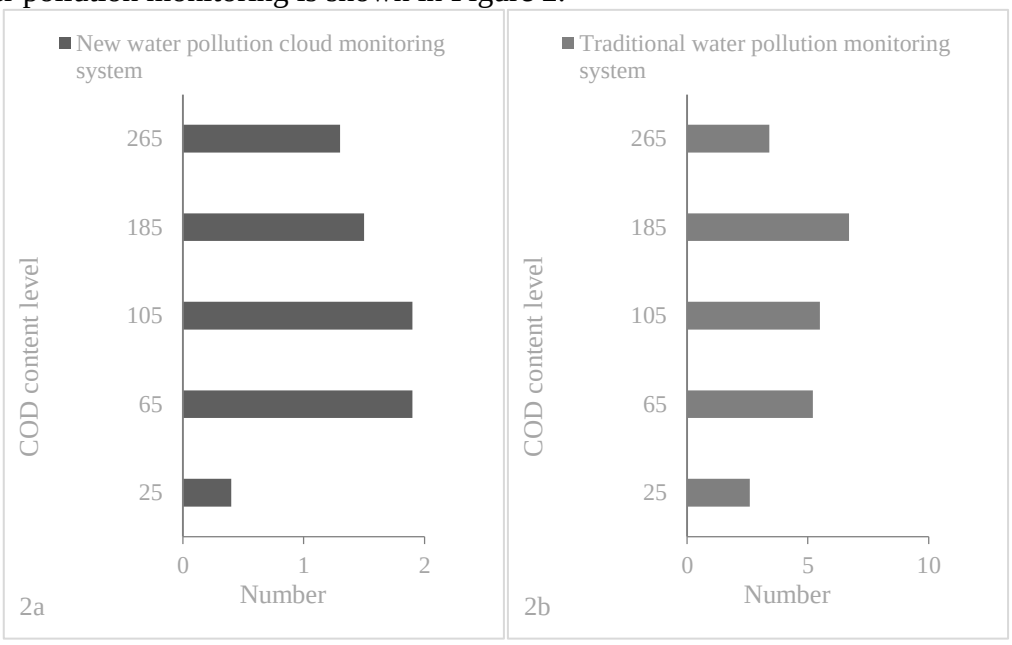
The water pollution cloud monitoring system proposed in this paper is called the new water pollution cloud monitoring system. The new water pollution cloud monitoring system and the traditional water pollution monitoring system were used to measure the water pollution in Z city. The effectiveness of the water pollution cloud monitoring system was judged by taking COD index as the judgment index of water environmental pollution. In addition, four water pollution monitoring technology experts were invited to evaluate the new water pollution cloud monitoring system in the form of interviews.

The water pollution cloud monitoring system and traditional water pollution monitoring system proposed in this paper were used to monitor the COD content in water quality. The monitoring accuracy results are shown in Table 1.

Table 1. Results of two water pollution monitoring systems

	COD actual value(mg/L)	COD monitoring result value(mg/L)
New water pollution cloud monitoring system	25 65 105 185 265	24.6 63.1 103.6 183.5 263.7
Traditional water pollution monitoring system	25 65 105 185 265	22.4 59.8 99.5 178.3 261.6

To evaluate the effect of two water pollution monitoring systems by using the mean value of absolute error and mean square error, it is necessary to obtain the absolute value and the square value of the deviation value of water pollution monitoring. The absolute value of the deviation value of water pollution monitoring is shown in Figure 2.



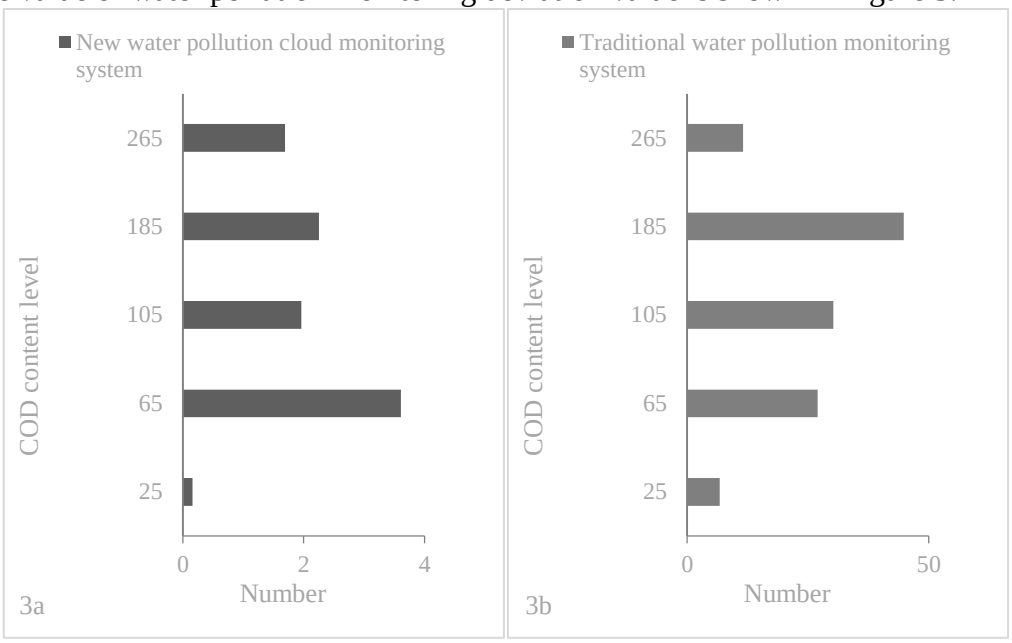
2a: Deviation value under the new water pollution cloud monitoring system

2b: Deviation value under traditional water pollution monitoring system

Figure 2. Absolute value of deviation value of water pollution monitoring

Figure 2a shows the deviation value under the new water pollution cloud monitoring system, and Figure 2b shows the deviation value under the traditional water pollution monitoring system. According to the data in Figure 2a, the average absolute error of the new water pollution cloud monitoring system was 1.4. According to the data in Figure 2b, the average absolute error of the traditional water pollution monitoring system was 4.68. From the perspective of the average absolute error, the average absolute error under the new water pollution cloud monitoring system was 3.28 lower than that under the traditional water pollution monitoring system, and the new water pollution cloud monitoring system had a high water pollution detection accuracy.

The square value of water pollution monitoring deviation value is shown in Figure 3.



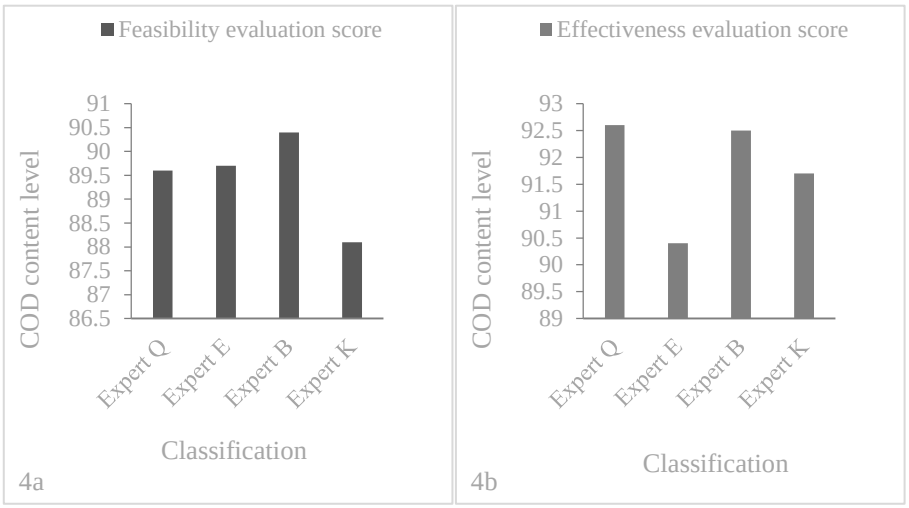
3a: square value of deviation value under the new water pollution cloud monitoring system

3b: square value of deviation value under traditional water pollution monitoring system

Figure 3. Square value of water pollution monitoring deviation value

Figure 3a shows the square value of the deviation value under the new water pollution cloud monitoring system, and Figure 3b shows the square value of the deviation value under the traditional water pollution monitoring system. According to the data in Figure 3a, the mean square error of the new water pollution cloud monitoring system was about 1.93. According to the data in Figure 3b, the mean square error of the traditional water pollution monitoring system was 24.1. From the perspective of mean square error value, the mean square error value of the new water pollution cloud monitoring system was 22.17 lower than that of the traditional water pollution monitoring system, and the water pollution detection result of the new water pollution cloud monitoring system was more accurate.

These four experts were called expert Q, expert E, expert B and expert K. The feasibility and effectiveness evaluation scores of the new water pollution cloud monitoring system by four water pollution monitoring technical experts are shown in Figure 4.



4a: Feasibility evaluation score of the new water pollution cloud monitoring system by experts

4b: The effectiveness evaluation score of the new water pollution cloud monitoring system by experts

Figure 4. The feasibility evaluation score and effectiveness evaluation of the new water pollution cloud monitoring system by four experts

Figure 4a shows the feasibility evaluation scores of experts on the new water pollution cloud monitoring system, and Figure 4b shows the effectiveness evaluation scores of experts on the new water pollution cloud monitoring system. According to Figure 4a, the four experts scored 89.6, 89.7, 90.4 and 88.1 respectively on the feasibility evaluation of the new water pollution cloud monitoring system. According to Figure 4b, the effectiveness evaluation scores of the four experts on the new water pollution cloud monitoring system were 92.6, 90.4, 92.5 and 91.7 respectively. From the average data, the average feasibility evaluation score of the four experts on the new water pollution cloud monitoring system was about 89.5, and the average effectiveness evaluation score of the four experts on the new water pollution cloud monitoring system was about 91.8. It showed that the new water pollution cloud monitoring system can play a certain role in water pollution monitoring.

5. Discussion

From the perspective of monitoring, this paper put forward two countermeasures to prevent and control water environmental pollution. Continuous improvement of water environment monitoring system: relevant personnel should comprehensively and accurately monitor the water quality to obtain more objective monitoring data, so as to lay a foundation for further water pollution prevention and control work. All units should strengthen communication and establish a coordination mechanism to clarify their responsibilities, which can prevent shifting responsibilities and improve the efficiency of monitoring work.

Improvement of monitoring level: water environment monitoring should focus on modern technology and ensure the high quality and efficiency of monitoring work, so as to improve the effectiveness of monitoring work. Geographic information system and big data can be used [14-15]. These technologies have their own advantages and are irreplaceable. The value of these technologies should be maximized to improve the level of monitoring personnel and realize dynamic and automatic monitoring of the environment, so as to achieve the best water environment monitoring effect. Relevant personnel should fully combine the actual needs of water environment

monitoring to reasonably and scientifically apply monitoring technology, means and instruments, so as to improve their monitoring level.

6. Conclusion

In the face of serious water pollution, relevant departments must strengthen the monitoring and management of water bodies. It is necessary to improve the monitoring quality of water resources and obtain accurate water pollution monitoring data, so as to provide support for active water pollution prevention. This paper summarized the contents and quality control methods of water pollution monitoring, and put forward the system for water pollution monitoring and the algorithm used in water pollution cloud monitoring system. From the perspective of water pollution monitoring, some suggestions for water pollution prevention and control were put forward. This paper drew the following conclusions through experiments: compared with the traditional water pollution monitoring system, the new water pollution cloud monitoring system has higher monitoring accuracy; the experts of water pollution monitoring technology have a high evaluation on the feasibility and effectiveness of the proposed water pollution cloud monitoring system.

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Data Availability

Data sharing is not applicable to this article as no new data were created or analysed in this study.

Conflict of Interest

The author states that this article has no conflict of interest.

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