Scholar Publishing Group
Academic Journal of Environmental Biology
https://doi.org/10.38007/AJEB.2020.010306
ISSN 2789-8407 Vol. 1, Issue 3: 44-51

The Response of River Biological Monitoring and Water Quality Based on Remote Sensing Image Technology

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Keywords: Remote Sensing Image Technology, River Biological Monitoring, Water Quality Response, Correlation Analysis

Abstract: With the development of space technology, the temporal resolution, spatial resolution and spectral resolution of remote sensing images have been greatly improved in accuracy. In the quantitative remote sensing monitoring of water quality, these characteristics of remote sensing images will affect the monitoring The accuracy of the results will have a great impact. Therefore, in the process of quantitative remote sensing monitoring of water quality, the selection of remote sensing image data is very important. In this paper, remote sensing image technology is used to study the biological monitoring and water quality responsiveness of a certain river. After taking water samples, SPOT-5 is used to obtain remote sensing data. After correlation analysis, the correlation of water quality indicators is obtained, and the response analysis of water quality indicators and microorganisms is carried out. The experimental results show that the total amount of microorganisms has a good response relationship with water quality.

1. Introduction

The problem of water quality monitoring has always been a focus of water environmental protection research. With the development of water quality monitoring technology and the attention of water environmental protection worldwide, the traditional field sampling water quality monitoring technology has been limited by many conditions such as manpower and material resources. It cannot meet the time and space requirements of current water quality monitoring. In recent years, with the leap of aerospace technology, the remote sensing technology industry has made great progress, and the temporal and spatial resolution of the obtained remote sensing images has been continuously improved. The quantitative monitoring of remote sensing water quality has the advantages of large-scale, rapid and dynamic monitoring. The quantitative monitoring of water quality by technology has become a hot spot in water quality monitoring [1].

The application of remote sensing image technology in water quality monitoring has a long history. The application of remote sensing technology to water quality monitoring research began in the early 1970s. During this period, with the improvement of the spectral resolution of remote sensing, in-depth spectral feature analysis for specific targets and acquisition of spectral features of a certain water quality parameter have become a reality. The content is also transformed from water area identification to quantitative inversion of water quality parameters, water quality analysis, etc. [2]. The choice of inversion method cannot be avoided in water quality inversion. The inversion method that can be used at first is physical method. With the application of multi-spectral remote sensing data, analytical/semi-analytical methods with ocean monitoring (initial application) as the research object have gradually emerged; later, the spectral resolution rose to a new stage, and empirical/semi-empirical methods began to be used in inland lakes, etc. Water pollution monitoring is favored. The development of these technologies is inseparable from the diversification of remote sensing data sources. According to the band width and quantity of remote sensing data, the data sources can be divided into multispectral, hyperspectral and other remote sensing data [4]. The development of technology will inevitably bring some research progress. For water quality remote sensing inversion, domestic and foreign scholars have obtained a certain high-precision inversion model, but it needs to be further optimized in terms of versatility and high precision [5]. Compared with the development of water quality remote sensing monitoring abroad, the domestic research time is relatively short. However, the application of water quality remote sensing to inland water pollution monitoring has also been widely studied in China.

This paper first puts forward the concept of remote sensing image technology and its application in water quality monitoring, and then introduces a water quality monitoring device. Then, a river water sample is sampled, the total bacterial DNA in the water is extracted, and the correlation between the DNA concentration of each sampling point and COD, TN, NH_4^+-N, and SS was obtained, thereby illustrating the response relationship between the total microorganisms and water quality.

2. Related Technologies

2.1. Remote Sensing Image Technology

The application of remote sensing images to the monitoring of microscopic quantitative water quality parameters in the water environment benefits from the improvement of spectral resolution. The high-segment remote sensing satellites launched by my country are based on the combination of spatial resolution, multi-spectral and large coverage, and are gradually applied in the field of civil research, respectively playing an important role in scientific research such as water environment, geographic mapping, and meteorological monitoring [6].

The analysis and processing of spectral data is the foundation of water quality inversion research, including spectral data acquisition and spectral data preprocessing. Data acquisition Complete the collection of field water samples, the collection of spectral curves by ground object spectrometers, and the quasi-synchronous multi-spectral remote sensing data obtained according to the collection time. Among them, the real concentration value of water samples is indispensable as modeling and model detection data, and water sample collection needs to be completed in the process of spectral data acquisition [7]. The initial acquired spectral data will inevitably be affected by interference factors such as weather, surrounding environment, and personnel operations in terms of accuracy. Corresponding preprocessing measures must be taken to minimize the influencing factors and improve the inversion accuracy. Data analysis solves two major problems of data source and basic data processing. The data source, that is, the data that needs to be acquired for water quality inversion includes the water samples collected in the field, the spectral curve collected by the ground object spectrometer, and the acquired quasi-synchronous remote sensing data [8-9]. The design of the field collection data should include the geographical location of the selected water area, the sampling distribution points of the water area, and the design of the sampling data registration form. Basic data processing, preliminary analysis of the type of acquired data and acquisition equipment, to provide a basis for subsequent targeted processing of spectral data [10].

2.2. Water Quality Monitoring Device

The layout design of the right mounting plate is shown in Figure 1. On the right mounting plate, the ozone generation module, gas flow sensor, temperature sensor and pressure sensor are mainly arranged [11]. The modules and components on the mounting board are mainly used to generate ozone gas, and to detect the flow rate of the gas before digestion, the concentration of ozone, and the temperature and pressure of the device during the digestion process. Among them, the ozone generating module is packaged in ABS plastic box, which has good insulation and corrosion resistance, and has strong comprehensive performance, which can well protect the internal components [12]. The use of modular packaging for the ozone generating components is beneficial to the overall maintenance and replacement of the module, and makes the whole more concise and reduces the overall complexity of the device system.

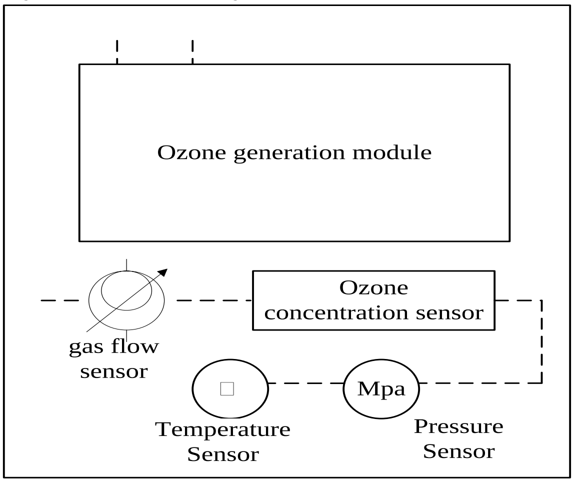

Figure 1. Layout of the right mounting plate

The ozone generation module box is mainly composed of an ozone generator, an anode water tank, a fan, a switching power supply, a cathode water tank, a syringe pump and a relay. Among them, the anode and cathode water tanks are made of quartz glass, which has the advantages of good heat resistance, high light transmittance and stable chemical properties. The switching power supply mainly supplies power for the ozone generator. In addition, the hydrogen produced at the outlet of the upper end of the cathode water tank as a by-product is led out of the device through the conduit in the device and discharged to the outside [13].

The middle mounting board is the largest of all mounting boards, so more components are laid out. The gas flow sensor, ozone concentration sensor and carbon dioxide concentration sensor in the installation board are mainly used to detect the relevant parameter information of the mixed gas at the outlet after the digestion of the water sample [14]. The condensing module on the upper right of the installation board is mainly used to condense the ozone gas produced by drying. Since the mixed gas of ozone and oxygen will have some water vapor after it is generated from the ozone generating module, it needs to be dried and condensed by the condensing module, otherwise it will be It will affect the detection results of the sensor; the condensation module on the upper left of the installation board is used to dry the mixed gas after passing through the water sample solution. The mixed gas is introduced from the lower end of the quartz glass reaction tube, and the pinhole aeration hole at the lower end can make The mixed gas is fully in contact with the water sample solution, and after the condensation module dries and condenses the water vapor in the mixed gas, the detection result of the sensor at the outlet will be more accurate [15-16].

3. Experimental Method

3.1. Collection of Water Samples

In this study, 8 sampling points (A~H) were selected in a certain river channel, and the microbial community structure analysis and follow-up research of the water body were carried out. In order to ensure the extraction amount of DNA in subsequent experiments, 500 mL of water samples were collected. Immediately after sampling, they were transported to the laboratory in an incubator with an ice box, and DNA extraction was completed within 24 hours [17].

3.2. Extraction of Total Bacterial Genome DNA in Water

Extraction and purification of total bacterial genome DNA in water. The water sample was first filtered by suction, and the filter membrane used a nitrocellulose filter membrane with a pore size of 0.22um, and the volume of the filtered water sample was 400mL. Use sterilized tweezers to roll up the filtered side of the filter membrane inward, put it into a 5 mL centrifuge tube, and then follow the following steps to extract DNA [18]. Add 1 mL PW1 solution to the centrifuge tube and tighten the lid; Fix the centrifuge tube on a vortex shaker and shake it at the maximum speed for 5 minutes to lyse the cells to the greatest extent; The solution was transferred to a clean 2mL centrifuge tube and centrifuged at 13000xg for 1min; Transfer the supernatant to a clean 2mL centrifuge tube, add 200uLPW2 solution, mix well and place at 4C for 5min, then centrifuge at 13000xg for 1min; Transfer the supernatant To a clean 2mL centrifuge tube, add 650μL PW3 solution and mix well; Put the spin filter in a clean 2mL centrifuge tube, add 650μL PW4 solution to the filter; Discard the filtrate, add 650μL PW5 solution to the filter, 13000xg Centrifuge for 1 min; put the spin filter in a clean 2 mL centrifuge tube, add 100 μL of PW6 solution to the filter, centrifuge at 13,000×g for 1 min, and the filtrate is the extracted DNA [19].

3.3. Data Analysis

The statistical analysis of the data involved in this paper is done by Excel and SPSS and other related software, and the image processing is done by Origin software.

4. Analysis of Experimental Results

4.1. Quantitative Remote Sensing Monitoring of Water Quality

At present, the remote sensing data used for water quality monitoring mainly include SeaWiFS, TM, ETM+, SPOT, QuickBird and so on. Analysis of various remote sensing data, among which SeaWiFS is mainly used for marine water quality research, and TM and ETM+ data, although the spectral resolution is high, cannot meet the needs of this paper in terms of spatiotemporal characteristics. After data screening and analysis, it is found that only the SPOT-5 remote sensing data obtained by the SPOT-5 satellite can meet the requirements in time and space. Based on this, referring to the acquisition time of water quality field monitoring data and the location of water quality monitoring points, SPOT-5 remote sensing images are used as the remote sensing data used in the quantitative remote sensing monitoring of water quality in this paper, and the acquisition time of the images is guaranteed to be consistent with the water quality field monitoring data collection. time synchronization. The band and spectral resolution data of SPOT-5 remote sensing image data are shown in Table 1.

Table 1. SPOT-5 remote sensing image features

	Spectral resolution	Spatial resolution(m)	Spectral range(μm)
SPOT-5	All colors	5	0.54-0.76
	near infrared	15	0.82-0.95
	red	15	0.65-0.7
	green	15	0.57-0.65
	shortwave infrared	30	1.47-1.71

4.2. Correlation Analysis Results between Remote Sensing Data Water Quality Variables

The significance of correlation analysis in quantitative remote sensing monitoring of water quality is mainly reflected in the verification of inversion accuracy. The calculation method of the product-difference correlation coefficient is as follows:

$$r = \frac{\sum_{i=1}^{n}(X_i - \bar{X})(Y_i - \bar{Y})}{nT_X T_Y} \tag{1}$$

The calculation formula obtained from the original data calculation is:

$$r = \frac{\sum_{i=1}^{n} X_i Y_i - (\sum_{i=1}^{n} X_i)(\sum_{i=1}^{n} Y_i)/n}{\sqrt{\sum_{i=1}^{n} X_i^2 - (\sum_{i=1}^{n} X_i)^2 / n}\sqrt{\sum_{i=1}^{n} Y_i^2 - (\sum_{i=1}^{n} Y_i)^2 / n}} \tag{2}$$

Among them, X is the data of each band of the remote sensing image, and Y is the field monitoring data of various water quality. The remote sensing image data after various preprocessing is the radiance value converted from the image gray value or the reflectance calculated by the atmospheric radiative transfer model.

When calculating the correlation coefficient, two methods are adopted: the comparison between the water quality measured data and the original data, and the comparison of the original data after taking the logarithm. The correlation between some of the water quality variables is strong, specifically: the correlation between InCODMn and InNH4+-N reaches 0.9214 (logarithm of data);

the correlation between InCOD and InCODMn reaches 0.9183 (logarithm of data); InCOD and InNH4+ The correlation of -N reaches 0.8451 (original data). The results of the correlation analysis between the measured water quality variables and water quality variables are shown in Table 2.

Table 2. Comparison of the correlation between measured water quality variables and water quality variables

	$\ln COD_{Mn}$	$\ln NH_4^+$-N	DO	lnCOD
$\ln COD_{Mn}$	1	-	-	-
$LnNH_4^+$-N	0.9214	1	-	-
DO	-0.7846	-0.7923	1	-
lnCOD	0.9183	0.8451	-0.7236	1

4.3 Response Analysis of Water Quality Indicators and Microorganisms

The concentration of DNA can indirectly reflect the change of the total amount of microorganisms, and then the response of DNA concentration and water quality can be used to reflect the response of microbial biomass and water quality. As shown in Table 3, DNA concentration has a good positive correlation with NH_4^+-N, SS, TN, COD_{Mn}, and the change trend of each pollutant is roughly the same as that of DNA concentration, indicating that the total amount of microorganisms has a good relationship with water quality. response relationship.

Table 3. Response of DNA concentration to NH4+-N, SS, TN, CODMn

	A	B	C	D	E	F	G	H
DNA	22	32	25	28	36	27	30	24
NH_4^+-N	1.7	3.5	2.4	2.6	3.9	3.2	3.6	2.2
SS	3.8	5.4	4.6	5.2	6.7	6.2	6.4	4.8
TN	2.3	3.7	2.8	3.2	4.1	3.5	3.8	3
COD_{Mn}	2.1	2.9	3.1	4.3	5.5	4.6	4.9	4.1

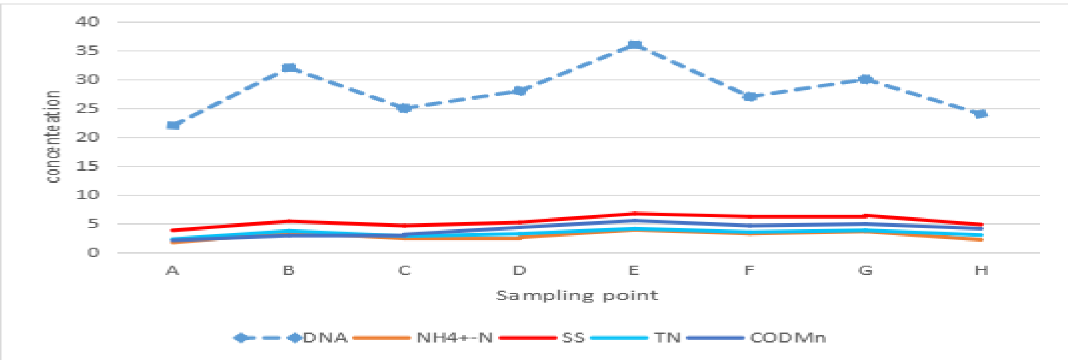

Figure 2. Water quality data

The results of water quality data analysis are shown in Figure 2. The monitoring values of NH_4^+-N, TP, TN, and COD_{Mn} at sampling point A are all at a lower level than other sampling points. According to the surface water quality inspection standards, it initially meets Class II1 water. However, the monitoring values of NH_4^+-N, TP, TN, and COD_{Mn} at sampling point E are all at high levels, which is a heavily polluted river channel, with serious black and odorous sediments, and the water quality has been classified as inferior V.

At the same time, this study also found that there is also a correlation between the total number of bacteria and environmental factors. COD_{Mn} is an important factor affecting the temporal and spatial distribution of the total number of bacteria. The reproduction rate of bacteria increases with the increase of COD_{Mn} concentration. To a certain extent, it reflects the level of organic matter content in the study area. Inorganic nitrogen is largely utilized as a nitrogen source, so there is also a good correlation with the total number of bacteria.

5. Conclusion

Regarding the water quality monitoring method, the traditional method collects and obtains a small range of water areas, consumes relatively high manpower and material resources, and the measurement point data also has limitations in geographical location. Sexuality and large-scale requirements, which are barriers to the inability of traditional methods to obtain samples of the entire waters. However, with the rapid development of space science and technology at the current stage, remote sensing image technology has provided a new way for water pollution monitoring. In this paper, this technology is used to obtain river remote sensing data, and to analyze the relationship between river microorganisms and water quality, which can monitor water quality and prevent water pollution.

Funding

This article is not supported by any foundation.

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.

References

[1] Ismanto H, Doloksaribu A, Susanti D S, et al. The Accuracy of Remote Sensing Image Interprepation On Changes In Land Use Suitability In Merauke Regency Papua. International Journal of Engineering Trends and Technology, 2020, 68(10):42-47.

[2] Sedaghat A, Mohammadi N. Rotation Invariant Local Binary Pattern Descriptor for Remote Sensing Image Matching. Journal of Geospatial Information Technology, 2019, 7(2):223-239. https://doi.org/10.29252/jgit.7.2.223

[3] Vishwakarma H, Katiyar S K. An approach for line feature extraction using hough transform for remote sensing images. International Journal of Civil Engineering and Technology, 2018, 9(6):388-394.

[4] Rusyn B P, Lutsyk A A, Kosarevych R Y. Modified Architecture of Lossless Image Compression Based on FPGA for On-Board Devices with Linear CCD. Journal of Automation and

Information Sciences, 2019, 51(2):41-49.

[5] Turibamwe E, Wangalwa R. A Comparative Study of Two Biological Monitoring Systems in Assessing Water Quality: A Case of River Birira, Sheema District, Uganda. Water Conservation and Management, 2020, 4(1):07-14. https://doi.org/10.26480/wcm.01.2020.07.14

[6] Bhutekar D D, Aher S B. Biological monitoring of riverine ecosystem and its correlation with water quality. Bioscience Biotechnology Research Communications, 2019, 12(1):194-202.

[7] Pattanayak A S, Pattnaik B S, Udgata S K, et al. Development of Chemical Oxygen on Demand (COD) Soft Sensor Using Edge Intelligence. IEEE Sensors Journal, 2020, PP(99):1-1.

[8] Jeong I S, Lee S R, Song I, et al. A Biological Monitoring Method based on the Response Behavior of Caenorhabditis Elegans to Chemicals in Water. Journal of Environment Informatics, 2019, 33(1):47-55.

[9] Rauen W B, Ferraresi A C, Maranho L, et al. Index-based and compliance assessment of water quality for a Brazilian subtropical reservoir. Engenharia Sanitaria E Ambiental, 2018, 23(5):841-848.

[10] Guellaf A, Kettani K. Performance of macroinvertebrates-based biotic indices for assessing water quality in martil river basin, northern morocco. Environmental Engineering and Management Journal, 2020, 20(1):141-150.

[11] Igor, Lima, Aboim, et al. Phytoplankton response to water quality seasonality in a Brazilian neotropical river.. Environmental monitoring and assessment, 2019, 192(1):70-70. https://doi.org/10.1007/s10661-019-7882-5

[12] Lakew A. Headwater Streams And Values Of Bio-Assessment For Sustainable River Management In Highlands Of Ethiopia. Ethiopian Journal of Environmental Studies and Management, 2020, 13(5):608-619.

[13] Ananga N, Pulcherie R, Aghaindum A G, et al. Physico-chemical and Biological Water Quality in a Sub-urban Area in Cameroon: Case of the Ngoumou Rural Council. Natural Resource Modelling, 2019, 4(6):198-204. https://doi.org/10.11648/j.ijnrem.20190406.16

[14] Silva T, Santo K, Matsumoto S T, et al. Monitoring of the water quality of the foz of Santa Maria da Vitória river and the Vitória bay-ES, by systematic studies of physical-chemical and biological parameters. Revista Virtual de Quimica, 2018, 10(5):1373-1392. https://doi.org/10.21577/1984-6835.20180094

[15] Azmi W A, Hussin N H, Amin N M. Monitoring of water quality using aquatic insects as biological indicators in three streams of Terengganu. Journal of Sustainability Science and Management, 2018, 13(1):67-76.

[16] Panda P K, Panda R B, Dash P K. The Study Of Water Quality Index And Seasonal Variations Of Physico-Chemical Parameters Of The River Salandi, Bhadrak, Odisha, India. Pollution research, 2019, 38(3):723-732.

[17] Saeidi Z, Vatandoost H. Aquatic Insect from Iran for Possible Use of Biological Control of Main Vector-Borne Disease of Malaria and Water Indicator of Contamination. Journal of Arthropod-Borne Diseases, 2018, 12(1):1-15.

[18] Beheary M S, Saleh E M, Serag M. Water Quality and Monitoring Of Some Pollution Indicators in Lake Manzala, Egypt. Advances in Environmental Biology, 2019, 13(6):7-12.

[19] Musthafa M M, Rajandram D, Abdullah F. Water Quality Assessment At Fraser's Hill And Pangkor Island, Malaysia Using Physico-Chemical And Biological Methods. Malaysian Forester, 2020, 83(2):199-214.