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Establishment of Water Quality Monitoring Database in Poyang Lake

XIONG Peng^{1, a}, FANG Chao-yang², CHEN Hong-wen¹, LIU
Zhi-gang¹, LIAO Bin¹, FENG Ming-lei¹¹Jiangxi Research Academy of Environmental Sciences, Nanchang, 330029, P.R.C.²Key laboratory of Poyang Lake Wetlands and Watersheds Research, Nanchang, 330022, P.R.C.^a LiaoShengbin045@126.com

Abstract

By selecting the data that can objectively reflect the water quality of Poyang Lake, using currently popular database management software and program language, a water quality database system is developed which can collect, manage, analyze and present water environment data. The result can provide information service for protecting precious lake data resources and for lake environmental protection and resources utilization.

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Keywords: Poyang Lake, Water Quality Monitoring, Database, Water Pollution Control and Prevention

Background

Poyang Lake is the largest inland fresh water lake in China which covers an area of 162,200 square kilometers. It has an area of 157,000 square kilometers in Jiangxi province, which occupies 94.1% of the whole Jiangxi territory. The Poyang Lake has a quite sophisticated and various ecological structures with entirety and multiplicity as its distinctive features [1]. The water environment of Poyang Lake is an important part of the ecological system, and the water quality of Poyang Lake is the core of its protection. The monitoring data shows that all the parameters conform to the II ~ III category of water quality except total phosphorus and total nitrogen [2].

Currently, the water quality monitoring and water environment management of Poyang Lake involves many departments, including environmental protection, water conservancy, agriculture, forestry and sanitation [3]. The source of basic data of water gross amount varies a lot, and water quality monitoring projects and their monitoring sites undertaken by each department differ greatly from each other. Consequently, the data collected are scarcely comparable.

Relevant researches show that since 1980s, the ecological health index of Poyang lake has been declining year by year, and it basically stays at a “relatively low” level from 2004 to 2008 (the main evaluative

elements are the total amount of phosphorus, nitrogen and ammonia) [4]. On account of this, to select the data that can objectively reflect the water quality of Poyang Lake and its variation tendency and to establish a water quality monitoring database is the premium of understanding the environmental issues of Poyang Lake and also promulgating the protective strategy of “a lake of clear water”. The application of its research results can serve as scientific evidence for understanding the water environment and schistosome problem of Poyang Lake, for analyzing and solving prominent water environment issues and water-related local diseases as well as for the decision-making departments in the government to formulate some strategies concerning development and protection.

Data Components of Water Quality

Guided by the national standard index system of water quality and management needs from different government departments towards Poyang Lake, this should take into consideration the factors affecting water quality and the actual situation of Poyang Lake—the epidemic area of schistosomiasis. Classification and identification of water quality investigation and monitoring data, lake pollution sources data, substrate monitoring data, regional pollution sources data as well as the density of lake oncomelania infection should be revised in accordance with the practical condition. And selection of such data will lead to a data set of water quality monitoring.

Table 1 Components and Types of Data

Data Sets	Data Subsets	Components
Data Sets of Water Environment Quality Monitoring	Water Environment Monitoring	Frequency and results of water environment routine monitoring conducted by departments of environmental protection and water resources, monitoring data acquired in major programs by relevant research institutes in this region ^[5] .
	Inflow (outflow) Water Environment Monitoring	Frequency and results of water environment routine monitoring conducted by departments of environmental protection and water resources in the main inflow mouths and Hukou, with monitoring data acquired in major programs by relevant research institutes in this region as reference.
	Eutrophication Indexes	The relevant research by research institutes including Jiangxi Environmental Science Institute and Jiangxi Normal University in recent 20 years ^[6] .
	Water quality of sources of drinking water	Frequency and results of environment monitoring conducted by environmental protection departments in the centralized sources of drinking water.
	water quality monitoring in nature reserves	Frequency and data of water environment monitoring conducted by environmental protection departments in the nature reserves (most are national nature reserves).
	water quality monitoring in the main breeding waters	Frequency and data of water environment monitoring conducted by environmental protection departments in the main breeding waters in this region.
Data Sets of Inflow Pollution Sources Investigation	Main pollution sources investigation	The results of general investigation in the pollution sources in Jiangxi. The statistics are mainly about the quantity of pollution sources and the main pollutant discharged ^[7] .
	Area-pollution investigation	The results of general investigation in the pollution sources in counties and regions. The statistics are mainly about the large-scaled livestock and poultry breeding, wastage in fields, domestic sewage in rural area, and quantity of the main pollutants.
Data Sets of Sediment and Soil Monitoring	heavy metal in sediment	Results of recent research by relevant research institutes including Jiangxi Environmental Science Institute, the database focuses on the contents and density of heavy metal in sediment of inflow rivers.
	POPS monitoring in sediment, soil and organism	Results of recent research by relevant research institutes, the database focuses on the density of POPS in sediment, soil and organism (fish mostly).
Data Sets of Oncomelania Infection Density and Scope Monitoring		Ecological condition of oncomelania and vegetation on grass island.
		Results of oncomelania. spread Monitoring by Jiangxi Provincial Institute of Parasitic Diseases

Establishment of Database Management System

Designing Concepts

In recent years, the database technology has been widely applied to china's lake exploitation, lake management and lake research field, and a series of lake databases have been set up [8-9]. However, the research results, data and material have not been worked up to form an information platform. Especially, the water quality monitoring database of Poyang Lake has not been initiated, which barricaded the construction work of Poyang ecological economic zone and affected the judgment about its development trend and variation tendency by researchers and decision-makers.

Water environment security is a vital component in the present ecological strategy of the Poyang Lake. However, it is difficult to manage such a large quantity of monitoring data. Flexible and effective management is an important measure to secure the water environment security. Through the management and effective usage, the ecological environment in the Poyang Lake can be improved.

The database of water quality monitoring in the Poyang Lake is aiming to collect, manage, analyze and present water quality monitoring data, inflow pollution investigation data, data of area-pollution investigation in the lake region, and data of oncomelania infection monitoring in the lake region. Since all the data have something to do with the specific localities, spatial presentation of the monitoring information facilitates statistically the construction of the Poyang Lake ecological economic zone. This system is designed and developed on the basis of GIS theory and technique. On account of plenty of historical data in the data sets collected in a long period, data historical version function is introduced to facilitate the data management and analysis. Therefore, functions including spatiotemporal query, time series analysis and thematic graph presentation, are provided in the system designing and realization process.

The system is constructed in the operating environment of a new generation designed by Microsoft. Efficient and flexible DotNET Framework improves the system performance and development efficiency to a great extent. As the latest GIS development environment by ESRI, ArcGIS Engine 9.3 provides powerful GIS application and analysis functions, by which the technique and analysis capability of the system are promoted to present and analyze the data in a better way[10].

Functions of Management System

Main Frame

The main frame of Water Quality Monitoring Database of Poyang Lake first provides an available space for further expansion. Secondly, it should be brief, simple and intuitive for user's understanding and operation. Thirdly, the design of the main frame should take the reasonable layout into consideration. Combined with the system's specific function, the design of the whole main frame should fully follow the sequence of all operations to start the system.



Fig. 1 Main Frame of Database

Main Functions of Database

Functions of the database mainly can be found in the following aspects: collecting, managing, analyzing and manifesting the monitoring data of the water quality; survey data of in-lake pollution; survey data of non-point source pollution in Poyang Lake area and survey data of snail infection in Poyang Lake. Also, the information inquiry of the exact location of the monitoring data can also be found here, so as to spatialize the manifestation of these data and fulfill the functions of inquiring both historically and spatially, analyzing according to time series and producing the features of special topic.

Management of the Database

Data security also includes the management of the user. Not everyone can add, change and export the data. And this requires the management of the user’s right of this system. The system classifies the users into administrator, super user and general user. The setting of the rights can be used to fix more users’ rights.

Evaluation result on the water quality of Poyang Lake by making use of the database

By the analysis on the database, the excessive items in the Poyang Lake area are mainly the TN and TP. All the other results conform totally to the III degree requirement in the first table of Environmental Quality Standard for Surface Water (GB3838-2002). The higher density areas of TN and TP mainly locate in the southern part of Poyang Lake area, namely Kangshan and Lian Lake, and the Benghu area.

The spatial distribution feature of COD, TN and TP can be seen, that is the southern part of the Lake area covers a higher concentration of these. The water quality in the northern part of the Lake is superior to the southern part. COD covers the whole lake, only a small parts of the lake (Nanjinshan, Kangshan, Meixizui, Sanshan, Xieshannan) graded IV, and the others graded II~III. The water quality is rather stable, especially Gan river, Fu river, Weilu in Xin river and middle area of the Lake. At the same, Gutang of Lushan and Hukou, etc taking a relatively higher level due to the industrial pollution. The spatial distribution of TN and TP is generally the same, namely the southern part is much high, and it is getting lower and lower towards Hukou. In addition to this, the density of TP is also very high in Qinglan Lake and Junshan Lake areas and so on.

Suggestions of water quality protection

Based on the Evaluation result on the water quality of Poyang Lake as well as the analysis of water environmental change trend and its influence, and considered the focal point of water environment security management of Poyang, this paper Put forward some suggestions of water quality protection.

Firstly, Strengthening the Water Environmental Protection of “Five Rivers” Source. To protect the five rivers’ source, the ecological function conservation area in the sources of Gan river, Fu river, Xin river, Xiu river, Rao river are delimited scientifically, boundary and mark are set up, the drainage outlet and the offshore pollution sources are forbidden to realize zero emission. This is to ensure stable and high-quality upstream water, thus guarantee the safety of water environment from source.

Secondly, Strengthen the Protection of Drinking Water Sources. Delimit the drinking water source conservation area strictly. Fulfilling the water environment monitoring system of drinking water sources, set up the automatic water quality monitoring stations in important drinking water region, strengthen the monitoring of water quality and pollution accidents, issue the information on water quality monitoring of drinking water sources regularly. Formulate implementation plan of water quality standards of drinking water source. Establish centralized drinking water source security warning systems and contingency plans, a safety warning system can be set up in a trinity of pollution source warning, water quality warning and water processing factory warning.

Thirdly, Strict Total Emissions Control. To implement Emission Permit System according to the results of the national census of pollution sources, issue emission licence according to the requirements of basin total amount control, put the decomposition of total amount control index into the practice of pollution sources, implement sewage with emission licence. Carry out strict environmental access policy to “high energy consumption, high pollution” industry.

Fourthly, Strengthening of the Industrial Pollution Control. With economic structural adjustment, perfect a compulsory elimination system. Boost clean production actively, vigorously develop circular economy, to increase the duplication rate of industrial water, and reduce energy consumption unit and pollutant discharges. Strictly enforce industrial access in terms of environmental protection, implement the construction project environmental impact evaluation system strictly, strengthen the regime of “three concurrences”. Strengthen the supervision of key industrial pollutants.

Fifthly, Integrated Renovation of Rural Environment. Extend rural waters treatment, silt-removing and dredging projects, ditch and pond channel management and diversion and drainage projects, in order to promote pollution-proof rivers, pollution-proof small waters and small hydropower stations for fuel project and create a qualified environment for better life.

Sixthly, Formulating Exacting Standards and Stringent Regulations. Make a higher pollution discharge standard and stringent industry access via implementing a stricter environment access mechanism, to implement a higher outlet qualitative standard for both industrial production and city domestic sewage, tougher measures will be made to examine the discharge that goes into lakes and reservoirs. Besides, regional effluent standards that are characterized by stricter terms than national ones will be worked out and further improved in those high-pollution industries such as textile, chemical engineering, papermaking, steel manufacturing, electrofacing, food processing, and pharmacy.

Conclusion and Prospect

Through the fully investigation and analysis of Poyang Lake Valley’s characteristics of ecological system and the water quality data of Poyang Lake, based on the typical analysis of the form and the content of basic data, water quality data and schistosomiasis data, meanwhile investigating and integrating the data requirements of the potential users, this study determines the database structure, the technical line of database system and the function of database system, and finally by adopting the latest development platform, the development tool of GIS and database system build up a database prototype system of water quality monitoring. The prototype system not only possesses the function of collecting, managing,

analyzing and manifesting the water quality data, but reserve the room for the expansion of the further data integration and function adding.

Over the years, the researchers from the department of water environment management application and science field used the obtained data to finish a large amount of work, and on this basis, many data processing, analysis and knowledge mining methods have been raised. Although many achievements have been written in articles come out on publications, because of readers' different knowledge background, their variable working conditions and the complication of the methods themselves, it is not only a time-consuming problem, but hard to achieve the goals, thereby affects the working process and effectiveness. To develop a special water environment data processing and analysis software platform, and to integrate those typical methods, no doubt, it's an effective way to solve this sort of problems. Whereas the tremendous effects of the internet on human data sharing and information dissemination, the system of water environment data processing and analysis has a wild application prospects[11]. The usage of the website in the realization of data and model sharing should be based on to achieve the knowledge and information sharing.

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