

# Design and Implementation of Visualization System for Wastewater Treatment in Dianchi Lake Based on WebGIS

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**Abstract.** Based on the current state's emphasis on environmental governance, combined with a series of pollution problems faced by Dianchi Lake, traditional environmental governance methods do not have real-time effective information analysis and processing capabilities. Therefore, the construction of an information visualization system that meets Dianchi wastewater treatment is currently the general trend of environmental construction. In this paper, the (B/S) model system architecture is used to establish a WebGIS-based Dianchi basin wastewater treatment visualization system, which greatly improves the system's interaction and development costs. The system database adopts the spatial database model of GeoDatabase, which well solves the correlation between spatial data and attribute data, and can display and analyze corresponding data according to the data format and attributes. It provides an accurate and efficient visualization platform system for Dianchi pollution treatment. The commissioning of this system has greatly improved the governance efficiency of the relevant management departments of Dianchi Lake, and provided reliable data support for the dynamic adjustment of the department's governance strategy.

## 1 Introduction

Dianchi Lake is located in Kunming City, the capital of southwest China. As the sixth largest inland freshwater lake in China, it not only plays an important role in regulating the environmental climate of Kunming, but also provides a strong supporting role for Kunming's economic development. However, with the continuous expansion of the industrialization process and the increasing population of the city, Dianchi has been polluted to varying degrees. In light of the current pollution situation, relevant government departments at all levels are facing major tests. The water management departments at all levels have vigorously controlled and controlled the main sources of sewage such as urban domestic sewage and industrial discharge, which has significantly improved the water quality of Dianchi Lake. However, due to the different treatment methods of various departments, the coordination degree of each water management department does not meet the advanced water pollution control level. It is extremely urgent to design a complete sewage treatment visualization system based on the above characteristics.

Since the 1980s, Western developed countries have begun to construct spatial information visualization projects. Through the development of various application platform systems based on spatial data, the country's economic production capacity has undergone tremendous changes. However, in the design framework of foreign related systems, most digital information platforms are designed based on (c/s) architecture. The

architecture has the advantages of good security and personalization, but its information interactivity is low, and it relies on a dedicated network, server, and client, which greatly increases development and maintenance costs. Based on the current budget reports of the relevant departments of Dianchi pollution control, and through the analysis and integration of the data provided by various departments, combined with the spatial attribute distribution characteristics in the data. This paper develops a visualization system for wastewater treatment in Dianchi Lake basin based on WebGIS. The WebGIS system has the access and sharing ability of spatial information. The implementation of the WebGIS visualization system adopts a browser/server (B/S) model architecture, and the system established has the following advantages: the user access is simple, and is not limited by time and place. The system application cost is low, cross-platform performance is good, and easy to operate. The use of this visualization system has greatly improved the informationization level of sewage treatment in Kunming. It has fundamentally improved the efficiency and accuracy of the work of various sewage treatment departments. The system realizes the rapid sharing of information between management departments and the application of WebGIS across platforms.

## 2 Data collection and data processing

### 2.1 Data collection

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The design and implementation of the wastewater treatment visualization system based on WebGIS in Dianchi Lake Basin is divided into related business data collection and remote sensing image data acquisition. The following is an introduction to two different types of data acquisition methods.

**Relevant business data:** Through field investigation combined with advanced surveying and mapping technology and space and attribute information data provided by relevant management departments, the collected data content covers all relevant business points within the eight districts and counties of Kunming. The scope of its business includes the spatial distribution of the relevant facilities for wastewater treatment related facilities and reclaimed water production, as well as the property information such as the name, operational capability and operational status of the relevant facilities.

**Remote sensing image data:** The HD satellite image data with a resolution of 0.25 meters is downloaded as a base map through the Google Maps Downloader. Set off the features of the relevant business data.

## 2.2 Data processing

The information of the point information such as the pump station element, the water replenishment point, the storage tank, and the reclaimed water intake point in the sewage treatment system is imported into the Arcmap 10.3 to generate the .shp format file by measuring the Excel table containing the spatial latitude and longitude position attribute from the relevant department. Line type element files such as water supply channels, river channels, drainage company pipelines, sewage main pipes, and reclaimed water irrigation channels are converted into .shp format files by importing the drawn CAD files into the toolbox that comes with Arcmap. Space position correction must be performed in online factor generation CAD data conversion. The surface elements such as the catchment area and the sewage treatment plant are generated by downloading the vector map to generate the .Shp format.

Because the standards and coordinate systems in different data collected by different departments are different, this will cause great errors in the display of the later data on the system, which affects the accuracy of the spatial position. Therefore, it is necessary to coordinate the conversion of various types of data. The various types of data in this system use the projection coordinate WGS1987 uniformly, so that it displays the complete functions and effects in the design and implementation of the system.

Through the style manager of Arcmap, each type of symbol is rendered, and the relevant business data is displayed with different colors and shapes to realize the clear distinction of different attribute elements on the satellite base map.

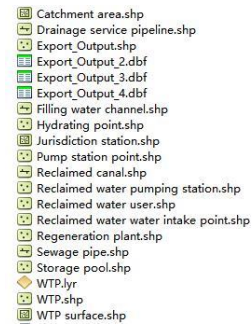


Fig. 1. Shipfile generated by dot line data



Fig. 2. Kunming remote sensing image data

## 3 Design and implementation of spatial database

The WebGIS-based Dianchi Lake Basin wastewater treatment visualization system uses the object-oriented spatial data model of ArcGIS-GeoDatabase as the spatial database model. GeoDatabase is a data model that uses standard data relational database technology to represent geographic information. The database model follows the behavioral integrity rules of spatial data and supports massive data storage. Through the corresponding interfaces of the web server and GIS server, the user can accurately retrieve relevant information. The GeoDatabase spatial database mainly stores two types of spatial data information in the design of the system: vector data and raster data. The vector data is mainly the sewage treatment point, the pipeline spatial position data and the related reclaimed water spatial data model. The related table class attribute data in the vector data is associated by the feature ID and the geometric field in the GeoDatabase spatial database. The raster data includes Kunming HD satellite remote sensing images. The database model is designed, processed and managed in an efficient and orderly manner. As an important part of the visualization system, the GeoDatabase spatial database accurately describes the real world of reality through entity objects such as points, lines, and polygons that contain spatial information and feature attribute objects that do not contain spatial information. The clear architecture of its database greatly reduces the cumbersome data. According to the classification of data collection, the system constructs the GeoDatabase spatial data model as shown below:

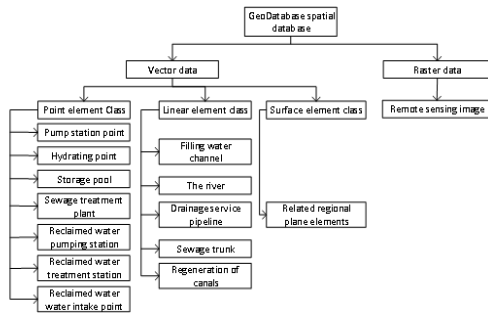


Fig. 3. GeoDatabase spatial data model

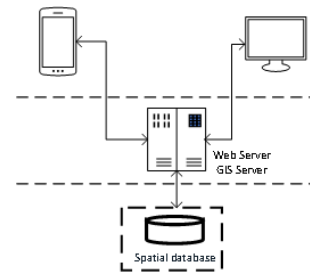


Fig. 5. Design framework of the wastewater visualization system in Dianchi Lake Basin

## 4 Visual system design and implementation

According to the actual needs of Dianchi wastewater management, the functional design of the WebGIS visualization platform is simple and practical, easy to operate, and satisfies the business needs of the sewage treatment department. The functional module architecture of the WebGIS visualization platform is designed as follows:

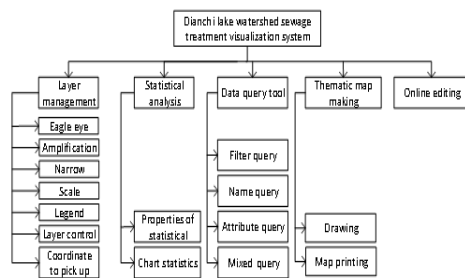


Fig. 4. WebGIS visualization platform function module architecture

### 4.1 System architecture design

According to the visualization characteristics of the system and the actual business requirements, the system adopts the browser/server (B/S) model architecture mode. The architecture is divided into three levels: database, application server and browser. The architecture works as follows: Firstly, through the geographic information processing software Arcmap and other software, the related business data is processed and stored in the GeoDatabase spatial database in ArcGIS. The user submits a data request to the server through the browser, and the server retrieves the corresponding data in the spatial database through the corresponding database interface. The data is returned to the server, and the server generates script information to be submitted to the server. The system design architecture maximizes the integration of the Internet and GIS, greatly reducing operating costs and expanding user usage. The system architecture design is as follows:

### 4.2 System function design

#### 4.2.1 Design and implementation of layer management and thematic map module

The layout of the main interface of the system is shown in the figure below. The top navigation bar contains: Homepage: Homepage Control to return the main page: Basemap Control: It can load and display the satellite map image, which is used to refine the environment in which the elements are displayed. Layer control: can display different layer feature spatial position and attribute information; analysis function: can carry out comparative analysis of data to provide accurate data protection for decision making. Thematic map production: You can paint on the map, click on the map to print, and print the map of the desired format range. Zoom function: Adjust the appropriate viewing size. Hawkeye: This feature allows you to quickly find and view maps. The main interface of the system is as follows:

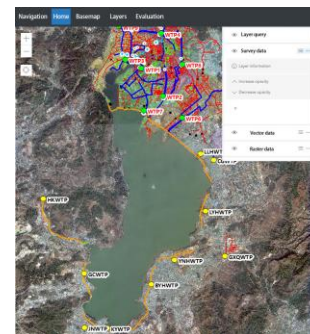


Fig. 6. System interface diagram

#### 4.2.2 Design and implementation of data query module

This module is mainly used for fast acquisition and matching of data information. In order to keep abreast of the system running status of the area to be queried or the relevant control point. The main query function of this system design is as follows: Name query: The association type of this query mode is one-to-one, which can be matched accurately. Fuzzy query: Display all the points, lines and surface information of the same field with one or two words in the field to be queried, and select the information to be queried according to the prompt. Filter the query: By setting the conditions to be

queried and then clicking Query, you can quickly get the data with the same condition attribute, which greatly facilitates the comparison and extraction of data information. The system query module interface is as follows:



Fig. 7. System query module interface

#### 4.2.3 Design and implementation of wastewater treatment analysis module

The module is mainly a dynamic visual analysis process for sewage treatment capacity and reclaimed water production capacity. By querying relevant points of interest, the relevant corresponding line graphs and column charts generated after clicking, Figure 8 shows that individual sewage treatment plant weekly treatment can be counted. According to the line chart generated below, the daily sewage treatment capacity of a single sewage treatment plant can be observed, and the reason for the decrease of sewage treatment capacity can be found in time by comparing the change of the treatment volume before and after the week. In order to carry out equipment maintenance or adjustment in time. Fig. 9 shows a comparative analysis of the system's weekly throughput for multiple wastewater treatment plants. From the generated chart, the daily sewage volume of each sewage treatment plant can be compared, and the dynamic comparison of each sewage treatment volume in a week. Through the comparison and analysis of the above dynamic data, it is possible to rationally dispatch the relevant departments of sewage treatment from the overall situation, so as to maximize the utilization of resources and greatly improve the efficiency of sewage treatment.

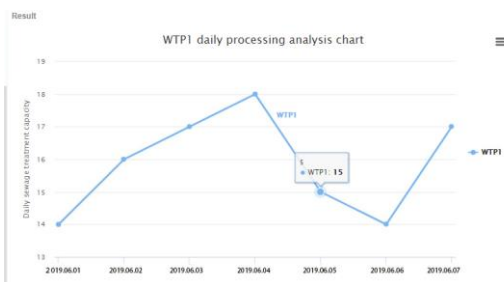


Fig. 8. WTP daily processing analysis chart

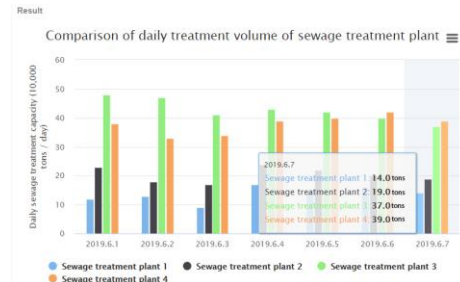


Fig. 9. Comparison of daily treatment volume of sewage treatment plant

## 5 Summary

In today's rapid economic development, environmental issues are currently not to be ignored and evaded. At present, in the environmental management of Dianchi Lake in Kunming, the government has made great efforts to rectify the work. Under the efforts of various departments, the effectiveness of Dianchi's governance has also been achieved. Significant progress. This paper combines the visualization system developed by WebGIS technology to achieve high-efficiency real-time monitoring, data acquisition, processing, analysis, map location operation, release and management of Dianchi environmental management, and adds information aid to Dianchi wastewater treatment through various functional modules. The coordinated use of the Dianchi governance provides a large number of reliable governance perspectives and comprehensive analysis. Maximize the efficiency of government departments. Therefore, the environmental management of Dianchi Lake is at the forefront of the country.

## References

1. Jiafu Liu, Shuai Li. Design of Urban Disaster Emergency System Based on WebGIS[J]. Journal of Jilin Normal University (Natural Science), 2018, v.39; No.142(1):135-140.
2. Kai YE, Zhi PU, Sicheng LIN. The river and lake information system of Tarim River Basin based on WebGIS technology[J]. Journal of Computer Systems, 2018, 27(2).
3. Wen Jin. WebGIS 3D visualization technology and its application in ground meteorological observation data analysis service system [D]. Nanchang University, 2018.
4. Xinwei Wang. Application of GIS Geographic Information System in Water Supply Pipeline Management[J]. Information Systems Engineering, 2019, 301(01): 85.
5. Liang Zhang. Application Research of WebGIS System Based on Geospatial Database[D]. Wuhan University of Technology, 2009.
6. Peng Hu, Xiping Yuan. Design of information management model considering regional water resources earthquake damage[J]. Journal of Earthquake Engineering, 2018, 40(05):231-237.