Big Data Analysis of the Ecological Environment in the Dianchi Watershed

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Abstract: To analyze the massive data on the ecological environment in Dianchi Watershed scientifically, understand its situation and dynamic trend over time, we plan to establish a feature-based four-dimensional space-time data model and build an integrated space-time database. The SuperMap map database is used to establish a space-time visual query and analysis system of the ecological environment information based on WebGIS with the B/S structure. The ecological environment information of the Dianchi Watershed is taken as the research object for scientific and comprehensive analysis and management of the ecological environment situation, thereby providing intuitive and reliable data information support for the decision-making of the ecological environment construction.

Keywords: Environmental Big Data, WebGIS, Watershed Ecosystem, Remote Sensing Investigation, Soil and Water Erosion

1. Introduction

With the integration of computer and network technologies, a new subject of computing mode and technology of distributed application program based on Internet, Wei and operation platform is put forward[1-2]. Integrating spatial information technology and network technology, WebGIS based on the Internet provides a new way to publish, share, query and analyze geospatial data and its attribute data. The lake science database and its information system is to collect, store, manage, process, retrieve, analyze and display the scientific research achievements, data, data, etc. of lakes and river watersheds[3], to systematically reveal the spatial distribution, time change and interrelation of each element of lakes and river watersheds, and provide data publishing, sharing, query and analysis services for relevant research. The multi-layered B/S model is a mature system design idea in the field of computer network software engineering[4-5]. It has the features of flexibility, reasonable and enough use of computer network resources, standardized construction, and suitable for network system management. The construction of We-bGIS based on the concept of the multi-layer model can address many problems in the deep application and development of the system, which is a research direction in the WebGIS field[6].

In this paper, remote sensing and super map database are used to extract and analyze the big environmental data and evaluate the ecological status of the watershed ecosystem, to correct the blind economic activities that damage the watershed ecosystem, enhance people's awareness of the protection of the watershed ecosystem, and provide a basis for managers to formulate policies.
2. WebGIS System with Multilayered B/S Structure

The application of WebGIS with a multi-layered B/S structure has become one of the research hotspots of GIS. According to the features of Lake data application, we plan to establish a multi-layered B/S structure WebGIS sharing network system in the database service system of lake science with B/S as the main and C/s as the auxiliary. Hence, we conducted a comparative research on the current situation of database B/S system at home and abroad. Its design has the features as follows: the organization of the scientific database. Most scientific databases use to store attribute data in the relational database, access the database through ADO in ASP, and then return the access results to users by IIS. The B/S of the USGS system in the United States takes the general release of spatial data and attribute data into comprehensive consideration. It is an excellent system organized by the industry. Users can browse and download the corresponding data as required.

The system is running in the network environment, which needs to manage massive data. At the same time, considering the flexibility of system expansion, the system structure must be advanced, reasonable and safe. The overall structure of the database information system of lake science is shown in Figure 1.

![Figure 1. Overall system framework design](image)

Basic data and special data enter data warehouse through LAN; Data warehouse divides data into the model, basic lake, typical watershed thematic and Meta databases. Users put forward application requests to the server through the user community, application service layer organizes user request, makes data request to the data-providing and management layer, and gives feedback of the calculation results.

The system is mainly composed of the B/S and supplemented by C/s. The C/S mode is used to realize the interface with various resource departments, data collection and maintenance, and the B/S mode is used to build the information portal of Nanjing Institute of lake and geography, Chinese Academy of Sciences, the system construction unit, to realize resource sharing and information WED) release. The feature of B/S structure is that it has a wide range of information publishing ability and better workflow control. It has no limit to the number of front-end users. The client only needs an ordinary browser, no other special software, and no special requirements for the network. Compared with the B/S mode, C/S mode has good interactivity, robust editing and processing ability for graphic data, high storage efficiency for spatial data, and the same query function as the B/S mode.

3. Data and research methods
3.1. Data collection and processing

The data sources of this study are as follows: land use data in 2008, 2013 and 2018 (data from land use database); average precipitation, temperature, evaporation and longitude, latitude and elevation of six meteorological stations in 2008, 2013 and 2018 (data from information room of National Meteorological Center); 1:250000 DEM data (data from national ecological environment investigation database); 1: 1 million soil type data (data from national soil type investigation database);

Data processing: 1) using RS as the leading technology and GIS as the auxiliary technology, using the ENVI software to analyze and process Landsat TM and MSS remote sensing images, and extracting NDVI (normalized vegetation index) value of the study area after image clipping. 2) Kriging interpolation method is used to interpolate the precipitation and evaporation of the study area and six surrounding meteorological stations. 3) Combined with the equation of slope length factor, WebGIS is used to extract slope and slope length from DEM data.

3.2. Research methods

Combined with the natural environment and features of the study area, the remote sensing changes in the ecosystem of the Dianchi Watershed were investigated. The soil erosion, water conservation function and environmental quality of the ecosystem were examined and evaluated.

The investigation of ecosystem change includes quantity change and spatial position change of each system type. According to the remote sensing investigation work plan of the former State Environmental Protection Administration of the people's Republic of China on the current situation of the ecological environment in the Middle East, and in combination with the current status of land use and the features of land resources in the investigated area, the Dianchi Watershed can be divided into six land-use types: cultivated land, forest land, grassland, water area, artificial surface and unused land. Based on the land use data of the Dianchi Watershed in 2008, 2013 and 2018, the area and proportion of each type of ecosystem in the three periods of the watershed were calculated, and the transfer change was analyzed.

The soil erosion amount in the study area was calculated by the universal soil erosion equation (USLE). The influence of natural factors on soil erosion is considered comprehensively, which is reflected in the rainfall erosivity factor, soil erodibility factor, terrain factor, vegetation and crop management factor and soil conservation factor. USLE is of strong practicability, with the expression as follows:

\[ A = R \times K \times L \times S \times C \times P \] (1)

Where A represents the actual soil erosion per unit area; R represents the Rainfall Erosivity Factor; K represents the soil erodibility factor; L represents the slope length factor; s represents the slope factor; C represents the crop coverage and management factor; P represents the soil conservation measure factor.

The investigation of the water conservation function is based on the water balance method to calculate the amount of water conservation in the study area. According to the relationship between precipitation, evapotranspiration and soil conservation capacity, the evapotranspiration is represented by equivalent runoff coefficient, with the calculation equation as follows:
\[ W_i = \sum (10 \times A_i \times F_i \times P_i \times k_i \times \alpha) \]  

Where \( W_i \) represents annual water conservation; \( P_i \) represents annual average precipitation; \( A_i \) represents land type area; \( F_i \) represents vegetation coverage; \( k_i \) represents development index; \( \alpha \) represents runoff coefficient.

4. Result analysis

Watershed ecosystem type. The research results (Table 1) show that the ecosystem of Dianchi Watershed mainly includes cultivated lands, with the largest area of the cultivated land ecosystem, accounting for more than 70% of the total area in three years. The proportion of forest land ecosystems accounts for 12% ~ 12.5%. The other ecosystem types such as water area, grassland, artificial surface and unused land system account for 15.26% ~ 15.29%, 0.02%, 2.27% ~ 2.50%, 0.02%, respectively.

**Table 1.** Area and proportion of ecosystem types in the Dianchi Watershed in 2008/2013/2018

| Ecosystem type | Cultivated land | Forest land | Grassland | waters | Artificial surface | Unused land |
|---------------|-----------------|-------------|-----------|--------|-------------------|-------------|
| 2008 Area/hm² | 28788.75        | 5080.69     | 9.63      | 6269.63| 931.56            | 0.10        |
| Proportion %  | 70.06           | 12.36       | 0.02      | 15.26  | 2.27              | 0.02        |
| 2013 Area/hm² | 28784.88        | 5042.06     | 9.63      | 6283.44| 960.25            | 0.10        |
| Proportion %  | 70.05           | 12.27       | 0.02      | 15.29  | 2.34              | 0.02        |
| 2018 Area/hm² | 28772.81        | 4992.44     | 9.63      | 6278.56| 1026.81           | 0.10        |
| Proportion %  | 70.02           | 12.15       | 0.02      | 15.28  | 2.50              | 0.02        |

Analysis of the changes in the watershed ecosystem types. The analysis of the changing area and proportion data of various kinds of ecosystems in 2008, 2013 and 2018 (Table 1) showed that the change of ecosystem area in the Dianchi Watershed during the 10 years had the following features: the growth of artificial surface (construction land) is the highest, with an overall increase of 95.25 hectares and a growth rate of 10.22%, of which the growth rate in 2013-2018 is relatively fast; the decrease of forest area is the most, with an overall reduction of 88.25 hectares; The cultivated land area decreased slightly, with an overall decrease of 15.94 hectares, with a small changing trend. The wetland area showed a trend of increasing first and then decreasing. However, the overall changing trend was not significant, with a total increase of 8.93 hectares from 2008 to 2018, and a growth rate of 0.14%. The grassland and unused land showed no significant changes.

Based on the statistics of the area change data of each type of ecosystem, this study uses the spatial superposition analysis of four-dimensional space-time data model to obtain the ecosystem type transfer matrix, which includes the structural features of the three-phase ecosystem change in the Dianchi Watershed, the direction and intensity of each type of change. The analysis of the change transfer matrix of various types of the ecosystem in the Dianchi Watershed suggests that the overall changing trend of ecosystem types in the Dianchi watershed is not significant from 2008 to 2018. The growth of artificial surface (construction land) is relatively more, the expansion of construction land is slightly faster, and the reduction of forest land area is relatively apparent. The other types of ecosystems in the watershed have no visible change, except that wetlands present a minor transfer...
in/out fluctuation.

5. Conclusions
In this paper, the main conclusions are drawn based on analysis and research as follows: Through the remote sensing data of land use in 2008, 2013 and 2018, the space-time change process and evolution features in the Dianchi Watershed in the early 21st century are studied. During 2008-2018, the overall changing trend of ecosystem types in the Dianchi Watershed is not significant. However, the growth of artificial surface (construction land) is relatively high, the expansion is relatively fast, the reduction in forest land is relatively apparent, and the wetland presents the transfer in/out fluctuation. The features of these changes are related to the urbanization process of the research area in the early 21st century and subject to the direct impact of the development and utilization of artificial land. The growth of artificial surface is mainly transformed from the forest lands, cultivated lands and a small part of water wetlands. It is recommended that the local administrative authority should continue to enhance the environmental protection in the watershed and improve the watershed management system; strengthen the protection of the natural ecosystem in the watershed, enhance the management of the aquatic ecosystem, reduce the discharge of domestic pollutants in the region, control the agricultural non-point source and rural domestic pollutions, prohibit the industrial pollution discharge around the lake, and protect the natural lakeshore; further improve people's awareness of environmental protection and accelerate the restoration and improvement of ecological environment quality.

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