



REVIEW

Application of GIS in Hydrologic Information Forecasting

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ABSTRACT

In recent years, China has attached great importance to the research in the field of hydrology, and hydrological work has also made great progress. Hydrological information forecasting is the focus of hydrological work, and it has close relationship with social development and people's life. After long-term development. More and more advanced information technology has gradually been applied in hydrological information forecasting, among which GIS has effectively improved the level of hydrological information forecasting. This paper analyzes the application of GIS in hydrological information forecasting to provide an in-depth understanding of this technology.

1. Introduction

GIS is a new type of advanced information technology, which has many technical characteristics and has been widely used in the field of hydrology research. It has effectively promoted the development of research in the field of hydrology. In the field of hydrology research, hydrological information forecasting is the key content, with significant social and ecological benefits. There are high demands for the work of hydrological information forecasting due to its complex content. The application of GIS technology in hydrological information forecasting effectively achieves the high quality and efficiency. How to apply GIS in hydrological information forecasting is the main content of this paper.

2. GIS Overview

GIS technology, known as geographic information system, is a type of analysis technology for spatial information

that has developed rapidly in recent years and is widely used in the field of resource and environmental research. This technology involves technologies such as computer, remote sensing, geography and information science. It can effectively realize the functions of spatial data collection, sorting, management and analysis, and visualize and output these data. The spatial data management subsystem is the core part of GIS technology. It mainly deals with the processing and analysis of spatial data. The special maps, measured data, statistical data and remote sensing image data are the main sources of spatial data. This technology can effectively convert the tabular data into the display effect of the geographic graph, and then browse, manipulate and analyze the displayed results. The result can be an intercontinental map or a detailed map of the city. The population, sales status, and transportation routes can be effectively reflected^[1].

3. Overview of Hydrological Information Forecasting

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The so-called hydrological information forecasting is mainly based on the data of pre- and current hydrometeorological data to qualitatively or quantitatively predict the hydrological situation of a certain area of water or a hydrological station in the future. The forecast period can be divided into short-term and medium term. The forecast methods include river forecasting, watershed forecasting, water quality forecasting, statistical forecasting and real-time forecasting. Hydrological information forecasting has significant social, economic and ecological benefits. The social benefits are reflected in the fact that it can predict floods, ice, water pollution and storm surges in real time, which can effectively avoid casualties. At the same time, it also plays a positive role in safeguarding the health of the people and social stability and national security. The economic benefits of hydrological information forecast can be divided into the benefits of disaster prevention and mitigation and the benefits of utilization, and its they are a comprehensive measure of benefits. The ecological and environmental benefits of hydrological information forecasting are mainly to release correct hydrological information in real time, avoiding or reducing floods, water pollution and other disasters, and protecting the ecological environment^[2].

4. Significance of GIS Application in Hydrological Information Forecasting

The application of GIS in hydrological information forecasting can accurately predict the status of urban water accumulation and water withdrawal, and provide reference for the management, renewal, design and planning of existing drainage facilities, so as to achieve the purposes of disaster reduction and prevention. In the planning of urban green space and location, GIS technology can realize visual display and storage of the characteristics of rainstorm space, the accumulation of water in urban streets and the distribution of heavy rain, and it also has a high-resolution, multi-level and high-frequency of data update, maintenance and management. In addition, GIS technology also plays an important role in hydrological information evaluation, which can realize basic data management, spatial and attribute data query, data statistics, display and retrieval, etc., which can help improving the level of hydrological information evaluation. Through GIS technology, soil erosion can be mastered, soil erosion degree can be divided, soil erosion calculation, soil and water conservation benefit evaluation and soil erosion process can be predicted to help soil and water conservation work^[3].

5. Application of GIS in Hydrological Information Forecasting

5.1 Application Points of GIS in Hydrological Information Forecasting

The parameters of the model are further determined. In the hydrological model of watershed hydrology, most of the parameters, such as the width, length, and area of land use, are closely related to the geographic information and can be determined by GIS technology. But for other model parameters, such as infiltration capability, etc., this technology can also be used to obtain the corresponding results through specific calculations. In the query of information and the analysis of spatial information, hydrological information forecasting generally uses electronic maps as the background, and then uses GIS technology and data management techniques for analysis, thus achieving the query, management, retrieval and calculation of water information. DEM is widely used in the calculation of the watershed concentration with hydraulic model for analysis, and a precise and accurate evaluation of the disaster results can be obtained. The GIS technology can provide accurate hydrological data. According to the specific conditions and different characteristics of the river basin, the watershed is further divided into several units with irregularities corresponding to the resolution, so as to better consider the distribution of the spatial space such as rainfall^[4].

5.2 Application Example of GIS in Hydrological Information Forecasting

In a medium-sized reservoir in Mulan County, Heilongjiang Province, a forecasting and dispatching system for flood conditions is developed. This project mainly established a computer system with data processing, query, display, reservoir flood forecasting and reservoir dispatching capabilities, thus providing reference data for the operation of the reservoir and the optimal scheduling of water resources, etc.. The system mainly uses the visual VB programming language and is developed in combination with the geographic information system software Map-info and the GIS MapX component.

5.2.1 Basic Principles

If the flow velocity in the watershed is evenly distributed, the cross-sectional time of the water falling into the watershed to the exit is generally determined by the distance of their cross section to the exit, based on which drawn the time line of the equal stream in the river map of the basin area. Since the slope of the large watershed and the conditions of the underlying surface are not completely

the same, and the distribution of the flow velocity in the watershed is not likely to be uniform, the large watershed is divided into several sub-basins according to different geographical conditions. The flow rate in each sub-basin can be regarded as a uniform distribution state. Suppose that at time τ , the net rain falling in the basin is $I(\tau)$, and the flow rate of the section is $Q(\tau)$, then the area of the section flow at the exit of the basin area equal to the stream is $\partial w(t-\tau)$, get:

$$Q(\tau) = \int_0^t \frac{\partial w(t-\tau)}{\partial \tau} I(\tau) d\tau$$

$$\frac{Q_1 + Q_2}{2} \Delta t - \frac{q_1 + q_2}{2} \Delta t = V_2 - V_1$$

The basic principle of flood control is the equilibrium equation of reservoir water volume:

In the above formula, Q_1 and Q_2 are the flows into the reservoir at the beginning and the end of the period respectively, q_1 and q_2 represent the flows out of the reservoir at the beginning and end of the period respectively, and V_1 and V_2 represent the amount of water stored in the reservoir at the beginning and end of the period, and Δt represents the length of time.

5.2.2 Method of Implementation

5.2.2.1 Generation of Digital Maps

Since the resources are shared in the network environment, many geographic information related data can be downloaded freely, and digital river model generation is performed by DEM, which can display the flow direction of the grid type water flow and the watershed of the watershed, etc., as well as can generate automatically the parameters of the river system, sub-basin and topography. However, since the watershed area of the Tianzhuang Reservoir is relatively small, and there is no accurate and complete relevant geographic data in the network environment, this requires the use of relevant software to produce according to actual needs and existing data^[5]. Generally, the electronic map of the relevant watershed area is drawn firstly, then the map of watershed is effectively scanned into the microcomputer, after which the corresponding software is used to implement the processing, so that objects such as rivers, stations, and watersheds can be effectively placed in different layers.

5.2.2.2 Database Binding

Using the electronic map of the basin as the basis, the visual programming tool MaPx is used to effectively inter-

act with the electronic maps of its components, events and methods, and then use SQL statements to query and bind data. For the storage method of spatial information data of GIS, there are mainly three methods of implementing a hybrid of a database file of a map file and an attribute relationship, a semi-relational spatial database, and a full-relational spatial database. In MapX, the data of a space and attribute in a layer is completely separated by the layer and the dataset object respectively, thereby realizing the effective expansion of the data source, and a layer space object can bind multiple number of database tables.

5.2.2.3 Function Realization

Only when it is bound to the data set, its layer has attribute data. Through the MaPx component, the coordinate database with (x, y) can be recorded in the map for dynamic display, and various statistics and queries can be implemented according to the data geographic information, thereby realizing multi-function, for example, value, assignment and thematic drawings and so on. Through the components of Mapx, the space distribution of the rainfall within a time zone specified by the user can be performed by different area colors, which combined with the time line of the rain and other streams, the corresponding parameters are determined, and each point and each small watershed corresponds to a precipitation. The amount of precipitation, in turn, enables the calculation of flood flow and time for effective precipitation in the corresponding basin area to the exit section.

In order to effectively reflect the influence of the spatial distribution of precipitation on the runoff of the basin, it is necessary to interpolate the observation data of the actually measured rainfall station into the discrete grid of the digital water system. By analyzing the rainfall and elevation presented in multiple time periods in the small watershed, it is found that the elevation of the rainfall station in this basin is not very representative. Therefore, this paper chooses the high-precision and easy-to-calculate distance inverse square ratio method to establish the discrete spatial data field of rainfall in the basin period^[6].

The time of the confluence often refers to the time required for the flow of a grid to the section of the outlet. The calculation of the confluence time starts from the section of the exit, and then along the upstream. The confluence time of the basin grid is expressed as $T_i = \tau_i + T_y$, Where T_i is the time at which the downstream mesh is converging, and τ_i represents the time that the grid flows, which specifically represents the time required for a grid of water to flow from the grid to the adjacent downstream grid. In the calculation order, when T_y is under calculation, the downstream T_y is known. According to the calcu-

lation, the time of each grid convergence is obtained. In the same period of time, the section grids whose water flows successively reach the exit belong to the same period of time. For a grid whose convergence time is T_i , if $(t-1)\Delta t < T_i \leq t\Delta t$, it means that the grid belongs to the time period of the t th uniform flow. Therefore, it is possible to effectively calculate the flood storage time, the flood peak flow and the total amount of floods, and effectively combine with the actual needs of the reservoir flood control, so that the reservoir conditions can be properly dispatched and controlled to achieve flood control and disaster reduction purposes, as well as the rational allocation of reservoir water resources.

6. Conclusion

In summary, the application of GIS in hydrological information forecasting has effectively improved the level of hydrological information forecasting, realized the high precision and high efficiency development of hydrological information forecasting, and had a positive impact on regional flood control and disaster reduction and rational allocation of water resources. As an advanced information technology, GIS' application in hydrological information forecasting is also the future trend of hydrological development.

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