Study on Hydrogeological Prospecting Technology of Healthy Environment for Urban Residents

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Abstract. Hydrogeological survey is the focus of environmental geological survey. Hydrogeological disasters have a greater impact and are closely related to the healthy living environment of residents. Understanding the actual situation of the hydrogeological environment through survey work can provide a reliable basis for disaster prevention and control. In this regard, the article will take hydrogeological survey as the research object, and conduct in-depth research on the content and main points of hydrogeological survey in environmental geological survey.

Key words. Geological environment, hydrological survey, residents’ living environment, healthy life.

1. Introduction
In engineering construction, the development of geological engineering survey work is inevitable, in which hydrogeological survey occupies a very important position. At present, many people do not pay enough attention to hydrogeological problems, resulting in groundwater damage to various rock construction projects from time to time. Therefore, as a geological engineering surveyor, it is necessary to pay enough attention to hydrogeological problems, understand the content of hydrogeological problems, and the potential damage of groundwater to the project, to improve the project construction plan and promote the improvement of project construction quality.

2. Survey purpose and analysis of hydrological characteristics

2.1. Purpose of hydrogeological survey
The hydrogeological survey work has a very clear goal. The purpose of this work is to fully identify all the conditions of the regional hydrogeology and fully understand the groundwater discharge, runoff, recharge conditions, distribution and burial conditions in the area, so as to achieve a rough estimate of the quality and quantity of groundwater resources in the area provides a true and accurate guidance for the use and development of geological resources [1].

2.2. Characteristics of hydrological survey
In the exploration of geological engineering, due to insufficient supervision of construction or other technical reasons, the loss of groundwater to rock mass construction projects is not accurately assessed, and many construction sites will have problems with groundwater damage to building quality. Therefore,
an in-depth analysis of the causes of these accidents is required. In the exploration of geological construction projects, it is necessary to focus on the assessment of the impact of groundwater rock buildings and projects, so that the problem can be better solved. During the exploration process, it is necessary to pay attention to the foundation of the building, and then the data information after finishing needs to be flexibly applied to the design of the construction plan of the construction project. It should be established based on the construction project plan, and be divided according to the damage and impact of groundwater on the construction of the building. Under different conditions, the construction site should improve the geological and hydrological problems that occur [2].

3. Application of GIS technology in hydrogeological survey

The GIS system is a specific spatial information system (as shown in Figure 1). It is supported by computer software and hardware systems to collect, manage, and calculate relevant geographic data information in the surface layer of some regions or the entire surface layer of the earth. Technical system for storage, display, description and analysis. A very obvious difference between GIS systems and other automatic mapping systems, management information systems, and transaction processing systems is that GIS systems process spatially distributed data, not only need to manage the specific attribute data of spatial entities, but also need to The data reflecting the position of the spatial entity and the spatial position of the topological relationship are managed. The GIS system organically combines these two kinds of data to carry out coordinated analysis and management of them, so that users can clearly see the actual location distribution of spatial objects, and at the same time they can see what information is available between them. Not only can the attribute information be used as a basis for querying the spatial position, but also the spatial position can be used as a basis for querying related attribute information.

GIS systems usually have a very powerful analysis model to be responsible for spatial analysis, for example, network analysis model, buffer analysis model, overlay analysis model, etc. The core content of the GIS system is spatial analysis and spatial query. Spatial analysis and query are a very important technical means for decision-making and evaluation based on spatial information. It can be found very clearly in the hydrogeological survey of the coal mine area that many data are closely related to the spatial location distribution, such as underground water inrush point, observation hole, surface water body, aquifer distribution, aquifer distribution, geology Boundary, geological structure, etc., which makes GIS system can be very broad and in-depth application in hydrogeological survey of coal mine area. For example, the coal mine water damage can be predicted with the support of the GIS system, thereby effectively avoiding the huge losses caused by coal mine water damage [3].

![Figure 1. GIS-based resource allocation system](image-url)
4. Geophysical prospecting technology and methods of use

4.1. Geophysical technology analysis
In the survey of hydrogeological engineering geological conditions of landslides, the task of geophysical prospecting is to use different geophysical methods to provide various geological information, to understand and solve the geological problems related to landslides. Such as: Identify the scope of the landslide, determine the trailing edge and the location of the exit; understand the spatial distribution pattern of the super-wet zone and groundwater, determine its burial depth, thickness, recharge and discharge relationship; explore the rock structure and geological structure of the landslide and nearby areas; Understand the spatial shape and approximate depth of the sliding surface, and make it play an important role in providing a basis for landslide stability analysis and prevention engineering design [4].

4.2. Geophysical methods
Among the selected electrical exploration methods, electrical sounding is a volumetric exploration method. It objectively reflects the underground space conditions of the landslide through the change of resistivity in the profile and vertical different depth planes. According to the geological information it provides, It is possible to preliminarily find out the spatial distribution pattern, stratum physical characteristics, rock mass structure and structural pattern of groundwater and super-humid zone, determine the possible position and spatial geometry of sliding surface, etc., in order to study the generation and development conditions of landslides. Under the macro control of the results of electrical survey work, for the specific problems, the joint profile method, borehole charging method, and natural electric field method are used to supplement and verify to obtain complete and reliable data.

In hydrogeological exploration, it is often necessary to classify certain indicators according to certain criteria (similarity or affinity). These mathematical methods that classify objective things according to certain criteria are called cluster analysis, which is a classification method of multi-statistic "cluster-by-object". However, in science, technology, and economic management, there are many things that have no clear division between classes, and the boundaries have ambiguities. The relationship between them is more of a fuzzy relationship. For the classification of such things, fuzzy mathematics methods are generally used, and we call the clustering analysis using fuzzy mathematics methods called fuzzy clustering analysis [5].

4.2.1. Obtaining data. Let the domain \( U = \{x_1, x_2, \ldots, x_m\} \) be the classified object, where \( m \) indicators represent the behaviour of each object, and the observed value of \( x_i \) is:

\[
e_i = \{x_{i1}, x_{i2}, \ldots, x_{in}\} \quad (i = 1, 2, \ldots, n)
\]

Then the original data matrix is \( A = (x_{ij})_{n \times m} \). In practical problems, different data generally have different dimensions. In order to enable comparison of quantities with different dimensions, the data needs to be normalized. Common methods are:

4.2.2. Data standardization processing. In order to allow the original data to meet the requirements of fuzzy clustering, it is necessary to standardize the original data. Common methods are:

(1) Translation-standard deviation transformation. Standardize the I variable and replace \( x_{ij} \) with \( x'_{ij} \), i.e.

\[
x'_{ij} = \frac{x_{ij} - \bar{x}_j}{S_j}, \quad (i = 1, 2, \ldots, n; j = 1, 2, \ldots, m)
\]

In the formula:
\[
\bar{x}_j = \frac{1}{n} \sum_{i=1}^{n} x_{ij}, S_j = \sqrt{\frac{1}{n-1} \sum_{i=1}^{n} (x_{ij} - \bar{x}_j)^2}, (j = 1, 2, \ldots, m) \tag{3}
\]

(2) Translation-range transformation. If after the translation-standard deviation transformation, there is still data \( x_{ij} \not\in [0, 1] \), then its translation-range transformation is obtained

\[
x''_{ij} = \frac{x''_{ij} - \min\{x''_{ij}\}}{\max\{x''_{ij}\} - \min\{x''_{ij}\}} \quad (j = 1, 2, \ldots, m)
\tag{4}
\]

Then the fuzzy matrix is

\[
R = (x''_{ij})_{n \times m}
\tag{5}
\]

4.2.3 Construct fuzzy similarity matrix. Suppose the domain \( X = \{x_1, x_2, \ldots, x_n\} \) is the observation value of \( x_i \), then there is the data matrix \( A = (x_{ij})_{n \times m} \). The similarity coefficient of \( x_i \) and \( x_j \) is \( F_{ij} = R(e_i, e_j) \). The formula for finding \( r_{ij} \) is as follows:

\[
r_{ij} = \frac{\sum_{k=1}^{m} x_{ik} \cdot x_{jk}}{\sqrt{\sum_{k=1}^{m} x_{ik}^2 \cdot \sum_{k=1}^{m} x_{jk}^2}}, \quad (i, j = 1, 2, \ldots, n)
\tag{6}
\]

5. Methods of remote sensing technology in water resources survey

5.1. Thermal infrared monitoring technology

Thermal infrared monitoring technology is also one of the main methods of remote sensing technology. It uses thermal infrared wavelengths to survey the surface temperature by judging the surface temperature and some changes in humidity, whether there is water underground under solar radiation. Resources, under solar radiation, will show changes in different temperatures. Under normal circumstances, thermal infrared method is used to determine the direction of underground rivers, and some corresponding topographic maps are drawn at the same time, and they are marked to facilitate subsequent research. Thermal infrared monitoring technology is currently widely used in water quality exploration to detect the presence of groundwater resources. Figure 2 shows the principle of infrared thermal monitoring technology.

![Figure 2. The principle of infrared thermal monitoring technology](image-url)
5.2. Specific application
Using Spot5 high-resolution satellite imagery and multispectral satellite imagery, 1: 10,000 topographic maps, 1: 200,000 geological maps, combined with other data, to interpret the strata and tectonic distribution in a certain area, neotectonics movements, earthquakes and crustal stability. Overview, analysis of engineering geological conditions in the line area, establishment of remote sensing interpretation signs of engineering geological conditions and unfavourable geological phenomena, providing constructive suggestions for route plan comparison and selection, and providing remote sensing geological data for further development of route engineering geological exploration and work site layout. Table 1 shows the identification and analysis of different hydrogeological conditions.

| Geological phenomenon | Image characteristics                                                                 | Interpretation method                                                                 |
|-----------------------|---------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
| Debris flow           | On the image, you can clearly see the trench deposition area, the main trench pass area, and the main trench upstream supply area | Interpretation mainly through image morphological features and tonal features         |
| Alluvial fan          | Located in the lower part of the foothills, the valley of the valley and the open area in front of the mountain, it is fan-shaped, and the remote sensing image is obvious | Interpretation through tonal features and shape features                               |
| landslide             | A special chair-like small landform is presented on the remote sensing image, and the forest in the landslide area is skewed or inclined | The interpretation of landslides mainly focuses on the determination of stability and type. In the new landslide that is developing, the elements of each part are clearly visible on the image, and the landslide that has tended to be stable has its elements blurred on the image. |
| Rock pile             | It can be clearly seen on the photograph that it is located at the foot of the slope and up the slope, pointing to the supply area, forming a strip with a lower width and a narrower width, generally trapezoidal, triangular, and tongue-shaped. Without any vegetation cover | The upper and lower bounds can be clearly distinguished according to the change of hue |
| collapse              | In the remote sensing image, the collapsed area is usually a light-coloured, non-vegetated spot pattern. At the top, a concave collapsed steep wall can be seen after the collapse, and a collapsed body can be seen at the foot of the slope. A large collapse may block the river and form a small lake upstream | A landslide that tends to be stable, with light Gray tones or dark spots, with steep upper slopes that are more pronounced, stable upper steep slopes that are slow to collapse, and dense vegetation |
| Water distribution    | With different rock layer structures, the water system also shows radial, centripetal, linear structures, etc. | Interpreted mainly through tones and shapes |

The results of the study found that the four types of landforms along the line are mainly structural erosion landforms (sand shale erosion, basalt erosion), dissolved landforms, structural denudation mid-
high mountains, and erosion accumulation landforms (valley basins). The terrain is relatively flat; the stratum is fully exposed, and the lithology is mainly sandstone, shale, siltstone, limestone, basalt, metamorphic rock, etc.; the fault zone and its derived secondary structures near the north and south of the work area are developed, it has certain influence on engineering geological conditions, as shown in Figure 3 [6].

![Figure 3. Infrared thermal hydrogeological exploration view](image)

6. Conclusion
In summary, the article mainly conducts in-depth research on the technical points and precautions of hydrogeological survey in environmental geological survey. Nowadays, people pay more and more attention to the ecological environment, so it is necessary to strengthen hydrogeological survey. Hydrogeological surveys have relatively high technical and professional requirements for surveying work, and require hydrogeological surveying personnel to master professional surveying techniques and have a high comprehensive quality. In addition, relevant departments should also attach great importance to hydrogeological survey work, take effective management measures for water resources, try to avoid hydrogeological problems causing serious geological disasters, and give full play to the advantages of hydrogeological survey work.

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