

# Application of GIS technology in ecological environment pollution prevention and control

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**Abstract:** With the rapid development of China's economy and the increase in population, environmental problems are becoming more and more prominent. In order to solve this problem, the government has taken a series of measures to protect the environment, in which GIS technology, as an emerging technical means, has been widely used in the field of environmental protection. GIS technology can integrate data collection, spatial analysis and decision-making process into a common information flow, which has great potential to be applied to the ecological and environmental pollution prevention and control of a comprehensive and complex nature. This paper mainly discusses the application of GIS technology from six aspects: environmental monitoring, environmental evaluation and prediction, environmental impact assessment, environmental planning and environmental emergency forecasting.

**Keywords:** GIS; Ecological environment; Pollution prevention and control.

## 1. Introduction

With the rapid economic development and increasing population, environmental problems have become one of the important issues of global concern. Ecological environment pollution is one of the prominent problems, which has caused serious impacts on human health and social stability. In order to solve this problem, governments have taken a series of measures to protect the ecological environment, including the use of a variety of scientific and technological means for environmental protection. In recent years, geographic information technology (GIS), as an emerging technical means, has been widely used in ecological environment pollution prevention and control. By utilizing the advantages of GIS technology, rapid processing and analysis of ecological environment data can be realized, thus providing strong support for decision-making in environmental protection.

## 2. Overview of GIS Technology

### 2.1. The concept of GIS

Geographic Information System (GIS) is a discipline developed with the development of geographic science, computer technology, remote sensing technology and information science, and it is a system for effective management and processing of geographic information [1]. It can organically combine various information with spatial location, spatial distribution and spatial relationship through digitization [2], and provide useful information for earth science, environmental science, environmental governance and so on.

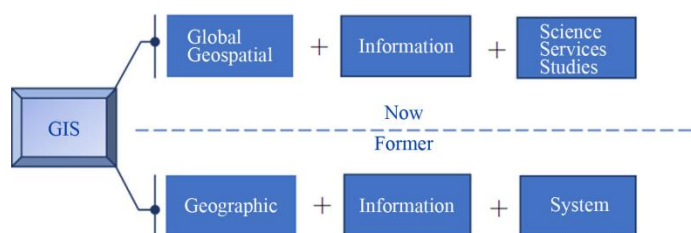


Figure 1. Concept of GIS

### 2.2. The emergence and development of GIS

The development of GIS began in the 1960s, when the National Aeronautics and Space Administration (NASA) developed the first map-based information retrieval system - MICS (MapInformation Retrieval and Analysis System). With the passage of time, GIS has gradually become an important information technology tool, and has been widely used in environmental monitoring, urban planning, resource exploration, disaster warning, etc. The development of GIS can be roughly divided into three phases: the first phase is the basic phase (1960-1975), during which the main research direction is the graphical image-based database; the second phase is the expansion phase (1986-2000), during which the existing database was mainly extended and some new functional modules were introduced; the third stage is the integration stage (2000 to present), during which the existing functional modules were mainly integrated and optimized, while some new functional modules were added. At present, GIS has become a mature and efficient application software platform.

### 2.3. The functions of GIS

The basic functions of GIS run through the whole process of data collection, analysis, decision-making and application [3], mainly including the following five aspects:

#### 2.3.1. Data collection and input

Data collection and input is an indispensable part of building a GIS. GIS data can come from a wide range of sources and be collected in a variety of ways, from traditional field measurements to modern technologies such as aerospace remote sensing, aerial surveys, and Global Positioning Satellite Systems (GPS) [4]. Data input is the process of entering the above collected data into the GIS and converting it into an internal format that is easy for the system to process [5].

#### 2.3.2. Data editing and processing

GIS not only has the editing and processing capabilities of traditional database systems, but also can edit and modify graphics, text data and attributes. At the same time, it has the ability to handle huge amount of spatial data, which enables

users to fully and effectively utilize the information sources.

#### **2.3.3. Data storage and management**

The core of GIS is geographic information database. Geographic information database can manage huge geographic graphics and text data, can be converted into other database management systems, and can read the data of other database management systems and then establish a new database. Geographic information database can not only realize the sharing of database resources, but it itself also provides a new data resource [6].

#### **2.3.4. Spatial query and analysis**

GIS, like other data processing systems, can retrieve and query geographic information. In addition, by using the spatial analysis function provided by GIS, information such as derived graphical data and attribute data can be obtained from the spatial relationship of graphical data and attribute data of physical objects according to the needs and purposes, which enables users to obtain important conclusions implicitly from them [6].

#### **2.3.5. Visualization expression and output**

GIS can not only output the full elements of the map, but also on-demand drawing and output of a variety of thematic maps, various types of statistical maps, etc. [7]. In addition, compared with the manual addition of other software, GIS can also customize the automatic mapping function, i.e., the spatial graphics containing attribute data will be displayed on the output map with automatic display attributes to ensure the consistency of the output map attributes with the attribute data and improve the accuracy rate.

### **2.4. The characteristics of GIS**

In the field of environmental pollution prevention and control, the introduction of GIS technology has brought great convenience and brand-new opportunities to the research and development of this complex interdisciplinary field, which is mainly reflected in the following three aspects:

#### **2.4.1. Shared data resources**

In the face of massive geographic information, GIS can break down barriers, so that data from different research fields and different geographical areas, such as planning and management information, natural resources, cadastral information, environmental protection information, etc., can be used to share information under consistent standards, which makes the universality of the data greatly improved, and facilitates interdisciplinary and inter-geographical research [8].

#### **2.4.2. Improve the quality of work**

GIS technology can summarize all the geographic elements according to a clear coordinate system, constitute a logical ordering in time and space, and analyze them accordingly, which can better demonstrate the relevant spatial issues. In addition, GIS technology in the application process embodies a variety of features such as large capacity, openness, intuition, convenience, dynamics, and other features, but also other conventional evaluation techniques can not reach the level [9], greatly improving the quality of work.

#### **2.4.3. Improve work efficiency**

The use of GIS can not only clearly obtain spatial information, but also more intuitively and graphically show the environmental quality and environmental conditions, its unique geospatial analysis and mixed data structure functions, whether in data statistics, image generation, topological superposition or in other types of analysis, it demonstrates

high efficiency and systematic application characteristics.

## **3. Application of GIS in ecological and environmental pollution management**

### **3.1. Application of GIS in environmental monitoring**

GIS technology can efficiently manage environmental monitoring information, and can be used to carry out monitoring point information query, monitoring point location analysis, monitoring point environmental quality trend analysis, etc., which can provide comprehensive reference data for monitors [10].

#### **3.1.1. Air environment quality monitoring**

Through GIS technology can be connected to various atmospheric monitoring points to share information data, realize the dynamic monitoring of atmospheric pollution, obtain the concentration distribution map of each pollutant, and understand the exceeding situation of each pollutant. Da Pengkui et al [11] used GIS technology to simulate the diffusion of air pollution, established a regional air pollution monitoring database, and confirmed that the method is more accurate than the traditional method. Xu Weijia et al [12] developed and applied a GIS-based air quality live release platform in the Pearl River Delta (PRD) region, which can real-time display the air quality situation and air quality spatial distribution characteristics of 62 monitoring locations in the PRD region, and realized the automation and networkization of the whole process from data collection, transmission, analysis, processing, and release. Wang Suzhen [13] and others used GIS technology to develop a real-time dynamic monitoring system for urban atmospheric environment, which can accurately locate the geographic distribution of pollution sources and realize the real-time dynamic collection and efficient transmission of atmospheric environment monitoring data.

#### **3.1.2. Water environment quality monitoring**

The use of GIS technology can manage and analyze the water environment monitoring data, determine the water environment pollution problems according to the changes in the water body, and take corresponding treatment and protection measures [14]. Zhu [15] based on the Jinji Lake basin of geospatial and water quality monitoring data and other information, the use of GIS developed the Jinji Lake water environment monitoring management information system, the Jinji Lake water quality pollutants to make a precise analysis of the watershed water quality improvement for the decision-making support services. Hu Chengang et al [16] integrated the water environment information of Dianchi basin, designed and developed a visualization platform, realized the management and maintenance of watershed information data, data search query and visual decision-making functions, and played an auxiliary decision-making role for the management of water environment in Dianchi basin.

#### **3.1.3. Ecological environment monitoring**

The application of GIS technology to ecological environment quality monitoring helps to understand the current situation and change trend of regional natural ecological environment, which is of practical significance for strengthening ecological environmental protection and ecological construction. Gao Yunteng et al [17]

simultaneously used GPS, remote sensing and GIS technology to dynamically monitor the land use changes in the Nansihu area of Shandong Province from 2000 to 2005, and assessed the status of the ecological environment, and found that there were ecological and environmental problems such as reduction of the wetland area, pollution of the water quality, and degradation of the ecological function, which provided a basis for decision-making on the development of the ecosystem in the future. Zhang Xian et al [18] took the main built-up area and surrounding areas of Yinchuan City as the research scope, constructed a remote sensing ecological index model, studied the ecological environment quality during the 15 years from 2002~2016 for dynamic monitoring and evaluation, analyzed the ecological environment changes in both time and space dimensions, and explored the driving factors of the changes.

### **3.2. Application of GIS technology in pollution control and ecological environment evaluation**

#### **3.2.1. Water pollution control**

The use of GIS technology for statistics and storage of water environment information can visualize the spatial distribution of environmental elements such as pollution sources, outfalls, monitoring cross sections, etc., and understand the spatial trend of water environment quality. GIS technology can also express various water environment information in various visual ways, and combine with the water quality model, evaluation model, etc., to provide an important basis for the scientific management of the water environment [19- 21]. Xia Bingxue [22] in the Three Gorges reservoir area according to the collection of hydrological and water quality information, based on GIS on the Three Gorges reservoir area water quality simulation and prediction study, the study shows that after the reservoir area of the overall quality of the reservoir area is better than before the reservoir, for the relevant departments to provide a strong technical support.

#### **3.2.2. Air Pollution Prevention and Control**

Through GIS to establish a reliable prediction model to determine the possible status of air pollutants, predict the direction of air pollutants in different time periods and distribution trends, so as to facilitate the proposal of scientific and effective air pollution control measures. Xu [23] used Web GIS to study the air pollution control model, predicted and analyzed the level of air pollution in Zhengzhou city, and gave targeted control recommendations. Wang Zhanyi [24] analyzed the type, quantity, concentration and spatial distribution of air pollution sources in Handan city based on GIS technology, predicted the pollution of the air environment in the place, and put forward the corresponding control methods for different spatial distribution of different pollution situations.

#### **3.2.3. Evaluation of ecological environment quality**

Using GIS technology to analyze the factors and spatial distribution of ecological environmental quality, to find out the environmental quality defects in the region, can put forward targeted management programs, and effectively promote the improvement of the ecological environment. Xu Pengwei et al. [25] took Hangzhou city as the research object, selected the natural environment, environmental quality, urbanization impact and other factors as evaluation indexes, built a spatial database using GIS, constructed a

comprehensive evaluation model, and evaluated the quality of Hangzhou's urban ecological environment. Guo Zecheng et al. [26] quantitatively analyzed the spatial distribution characteristics and influencing factors of ecological environment quality in Shiyang River Basin by constructing a comprehensive index system of ecological environment quality based on RS and GIS technology.

### **3.3. Application of GIS technology in environmental planning**

Environmental planning information involves basic geographic information, industrial layout, distribution of pollution sources, hydrological terrain and other aspects, covering environmental quality, ecology, pollution sources, ecological red line and other environmental elements or fields. The application of GIS in environmental planning can not only integrate and hierarchically manage all the elements of the above different fields, realize the query, analysis, output and other functions of environmental planning information, but also carry out a three-dimensional comparative analysis of the various elements of the environment, and formulate management plans for the situation of pollution to further enhance the relevance of environmental planning. For example, in the preparation of the environmental master plan, the use of GIS will be "three lines and a single" and "multi-planning" convergence and integration, to avoid spatial conflict problems.

## **4. Conclusion**

This study draws the following conclusions by exploring the application of GIS technology in ecological environment pollution prevention and control: first of all, GIS technology can provide environmental protection departments with rich data resources and analysis tools. By integrating various geographic information sources, such as remote sensing images, topographic and geomorphological maps, meteorological data, etc., a complete environmental database system is constructed; at the same time, by using a variety of statistical and visualization functions provided by GIS software, real-time monitoring and early warning of various types of pollutant discharges can be realized; secondly, GIS technology can also provide a decision support system for environmental protection policy makers. Through the establishment of ecological compensation mechanism, land use planning optimization model and other aspects of the application, to improve the management efficiency of government departments; Finally, GIS technology can also provide a convenient information service platform for the public. Through the construction of online map query system, community environmental health evaluation system and other public service websites, public participation and supervision can be enhanced.

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