

# The application of GIS in environmental sciences

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**Abstract:** Since the reform and opening-up, China has earned obvious economic progress. Particularly after entering the 21st century, with transformation in society every day, great changes have happened to people's living standards and lifestyles driven by economy, science and technology. However, a corn has two sides. The economic development depends on natural environment and at the same time may cause great damage to natural environment. Therefore, to maintain social stability and implement the important concept of sustainable development in China, China has attached great importance to environmental protection in the process of economic development, and improved the ecological environment by means of GIS technology to a large degree. Thus, it is very necessary to conduct in-depth research on this technology to strengthen China's achievements in environmental protection. This paper has firstly elaborated GIS technology and environmental science respectively, and then analyzed the application of the technology in environmental science in the hope of helping environmental improvement.

## 1. Introduction

GIS technology which can gather data collecting, storing, sorting, analyzing, managing, outputting, and other data application methods plays a very important role in processing various information in environmental science, and it facilitates researches on environmental science. GIS technology created under the background of continuous environmental deterioration is the outcome of people's expectations for environmental improving. The technology has indeed improved the environment after application in environmental science. This technology with very wide applications scope and very strong data processing ability has attracted worldwide attention since its appearance. Particularly, environmental scientists pay great attention to it. Detailed understanding of this technology is required for environmental science to be elaborated in this paper, which is the main purpose of this research.

## 2. Overview of GIS Technology and Environmental Science

### 2.1. Technological concept of GIS and its composition

#### 2.1.1. Technological concept of GIS and its development and application

GIS technology (Geographic Information System) is a technology for geographic information describing, sorting, analyzing and processing which can be realized based on computer technology by inputting and calculating geographic information related, establishing corresponding shape layers through data integration and analysis, and then establishing geographic information database through combination of shape layers and data, thus carrying out analysis of geographic information and establishing convenient geographic information system for subsequent analysis work<sup>[1]</sup>. By continuously applying GIS technology, GIS has gradually developed into an independent discipline after integrating multi-disciplinary and multiple data forms with extensive function coverage, which can be explained mainly from four aspects of function, toolbox, database and application. Function refers to the ability of GIS technology in data collection, storage, analysis, and processing. The toolbox refers to the tool set that realizes above functions and plays an important role for GIS functions. The database refers to a system established by integrating various data information in GIS

available for comprehensively inquiring a specific data. It usually refers to the application of the technology in land information processing, environment planning, and establishment of city information system. GSI technology originated in the 1960s has developed in different stages from the 1970s and 1980s until the 21st century, and gradually become matured. Particularly after entering the 21st century, the rapid growth of information technology has provided powerful guarantee for the development of GIS technology in the 21st century.

### **2.1.2. Establishment of GIS**

GIS layers cannot be established without calculation technology. Only after establishing the technology, it can be similar to layers creating CAD and Photoshop by adding multiple layers of transparent sheets in the drawing position of the software. The electronic map is set up by this means and the whole electronic region is a combination of numerous layers. The layers created by GIS technology will eventually form a complete spatial database. The electronic map is the manifestation after visualization processing of the spatial database. GIS layers can be categorized into two types, namely grid map layer and vector layer, which are different in stored data. And GIS layer can also be categorized from the perspectives of point, line, and surface mainly because GIS layers are different in geometric storage objects.

### **2.1.3. Establishment of GIS spatial database**

Establishing layers through GIS technology is for better processing geographic information which will become the spatial database of GIS after continuous integration. Apart from characteristics of general data selectivity, timeliness and reliability, spatial data have some unique features, specifically in five aspects. The first is spatiality, which is also the most symbolic feature of spatial databases for easily distinguishing ordinary data between GIS spatial data. as well as an important basis for describing various entities. The second is Abstractness. As spatial data embodies the display and the world, its Abstractness can be reflected in the real world full of changes . The third is its dynamic nature. We usually obtain different results when observing the same thing from different angles, which requires us to consider the change when embodying real things through spatial data. Thus, the dynamic change feature of spatial data can also be reflected. The fourth is multi-spatio-temporality. As data in different spaces at different times that are recorded inside spatial data, even the same thing will have different time and space changes in the spatial data, which manifests the time-space characteristic of data. The fifth is its massive nature. Massive data are gathered inside the space data which contains many elements such as topography and geomorphology. Therefore, its massive nature is very obvious.

## **2.2. Environmental science and its composition**

### **2.2.1. Definition of environmental science**

Environmental science as a discipline studying the environment covers knowledge in disciplines of physics, chemistry, and geography. It is available to conduct interdisciplinary and quantitative analysis of the environment and establish a complete environmental analysis system. Moreover, due to the direct relation between environment changes and human beings, contents of economics, law, and sociology disciplines are contained in environmental science. It can be known from the definition and analysis of environmental science that environment sustainability lies not only in analyzing the environment, but also in deciding mankind orientation in environmental change through environment analysis, thus finding out the way of joint development for mankind and the environment.

### **2.2.2. Connotation of environmental science**

It can be known from the definition of environmental science that environmental science with extremely remarkable interdisciplinary nature can embody physics, chemistry, geography, politics, law, and economy. Thus, environmental science can not only influence the environment, but also strongly affect human society. It can also be known through environmental science that human beings and the environment are mutually restrained. So, one changes will cause another to change.

With short period of development, environmental science became an independent discipline in the 1960s, which has been more than half a century. People started to value environment since 1962 when Rachael Carson published the book "Silent Spring", a historic work with historical significance on environmental science. Later, after the blowout accident occurred in California and fire in a river in Cuyahoga, Ohio in 1969, people paid greater attention to the environment, which also laid the foundation for China's environmental science to take into shape and gradually develop into a new discipline. Environmental science has not attracted enough attention until 1960s mainly because of lacking relevant laws in environmental science. Later, with the improvement of people's focus on the environment, people started to study the environment and initially established this discipline with the fusion of multidisciplinary knowledge and the establishment of relevant laws. Environmental science at first involved the analysis and study of environment. With its gradual development, the relationship between human beings and the environment and the impact of human behavior on the environment became the main research contents. Then, the distinction between macroscopic and microscopic aspects appeared in environmental science. Macroscopically, it refers to the mutual synergy and impact between mankind and the environment, namely, the specific relationship between economic development and environmental change. Microscopically, it studies the change and transformation of matters in the environment from a microcosmic perspective, thus finding out the specific laws of environmental changes. In particular, it is necessary to carry out researches on environment sustainability in a microscopic way, namely, to analyze the influence of various substances emitted by mankind on various life entities in the environment, thus solving these problems and realizing the harmony between mankind and the environment.

### **2.2.3. Overview of environmental science**

With environmental deterioration, people are more concerned about the environment. With the emerging of many new technologies, people's lifestyle has been changed and people are paying more attention to environment improvement. Environmental science has gained better developed in such an environment. It can be known from previous text that environmental science containing multi-discipline knowledge was treated as a discipline by people in recent decades despite of its development for more than fifty years. In recent years, a lot of energy in the natural environment have been consumed with continuous development of human society and plenty of harmful substances have been discharged into the natural environment, which resulted in energy depletion and ecological deterioration problems. With few and fewer parts without human participation in natural environment, human beings aware of the seriousness have gradually paid attention to environmental protection and then promoted the progress of environmental science.

## **3. Application of GIS technology in environmental science**

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

Environmental planning refers to the human behavior for harmonious development with their own activities by rational environmental arrangement. GIS technology as a very important role in environmental planning can be used to organize and analyze data in the environment. Then, the layers of environment can be established through data for calculation by layer superposition. In this way, the most reasonable way for environmental planning can be obtained. Moreover, GIS technology can be used for visualization of environmental planning so that people can directly know environmental planning and understand the function of environmental planning. In recent years, China has particularly stressed public participation while conducting environmental planning. Public participation can be intensified through the visualization of environmental planning by GIS technology, thus further improving its rationality.

### **3.2. Application of GIS technology in environmental impact assessment**

The environmental evaluation is mainly aimed at projects influencing the environment. Through the analysis of the project with GIS technology, it is available to judge the specific factors influencing

the environment, and at the same time distinguish the degree of environmental impact, thus avoiding the impact by reasonable methods. Previous researchers have summarized the centralized factors influencing the environment, including mineral projects, urban high-voltage power grid projects and urban transportation projects. Therefore, it is necessary to analyze the impact by using GIS technology during project planning period and take relevant measures to reduce the impact on the environment.

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

Environmental monitoring is also an important stage before environmental planning, mainly including atmospheric environment, water environment, and soil quality. First is the application of GIS technology in atmospheric environment monitoring. Due to great changes in atmospheric environment, the atmosphere will have more complex changes once polluted. So, effective atmosphere monitoring by using GIS technology can help people to adjust accordingly according to specific changes in the atmosphere. Main contents of atmosphere monitoring include SO<sub>2</sub>, TSP, NO<sub>2</sub>, O<sub>3</sub> and other substances. After clarifying the distribution and content of these substances in the atmosphere, we can take corresponding improvement measures. Second is the application of GIS technology in water environment monitoring. Water environment is similar to the atmospheric environment to a certain degree with obvious changes. Water environment monitoring is mainly targeted at substances or microorganisms harmful to the human body. And it is necessary to prevent the discharge of domestic wastewater, industrial and agricultural water, which can be realized by analyzing some of the super-standard substances in water with GIS technology. The last is soil quality monitoring. As soil quality is closely related to the agricultural cultivation in China, GIS technology can be used to analyze the specific reasons for changes in soil quality. Salinization and acidification are main changes which are usually caused by excessive utilization of chemical fertilizers, excessively fast water loss and acid rain. After analyzing and determining specific reasons, we can take corresponding improvement measures.

## **4. Summary**

To sum up, economic development has caused serious damage to the environment, which urgently requires for improving the gradually deteriorating environment by effective means. The application of GIS technology in environmental science has not only promoted the development of this discipline, but also greatly improved the efficiency and rationality of environmental protection work. This is of great significance for the application of environmental science in the future society and the improvement of human living environment.

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