

# An overview of ecological monitoring based on geographic information system (GIS) and remote sensing (RS) technology in China

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**Abstract.** Due to the rapid development of human economy and society, the resulting ecological problems are becoming more and more prominent, and the dynamic monitoring of the various elements in the ecosystem has become the focus of the current research. For the complex structure and function of the ecological environment monitoring, advanced technical means should be adopted. With the development of spatial information technology, the ecological monitoring technology based on GIS and RS is becoming more and more perfect, and spatial analysis will play an important role in the field of environmental protection. Based on the GIS and RS technology, this paper analyzes the general centralized ecological monitoring model, and makes an objective analysis of the current ecological monitoring trend of China. These are important for the protection and management of ecological environment in China.

## 1. Introduction

Ecological monitoring is aimed to observe the ecological system of specific region in time and space, monitor the ecological environment quality of the change of parameters of the main, evaluate and predict the impact of human activities on the ecological system. It can provide decision-making service for the rational use of resources and the improvement of ecological environment and natural protection. Raffaelli and Mason proposed the first use of a bio-indicator for monitoring and evaluation of the environmental situation in biological wastewater system [1,2]. With deepening awareness of the environmental protection, more attention should be paid to the ecological balance and sustainable development of resources [3-5]. The environmental protection nowadays mainly focused on solving the problem of environmental pollution [6,7], which is much complexity than ever before. Therefore, there is an urgent need to establish an effective dynamic monitoring and control system to monitor ecological environment environmental and ecological evolution of trends and characteristics, namely ecological environment monitoring [8,9]. China has paid more and more attention to ecological environment monitoring, but monitoring coverage is small, and many modern technologies do not play a role in ecological monitoring [10-12].

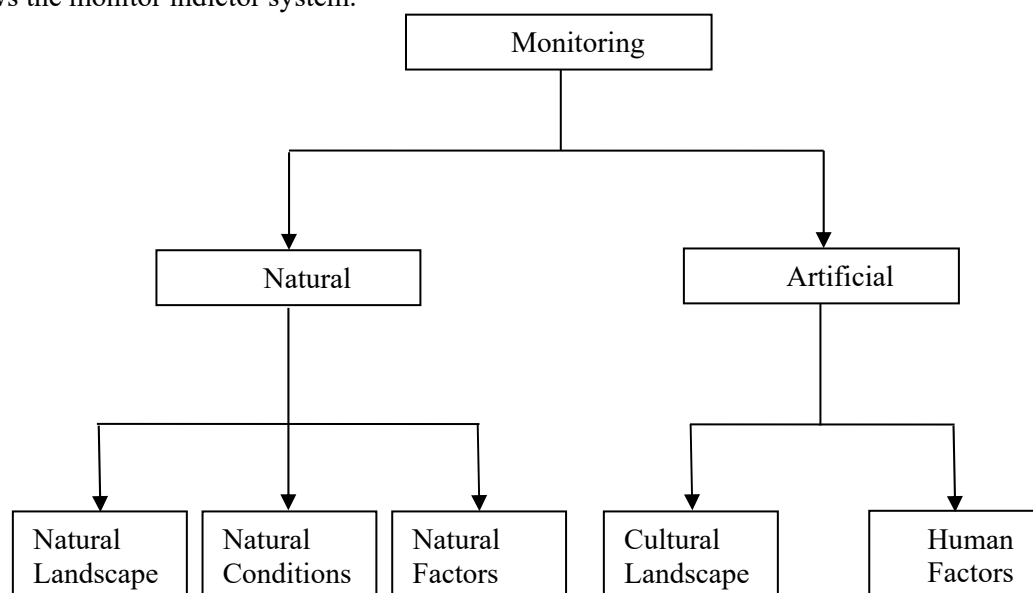
Recently, geographic information systems (GIS) and remote sensing (RS) have emerged as powerful tools to support ecological monitoring assessments [13-16]. Satellite images are especially valuable because they provide frequently updated maps of inaccessible areas or areas with rapidly



changing landforms [17,18]. The integration of RS with GIS provides an excellent framework for data capture, storage, synthesis, measurement, and analysis, all of which are essential to eco-environmental analysis [19-21]. An ecological monitoring system includes natural environmental factors, social factors and human factors. Application of GIS system and RS monitor in ecological environment monitoring provides an effective platform in modern environmental protection [22-24].

## 2. Monitoring indicators

The selection of monitoring indicators is very important in a regional ecological monitoring, and it should have a certain representation and operability. But it should be noted that this selection of factors is not exhaustive, and only those salient factors that have great significance were selected. In the identified ecosystem, the use of a series of project indicators to reflect the basic characteristics of the ecosystem and the main ecological problems is the main content of ecological monitoring and basic work. According to the monitoring object, all of these can be divided into two categories: natural indicators, including natural landscape, natural conditions, natural factors and other natural indicators; artificial indicators, including cultural landscape, human factors and other artificial indicators. Figure 1 shows the monitor indicator system.



**Figure 1.** Monitor indicators system

## 3. Methods

Ecological monitoring focuses on the macro characteristics, which is a combination of macro and micro-monitoring work. To monitor the complex macro-ecological environment, we must adopt advanced technical means. Ecological monitoring platform is the basis of macro-monitoring, which should be supported by GIS and RS technology and have enough capacity of computer and aerospace information processing device.

Geographic information system (GIS) and remote sensing (RS) technology form a complete technical system for spatial observation, spatial positioning and spatial analysis of the Earth. It reflects the interrelationships and patterns of ecosystem elements at the global scale, provides macroeconomic and environmental images of precise positioning in large areas around the world, and reveals the interactions and relationships of lithosphere, hydrosphere, gas circle and biosphere. The mathematical model established on the basis of GIS and RS can promote the transition from qualitative description to quantitative analysis, so that the monitoring precision and scope can be extended to the maximum extent. GIS and RS technologies are the development direction of macro ecological environment monitoring, which is the main technical foundation of its development. And in the long period of time,

remote sensing and geographic information system means will be more widely used in ecological environment monitoring and play a greater role.

Traditional monitoring methods can solve local monitoring problems, however, integrated overall and accurate monitoring results must rely on GIS and RS technology. In the current and future, the ecological monitoring should long-term focus on the realization of ecological monitoring network in ecological data analysis. Make full use of computer technology to ecological data, including remote sensing, aerial photography, and ground fixed-point monitoring of organic combination, relies on specialized hardware and software to intelligent monitoring the ecological system. This can also greatly improve the data accuracy, while save the manpower cost.

#### 4. Trends in ecological monitoring research

As an important part of environmental monitoring, ecological monitoring is the foundation of the ecological environment management and scientific research. Ecological monitoring should combine GIS and RS technology and mathematical statistical analysis of spatial data with geographical attributes for production and reproduction.

The indicators for ecological monitoring will be more comprehensive and detailed. Currently, the selection of indicators is given priority to natural geographical conditions and biological factors. It should be more appropriate to consider impact on the natural ecological system of humanities and social factors closely. Evaluation of ecological monitoring should employ a number of new ideas, techniques and methods. Nowadays, the domestic ecological monitoring gradually changes from static to the dynamic. Some scholars introduce landscape ecology, spatial heterogeneity theory and the spatial scales theory into ecological monitoring and evaluation, which will establish a more comprehensive and objective monitoring index system based on ecological stability and ecological security pattern from different scales.

The overall trend of ecological environmental monitoring is the combination of GIS and RS technology with ground monitoring, from a macro and micro perspective to a comprehensive review of ecological quality in China. Considering the global ecological quality changes, Network design also tends to be integrated, and result in gradually evaluation from the ecological quality evaluation to ecological risk assessment to provide early warning. In information management, ecological monitoring should emphasize the standardization of operation process, and widely use GIS and RS to strengthen cooperation between countries.

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