

Application Research of Geographic Information Systems in Forest Resource Survey and Planning

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Abstract: With technological advancement, Geographic Information Systems (GIS) have become a core tool in forest resource management. GIS integrates computer science, geography, and remote sensing technologies, enabling comprehensive exploration, precise management, and scientific planning of forest resources. This paper delves into the diverse applications of GIS in forest resource survey and planning, demonstrating its crucial role in enhancing management efficiency and promoting sustainable development. Through GIS, we gain deeper insights into, protect, and manage forest resources more effectively, thereby making positive contributions to the ecological balance of the Earth and long-term human well-being.

Keywords: Geographic Information Systems; forest resource survey; planning applications

Introduction

The rational utilization of forest resources can not only improve the living standards of residents but also facilitate the smooth implementation of ecological and environmental protection efforts. This paper provides an overview of the various applications of Geographic Information Systems (GIS) in forest resource survey and planning. It begins with a brief introduction to the basic concepts of GIS and its significance in fields such as geography and spatial sciences. The focus then shifts to a detailed discussion of GIS applications in forest resource inventory and mapping, basic information management, forest structure adjustment and optimization, natural forest protection and monitoring, and dynamic monitoring of forest resources. Through GIS technology, we can more effectively protect, manage, and plan forest resources,

achieving sustainable development in ecological, economic, and social aspects.

1. Overview of Geographic Information Systems

Geographic Information Systems (GIS) are powerful integrated systems specifically designed for handling geospatial information. These systems utilize both computer hardware and software to comprehensively collect, accurately store, scientifically compute, and intuitively display geographic information about the Earth's surface. From an application perspective, GIS is a crucial tool in geography and spatial sciences, aiding in better understanding and analysis of geographical phenomena. It provides robust support for various fields, including geographical research, urban planning, and environmental monitoring.



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Whether studying topography, climate change, resource surveys, or disaster warning, GIS demonstrates unique advantages. Technically, GIS integrates multiple advanced technologies. The application of computer technology allows for the efficient processing of vast amounts of geographic information. Digital technology facilitates the convenient acquisition, transmission, and application of this information. Spatial technology and satellite positioning significantly enhance the precision and real-time capabilities of geographic data. Additionally, the incorporation of network technology enables the sharing and collaborative use of geographic information.

2. Investigation of Forest Resources Using Geographic Information Systems

2.1 Forest Land Resource Survey

The forest land resource survey is a crucial component of forest resource investigations, aiming to clarify the area, geographical distribution, ownership, and utilization of forest lands. Through this survey, we can comprehensively understand the overall status of forest lands, providing detailed foundational data for subsequent forest resource management, protection, and planning. (1). Area Survey: Initial area estimates are conducted using remote sensing imagery, complemented by ground-based field measurements to ensure data accuracy. Geographic Information System (GIS) technology plays a key role in this process, aiding in the precise delineation of forest land boundaries, thereby yielding accurate area data. (2). Distribution Survey: This aspect focuses on understanding the specific geographical location of forest lands. Utilizing remote sensing imagery and GIS technology, detailed maps of forest land distribution can be created, visually presenting the spatial layout of these lands. (3). Ownership Survey: This involves verifying and recording the ownership information for each parcel of forest land. Clarifying property rights is essential for preventing illegal encroachments and facilitating rational planning of forest land use.

2.2 Forest Tree Resource Survey

The forest tree resource survey is an important step in exploring the internal characteristics of forests in detail. In this process, we thoroughly investigate key data such as species composition, age structure, stand density, and timber volume to reveal the full picture of

forest tree resources. Regarding species composition, we meticulously document and analyze the distribution and proportion of each tree species within the forest. This not only helps us understand the biodiversity of the forest but also reveals its ecological balance, providing strong support for ecological protection efforts. The investigation of age structure focuses on the age distribution of the trees. Through this data, we can understand the growth stages and regenerative capacity of the forest, which are crucial for assessing whether the forest is mature and capable of sustainable development. This information is vital for long-term timber supply and forest health management. Stand density, or the spatial arrangement of trees, is also a key focus. Through sampling or comprehensive surveys, we can determine this critical indicator. An optimal stand density ensures the healthy growth of trees and contributes to the maximization of timber yield.

2.3 Forest Ecological Environment Survey

The forest ecological environment survey is an indispensable part of forest resource investigations. It involves an in-depth exploration of key environmental factors such as soil, hydrology, and climate within the forest. These surveys not only reveal the health status of forest ecosystems but also provide scientific basis for forest protection and ecological restoration strategies. In soil surveys, the focus is on analyzing soil composition, structure, and fertility to assess their impact on tree growth. Understanding the physical and chemical properties of the soil, as well as its microbial communities, helps us select suitable tree species and formulate scientific soil management measures. Hydrological surveys examine the role of forests in water conservation and water quality protection. We monitor the flow paths, water quality conditions, and dynamic changes in groundwater levels within the forest to evaluate the importance of forests in water resource management. These data are crucial for maintaining the hydrological balance of forest ecosystems. Climate surveys focus on the microclimate characteristics within forests, including temperature, humidity, wind speed, and light. By analyzing these factors, we can understand the regulatory role of forests on climate and the potential impacts of climate change on forest ecosystems. This is significant for predicting and responding to forest dynamics in the context of global climate change.

3. Application of Geographic Information Systems in Forest Resource Survey and Planning

3.1 Forest Resource Inventory and Mapping

Forest resource inventory and mapping are critical components of forestry management. The aim of this process is to comprehensively understand and assess the quantity, quality, and distribution of forest resources, thereby providing strong support for the sustainable use and scientific planning of these resources.(1). Inventory Work:This typically involves the collection of detailed data on tree species, quantity, age, and growth conditions.These data reflect the current state of the forest and form the basis for predicting future forest development trends.Regular inventories allow for the timely detection of dynamic changes in forest resources, including tree growth, pest outbreaks, and the impact of human activities on the forest.(2). Mapping:Mapping involves visualizing these inventory data, presenting the distribution and characteristics of forest resources in the form of maps.This visualization helps forestry managers better understand the status of forest resources and provides a clear basis for scientific planning.For example, maps can clearly show where different tree species are distributed, which areas have trees in good growth condition, and which areas may have issues.(3).Importance of Inventory and Mapping:Forest resource inventory and mapping are crucial for providing scientific evidence for forestry management.They lay a solid foundation for ecological protection and biodiversity maintenance. Through these efforts, we can better understand forests, plan, and manage them more scientifically, achieving the sustainable use of forest resources and protecting our green home.

3.2 Forest Resource Basic Information Management

Forest resource basic information management is a crucial part of forestry work and plays a significant role in ensuring the sustainable development of forestry. In the past, limited by technology, the collection and organization of forest resources were time-consuming and inefficient, and the accuracy and timeliness of data were often difficult to guarantee. However, the advent and application of GIS technology have brought revolutionary changes to this field.GIS technology has built a comprehensive

and precise forest resource information platform for forestry managers. Through this platform, managers can quickly obtain core information about forest distribution, tree types, and forest area. This information is valuable for decision-making, as it helps managers fully understand the current overall status of forest resources and provides a solid data foundation for future forest resource planning. More importantly, GIS technology demonstrates its powerful information integration capabilities. It can effectively integrate and analyze data from various sources, such as meteorological data and land use data. This cross-disciplinary data integration provides more comprehensive scientific support for forest resource management decisions. For example, by combining meteorological data, forestry managers can more accurately predict the potential impact of extreme weather on forest resources and develop contingency plans in advance. Analyzing land use data in depth allows for more scientific planning of forest land use and development, achieving multiple benefits in ecological, economic, and social aspects.

3.3 Forest Structure Adjustment and Optimization

Forest structure adjustment and optimization are important measures for improving forest quality and efficiency:(1).Species Adjustment:In terms of species adjustment, GIS's buffer analysis function provides great convenience in determining the proportion and distribution of different blocks. By setting specific buffer zone ranges, managers can clearly see the characteristics and needs of each block. This allows for targeted adjustments to the forest structure based on actual conditions. Such targeted adjustments not only enhance the ecological benefits of the forest but also maximize economic benefits. (2).Tree Species Adjustment on Forest Land:GIS technology performs exceptionally well in adjusting tree species on forest land. By importing information from field surveys of various plots and utilizing its powerful 3D spatial analysis capabilities, GIS can visually and comprehensibly display this data. This enables managers to conduct in-depth analysis and evaluation of forest land, thereby formulating more rational plans for adjusting tree species structures. (3). Age Structure Adjustment of Trees:GIS technology also plays a crucial role in adjusting the age structure

of trees. Through in-depth analysis of existing tree data, including age and growth conditions, GIS helps managers accurately grasp the current age structure of forest land. Based on this data, GIS can provide optimal adjustment plans to ensure the sustainable development of the forest and enhance its overall quality and efficiency.

3.4 Conservation and Monitoring of Natural Forests

Natural forests, as a precious heritage bestowed by nature, bear the crucial mission of maintaining ecological balance and safeguarding biodiversity. However, in today's rapidly advancing human civilization, natural forests face unprecedented challenges. The progress of urban industrialization has led to increasingly deteriorating living conditions for natural forests, and their living space continues to shrink. To protect these valuable ecological resources, effective measures must be taken. The combination of GIS and remote sensing technology provides us with a new solution. Leveraging remote sensing technology, we can obtain extensive and high-precision surface information, including forest density, vegetation types, and forest age structure, all of which can be observed comprehensively. GIS technology, on the other hand, enables efficient management and analysis of this vast amount of geographic information, helping us gain deeper insights into the ecological conditions of natural forests. The integration of these two technologies not only provides us with a more comprehensive and accurate understanding of natural forests but also serves as a scientific basis for formulating protection strategies. Using GIS's spatial analysis capabilities, we can delineate different management zones for natural forests based on their ecological characteristics and conservation needs, such as logging prohibition zones, protected areas, and commercial forest areas.

3.5 Dynamic Monitoring of Forest Resources

Forest resources are integral components of the Earth's ecosystem, playing a crucial role in maintaining global ecological balance and human well-being. However, due to natural and anthropogenic factors, forest resources are constantly undergoing dynamic changes. To promptly grasp these changes and implement appropriate management measures,

dynamic monitoring of forest resources is essential, and GIS technology plays a key role in this aspect. Through the combined use of regular remote sensing data and GIS analysis, we can achieve long-term and continuous monitoring of forest resources. Specifically, remote sensing technology provides periodic and wide-ranging information on land surface cover, including key parameters such as forest types and area. GIS technology, in turn, efficiently processes and analyzes these data, generating intuitive and understandable monitoring results. The advantage of using GIS for dynamic monitoring of forest resources lies in its ability to provide real-time data support. Whenever remote sensing data is updated, GIS technology allows for rapid processing and analysis, enabling timely detection and response to changes in forest resources. For instance, when unauthorized logging or natural disasters are detected in a certain area of forest land, interventions and protective measures can be promptly implemented. In summary, GIS-enabled dynamic monitoring ensures that forest resources can be effectively managed and protected in response to ongoing changes, thereby contributing to sustainable forest management and biodiversity conservation efforts.

Conclusion

In summary, Geographic Information Systems (GIS) play a pivotal role in the planning and management of forest resources. Through GIS technology, we can comprehensively and accurately understand the current status of forest resources, providing a solid data foundation for scientific management and planning. Moreover, GIS helps us monitor dynamic changes in forest resources in a timely manner, effectively addressing challenges posed by various natural and human factors. Looking ahead, with continuous advancements and improvements in GIS technology, we believe it will play an increasingly crucial role in the management and conservation of forest resources, contributing to the sustainable development of ecological civilization.

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