

Thinking on the application of "smart forestry" in forest resource control

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Abstract: With the high development of intelligent technology, intelligent forestry has emerged at the historic moment, injecting new vitality into forest resource management and control. Smart forestry refers to the use of emerging technologies such as the Internet of Things, big data and artificial intelligence to achieve accurate and intelligent management and control of forestry production and operation activities. This paper analyzes the application value, current situation and existing problems of smart forestry in forest resource management and control, and puts forward some strategic suggestions to strengthen the application of smart forestry in forest resource management and control. Smart forestry can improve resource utilization efficiency, optimize decision-making, reduce management costs, and promote sustainable development. However, due to factors such as lagging infrastructure, poor data quality and shortage of talents, its application in forest resource management and control still faces many challenges. In the future, it is necessary to increase investment in infrastructure, integrate multi-source data, cultivate compound talents, strengthen departmental collaboration, and improve laws and regulations in order to give full play to the important role of smart forestry in forest resource management and control.

1. Introduction

Forest is an important natural resource for human beings, which plays an irreplaceable role in maintaining ecological balance and coping with climate change. With the development of society and the growth of population, forest resources are increasingly showing their valuable and non-renewable. To strengthen the rational utilization and sustainable management of forest resources is a major issue that governments and the whole world pay attention to. China has vast territory and rich forest resources, but the control of forest resources needs to be strengthened. Scientific and reasonable management and control of forest resources is crucial to promoting the construction of national ecological civilization and promoting green development. In recent years, emerging technologies such as the Internet of Things, big data, and artificial intelligence have continued to break through and innovate, and smart forestry has emerged at the historic moment and gradually shown broad application prospects. Smart forestry organically integrates modern information technology with forestry, and provides strong support for accurate and efficient management of forest resources through remote real-time monitoring, big data analysis and intelligent decision-making. China has defined the guiding ideology and overall goal of implementing the development strategy of smart forestry, and smart forestry is playing an increasingly important role in forest resource management and control.

2. Application value of intelligent forestry in forest resource management

2.1 Improving the efficiency of resource utilization

The traditional forestry resource management mode has some problems such as information lag and lack of precision, so it is difficult to realize real-time and accurate control of resources. By constructing a full-coverage forest growth environment detection system, collecting forest

environment big data, and combining artificial intelligence algorithms, smart forestry can dynamically monitor forest growth status in real time and predict potential threats, so as to formulate scientific care strategies and cutting plans, and maximize the utilization efficiency of forestry resources.

2.2 Improving decision-making

Smart forestry can collect all kinds of data such as weather, soil, pests and diseases, and provide decision support for forestry management through big data analysis and intelligent modeling. Compared with the traditional mode of relying on experience judgment, intelligent analysis is more objective and efficient, which is helpful to make scientific and reasonable management decision plan, and realize the optimal allocation and high-quality development of forestry resources.

2.3 Reduce management costs

Smart forestry uses a large number of automated monitoring and intelligent management means, reducing human input, reducing the cost of daily patrol, investigation and other management links. At the same time, relying on the decision support of big data helps to avoid the waste of resources caused by blind decision-making, so as to improve management efficiency and reduce the overall operating cost.

2.4 Promoting green and sustainable development

Through accurate monitoring and analysis of the forest ecosystem, smart forestry can better grasp the dynamic changes of the forest land, timely detect ecological anomalies, and take targeted restoration measures, thus contributing to the continuous improvement of the ecological environment and the realization of carbon neutrality goals. At the same time, intelligent management is conducive to controlling the use of pollutants such as fertilizers and pesticides, and promoting the transformation of forestry production to the direction of green environmental protection.

3. Application status of intelligent forestry in forest resource management in China

3.1 Increased support from policies and regulations

In recent years, China has introduced a series of policies and measures to support the development of smart forestry. Policy documents such as the "National Forestry Ecological Big Data Guidance" and the "13th Five-Year Development Plan for Internet + Smart Forestry" have pointed out the direction for the development of smart forestry. In 2022, the National Forestry and Grassland Administration issued the Opinions on Accelerating the Modernization of Forestry Construction, proposing to initially build a smart forestry monitoring and early warning system by 2025..

3.2 Infrastructure development was gradually strengthened

In recent years, China has vigorously promoted the application of a new generation of information technology in the field of forestry, and the construction of infrastructure such as the Internet of Things and Beidou navigation has made great progress. By the end of 2022, 33,000 national ecological and environmental monitoring points had been built across the country, which enabled real-time monitoring of important ecosystems. At the same time, more than 60,000 iot monitoring devices have been deployed in the national nature reserve, which can dynamically monitor forest resources and wildlife in the reserve, timely detect abnormal situations and trigger early warnings. In addition, the Beidou navigation system has also been widely used in forestry investigation, wood transportation, fire control and other aspects, improving the precision level of forestry production and laying a solid foundation for the intelligent management of forest resources.

3.3 The application of big data has achieved initial results

With the development of Internet of Things, remote sensing and other technologies, how to

efficiently integrate and utilize massive forestry data has become a key issue. Various localities have taken action to explore the application practice of big data in the field of forestry. Taking Yunnan Province as an example, the provincial Forestry Bureau has built a comprehensive forestry big data service platform by integrating remote sensing images, geographic data, and Internet of Things monitoring data of the province. The platform can automatically generate various thematic data products, provide value-added services such as spatial analysis and decision analysis, provide accurate decision support for forestry planning, afforestation, forest fire prevention, disease and pest control, etc., and promote the development of forestry resource data in the direction of precision, standardization and intelligence.

3.4 Accelerating the empowerment of emerging technologies

Emerging technologies such as artificial intelligence and 5G communication are accelerating their application in the forestry field, injecting new momentum into smart forestry. Beijing Forestry University has jointly developed a set of intelligent 3D reconstruction and forest information extraction algorithm system based on artificial intelligence technology. Using the point cloud data obtained by low-altitude aerial survey of unmanned aerial vehicles, it can conduct high-precision 3D modeling of forest trees, automatically identify tree species, measure tree height and canopy parameters, etc., which significantly improves the efficiency and accuracy of traditional forestry investigation. Guangxi introduced 5G communication technology to achieve remote real-time transmission of remote sensing monitoring data of drones, operators can view monitoring images in real time thousands of miles away, and immediately command nearby personnel to fight and rescue forest fires once they are found, greatly improving the timeliness and success rate of forest fire prevention.

4. The main problems of intelligent forestry in forest resource management in China

4.1 Infrastructure development is still lagging behind

China's land area is vast, forest ecosystem variety, regional differences are significant. The existing infrastructure such as Internet of Things sensors and satellite remote sensing monitoring is still difficult to fully meet the needs of comprehensive and refined management and control of forest resources in terms of coverage and monitoring means. Some underdeveloped areas and remote areas have relatively backward infrastructure construction and insufficient monitoring equipment, which leads to obvious difficulties in forest resource data collection in these areas. The number of forestry iot sensors is insufficient, the layout is uneven, and satellite remote sensing is limited by weather and time, which restricts the dynamic real-time monitoring of forest resources.

4.2 Data quality needs to be improved

At present, forestry big data mainly comes from artificial survey statistics and satellite remote sensing images, and the data source is relatively single. Data from different sources differ greatly in spatial and temporal resolution, update frequency, accuracy and other aspects, which is difficult to efficiently support intelligent analysis and decision-making requirements. The lack of unified data standards makes it difficult to integrate multi-source heterogeneous data with high quality, and data quality and availability need to be further improved. The historical potential deviation of forestry survey data is large, satellite remote sensing is affected by weather, the timeliness and continuity are insufficient, and the Internet of Things ground observation data lacks comprehensive analysis and application, which seriously restricts the depth of data enabling.

4.3 The construction of talent team lags behind

Intelligent forestry is a new field of cross integration, and the demand for compound talents is particularly urgent. At present, there is a serious shortage of forestry data science talents in China, and there is a shortage of innovative talents who master forestry professional knowledge and are proficient in big data analysis, artificial intelligence algorithm and other technologies. The lack of compound talents who understand the reality of forestry and can use intelligent technology to

analyze and make decisions restricts the in-depth application and efficient promotion of intelligent forestry technology in the forestry field. Talent bottleneck has become an important factor restricting the development of smart forestry, how to train and introduce excellent compound talents is an urgent matter to be solved.

4.4 The policy system needs to be improved

Smart forestry is an emerging cross-cutting field. At present, in terms of data standardization, information security, privacy protection, etc., there is a lack of clear laws and regulations and long-term management mechanisms as guidance and constraints. The relevant standard system is not perfect enough, which brings many obstacles to data collection, transmission, storage and application. The organic connection between intelligent forestry and traditional forestry also needs to be solved. In addition, the commercial operation model and policy incentive and constraint mechanism of smart forestry are not perfect, which is not conducive to the high-quality sustainable development of smart forestry, and the lagging construction of the policy system has hindered the innovative practice of smart forestry to a certain extent.

5. Countermeasures and suggestions to strengthen the application of smart forestry in forest resource management and control

5.1 Continue to increase investment in infrastructure

Continued investment in infrastructure is a top priority in promoting smart forestry to play a greater role in forest resource management. First of all, it is necessary to further expand the coverage of the Internet of Things sensor in the forest land, improve the density and distribution of the sensor balance, so that it can achieve panoramic monitoring of forest resources. At the same time, the application of satellite remote sensing and other space remote sensing means should be strengthened to improve image resolution and space-time continuity, and comprehensive data collection should be combined with UAV aerial survey and other ways to ensure timely acquisition of forest dynamic change information. According to the research of Yang Zhongqin (2022), the update and upgrading of the new generation of information technology in the forestry field should be promoted in a timely manner, and cutting-edge technologies such as 5G and artificial intelligence should be introduced to improve the monitoring and analysis capabilities of smart forestry [1]. In addition, forestry management departments should coordinate all kinds of monitoring facilities, establish an integrated monitoring system, avoid repeated construction of resources waste, improve the efficiency of facilities. In addition, we should pay attention to the introduction of social capital, encourage powerful enterprises and institutions to participate in infrastructure construction and operation, and attract more social forces to join the development of smart forestry. The government can promote the diversified development of infrastructure construction through various ways such as purchasing services and franchising. Sun Jingyao and Chen Tao (2022) proposed that the investment and financing mechanism should also be improved to provide sustained and stable financial support for the construction of smart forestry infrastructure to ensure the continuous and in-depth progress of the construction [2]. Only by increasing human and material resources investment, building a smart forestry infrastructure with wide coverage, dense network and high intelligence can we truly realize the accurate management and control of forest resources in the whole process and fully release the application potential of smart forestry.

5.2 Integration and aggregation of heterogeneous data from multiple sources

The integration and aggregation of multi-source heterogeneous data is an important basis for smart forestry to play a role, which needs to be based on actual needs, clear monitoring objectives and key indicators, and adopt a variety of channels and means to collect data. On the one hand, it is necessary to make full use of aerospace remote sensing means to obtain high-resolution and multi-band forest satellite images and grasp the distribution and change of forest resources at the macro scale. On the other hand, we should promote the application of UAV low altitude detection

technology, collect high-precision three-dimensional point cloud data, and monitor the forest structure details of individual trees and forest window levels. At the same time, it is necessary to increase the investment of ground observation equipment of the Internet of Things to perceive the dynamics of the microscopic environment of forest land in real time, such as temperature and humidity, atmospheric components, and physical and chemical properties of soil. In view of the heterogeneity of multi-source data in terms of format, coding and standards, Li Helong (2022) pointed out that unified forestry data standards should be formulated to clarify standards such as metadata definition, transmission format and quality control indicators [3]. On this basis, a unified data exchange platform is constructed to realize the efficient integration and sharing of heterogeneous data. By means of big data storage, processing and analysis, forestry management departments can really break through the data barriers, mining the relationship between different data sources, and maximize the value of data. At the same time, it is also necessary to strengthen the application of artificial intelligence technology, intelligent annotation and denoising of multi-source data, and comprehensively improve the quality and availability of data. Only the integration of various forms and types of monitoring data can provide comprehensive and reliable support for data-driven smart forestry management decisions.

5.3 Strengthening the training of versatile talents

Strengthening the cultivation of compound talents is the key link to promote the development of smart forestry. It is necessary to base on the actual needs of forestry, innovate the personnel training model, optimize the knowledge structure, increase the penetration proportion of emerging technologies such as data science and artificial intelligence in forestry professional courses, so that students can master cutting-edge theoretical knowledge and have cross-border composite application ability. In the teaching process, we should strengthen the case teaching, project training and other practical links, and strive to cultivate students' innovative thinking and comprehensive ability to solve complex problems. At the same time, colleges and universities should strengthen the cooperation with forestry authorities and scientific research institutions, encourage teachers to practice in the front line, invite industry experts to set up special lectures, promote the deep integration of industry, university and research, and improve the quality of composite talent training. Song Guang (2022) pointed out that it is necessary to establish a talent training base for forestry data science at the national level and focus on building a high-level compound talent training highland. Pilot exploration will be carried out in the base to establish an innovative training model of interdisciplinary, industry-education integration, and explore a new path for career development [4]. Relevant departments should improve the policy system of talent introduction, training and incentive, and smooth the channels for talent growth. This requires the forestry administration to be able to introduce talent to give green channels, provide good remuneration and career development space; provide regular training opportunities for on-the-job talent, and establish effective incentive mechanisms, fully mobilize the enthusiasm of talent. At the same time, we should also pay attention to training complex managers and decision makers, so that they can accurately grasp the law of forestry development and data analysis technology, and promote the deep integration of smart forestry and forestry management practices. Only by fundamentally solving the problem of talent constraints can we inject a steady stream of power into the sustainable development of smart forestry.

5.4 Strengthening inter-departmental coordination

Smart forestry is an emerging field of cross-integration, which requires close cooperation across departments and fields. First of all, the forestry authorities should strengthen the docking with industry and information technology, science and technology and other departments, and reach coordination and agreement on the construction of smart forestry infrastructure and data resource sharing. Industry and information technology departments can provide technical guidance and standard support for the construction of forestry Internet of things; Science and technology departments can guide relevant scientific research forces to carry out key technology research in smart forestry. All departments should establish an effective information sharing and work docking

mechanism to achieve complementary advantages and coordinated promotion. Secondly, Wang Jianwu (2018) pointed out the need for overall coordination and up-down linkage at the national level. The state should formulate the top-level design and roadmap for the development of smart forestry, clarify the goals, tasks and key projects, and systematically deploy funds, talents, policies, etc. [5]. Local governments at all levels should, in light of local realities, refine and decompose work tasks, formulate specific implementation plans, and do a good job of seamless connection between top-level design and grassroots practice. In addition, it is necessary to give full play to the overall coordination role of the government in promoting smart forestry. Governments at all levels should strengthen coordination, fully mobilize resources from all aspects, form a work pattern of departmental coordination and connectivity, and avoid the problems of rigid limbs and poor connection in the construction of smart forestry. At the same time, we should also pay attention to the linkage between government and enterprises, encourage enterprises to explore and innovate in the field of smart forestry, and inject vitality into the development of smart forestry industrialization.

5.5 Improving policies and regulations

It is necessary to speed up the construction of laws and regulations that are compatible with the development of smart forestry, and create a good legal environment for the construction of smart forestry from the top-level design. It is necessary to formulate clear laws and regulations on data security, privacy protection, open sharing and other fields, regulate the whole process of data collection, transmission, storage and use, and protect the legitimate rights and interests of individuals and the public. At the same time, relevant regulations should be introduced to clarify the rights and obligations of each participant, and institutional arrangements should be made in terms of data property rights, data transactions, and income distribution, so as to create conditions for the cultivation of smart forestry business models and the development of smart forestry industrialization. It is also necessary to establish a sound intelligent forestry standardization system as soon as possible. At the same time, we need to speed up the formulation of forestry internet of things, satellite remote sensing, UAV aerial survey and other technical standards, standardized monitoring facilities and data collection process to ensure data quality. At the same time, it is also necessary to formulate standards and norms in the fields of forestry big data processing, modeling and analysis to ensure the interoperability and sharing of data between different systems. The establishment of standardization system will be conducive to the popularization and industrialization of technology. Finally, it is necessary to formulate a regulatory system for the development of smart forestry, strengthen the supervision of smart forestry infrastructure, data resources, and service applications, and maintain a fair and orderly market environment. At the same time, it is necessary to establish corresponding incentive policies to encourage enterprises and social capital to actively invest in the construction of smart forestry, and follow standard management to achieve sound development. Violations of laws and regulations should be punished according to law, and an institutional environment conducive to the innovation and development of smart forestry should be formed. Only by improving the system of policies and regulations can we escort smart forestry and promote the steady and long-term development of smart forestry.

6. Conclusion

Intelligent forestry is an important enabling means to promote the development of modern forestry and has important application value in forest resource management and control. At present, smart forestry in China is in its infancy and still faces many shortcomings, and it is urgent to continue to lay a solid foundation in infrastructure, data application, personnel training, policy protection and other aspects. Only by further strengthening the development of smart forestry can we fully release its huge potential in improving management efficiency, optimizing the quality of decision-making, and protecting the ecological environment, and contribute an important force to promoting the high-quality development of forestry in China.

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