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Explore the application of remote sensing technology in forest fire detection

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Abstract. Forest is one of the most important resources on the planet and an important foundation for ensuring the sustainable development of human beings. Forest fires are frequent, spreading fast, in wide areas and difficult to control, and difficult to predict and prevent. Monitoring fires in a timely and accurate is critical to protecting the environment and the safety of personal property. This article mainly studies the application and differences between remote sensing technology and RS GIS technology in forest fire monitoring and post-disaster monitoring and treatment. Studies have found that combustion materials, low temperatures in weather, high temperatures, and human activities are the main causes of forest fires. RS technology has the advantages of fast speed, rich information channels, fast update speed, and convenient operation convenience. GIS can operate and comprehensive analysis of multi-factor data, which facilitates the required information in a variety of forms such as graphics, images, numbers, and other forms to meet the needs of each application field and research work. In forest fire rescue, combining RS and GIS technology can improve the efficiency and accuracy of obtaining information about the fire on-site, which is conducive to improving the efficiency of rescue. Research on this article hopes to guide the disaster prevention and mitigation strategy of relevant departments.

Keywords: Forest Fire; Remote Sensing Technology; GIS.

1. Introduction

Forests are an important resource on the earth. They play a wide range of roles, such as regulating the climate, maintaining soil and water, and mitigating or preventing natural disasters such as droughts and floods, sandstorms, and hailstorms. They are an important foundation for ensuring the sustainable development of human beings and are important for many animals. Where plants live. However, forest fires occur frequently, spread quickly, cover a wide area, and are difficult to control, making them difficult to predict and prevent. The fire had a great impact on the surrounding environment and people and property. It greatly destroyed the diversity of forest vegetation, reduced the rate of forest vegetation renewal, and destroyed the original function of conserving water sources. Due to the loss of forest cover, local temperature increases and humidity decreases, prompting a large number of pests to breed and destroy plants. Fires also destroy the composition of forest soil, turning organic matter into inorganic matter and causing some minerals to disappear. Therefore, timely and accurate monitoring of forest fires is very necessary to protect the environment and reduce losses to people and property.

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The traditional methods of monitoring forest fires are mainly manual inspections on the ground and drone inspections. These methods are time-consuming, expensive, and potentially dangerous. Manual inspections on the ground require a lot of labor costs. People need to go to the fire scene to conduct inspections one by one. Sometimes the fire is not completely extinguished, and secondary fires are easy to occur when the wind blows, posing a threat to the personnel conducting manual inspections, and the manual inspection speed is very slow. The efficiency is extremely low, and the monitoring accuracy for blind areas is very low. However, satellite remote sensing technology allows for faster, wider, and more detailed monitoring of forest fires. Satellite remote sensing technology has the characteristics of high-resolution scanning, wide range, and real-time updates. It has high accessibility and a simple process. With the advantages of high spatial resolution, rich information obtained, and fast update speed, it provides an important technical means to achieve the multi-faceted prevention and control goals of forest fires. In recent years, many serious forest fires have occurred in our country, such as the 2019 fire in Qinyuan County, Shanxi, the fire in Muli County, Sichuan; the 2020 fire in Muli County, Sichuan, etc. High-scoring remote sensing is used in emergency monitoring and control of these fires. It has played a huge role in rescue operations and has gradually become an important technology in daily forest fire monitoring operations.

Therefore, this article will evaluate satellite remote sensing technology and other traditional monitoring technologies by introducing the causes of forest fires, the application of rs gis in forest fire monitoring, and the application of remote sensing-based fire monitoring in disaster management. At the end of this article, this paper will give some suggestions.

2. Causes of forest fires

The occurrence of forest fires needs to meet three conditions: combustibles, fire-dangerous weather, and fire sources. Combustible materials refer to all organic matter in the forest, such as trees, shrubs, grasses, fallen leaves, humus, and peat. Combustibles are the material basis for forest fires [1]. Monitoring the types and spatial distribution of combustibles is beneficial to forest fire prediction. Satellite remote sensing technology has a wide scanning range and fast update speed, which is conducive to the analysis and mapping of combustibles. For example, Qin Xianlin et al. [2] used MODIS technology to classify forest combustibles in Heilongjiang Province. Ding Haiyong et al.[3] used MODIS technology to extract information from the Bilahe Forest Farm in Daxinganling, Northeast China.

In addition to combustibles, weather conditions, and human activities are also the main causes of forest fires. Regarding fire weather, generally the lower the humidity and the higher the temperature, the easier it is to cause a fire. Fire sources are divided into two ways of generation, namely natural generation and artificial generation. Common natural methods are lightning strikes, fires, volcanic eruptions, etc. Common man-made methods of production include burning charcoal, grazing, outdoor cooking, heating, smoking, etc. The commonly used mathematical model for predicting forest fires is Logistic Regression (LR) [4]. This model can better predict the spatial size of forest fires [5]. Therefore, people often use the gompit regression model with the LR model. For example, Liang Huiling et al. [5] use LR and Random Forest algorithms to predict forest fires. Su Zhangwen [6] used more traditional regression models and spatial regression models to study forest fire data in the Daxinganling region of Northeast China.

Forest fires have caused great impact and harm to people's lives. On the one hand, forest fires will lead to a serious reduction in forest stock; on the other hand, they will also hurt forest growth. As a renewable resource with a long growth cycle, forests take a long time to recover after a fire. Moreover, after high-intensity and large-area forest fires, it is difficult for the forest to return to its original state and is usually replaced by low-priced forests or shrubs. If it is hit by fire many times, it may evolve into barren grassland or even bare land, which will lead to a significant reduction in the earth's forest resources and may also lead to the extinction of some species that rely on forests as their habitats. In addition, forests also play an important role in conserving water sources. The loss of trees caused by forest fires may cause soil erosion, causing soil to flow into rivers and lakes, seriously affecting water quality. When forest fires occur, combustion releases large amounts of smoke and harmful gases such

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as carbon monoxide and carbon dioxide, seriously damaging air quality. In addition, forest fires also pose a threat to people's lives and property safety, causing serious threats to factories, houses, transmission lines, livestock, and food in forest areas.

It is difficult to control forest fires after they occur. This is mainly due to the following factors: First, the meteorological conditions are complex, especially in southwest China, which has a subtropical plateau monsoon climate with low humidity and sometimes strong winds, which increases the difficulty of putting out fires. source difficulty. Secondly, the terrain is difficult, which makes it difficult for vehicles and large equipment to enter the fire scene, limiting effective actions to respond to fires. Third, the operating conditions are limited. For example, it is difficult for a helicopter to accurately drop water on the fire source, so the fire extinguishing effect is affected. Finally, forest fires are easy to rekindle because the humus layer is thick. Once the fire source is extinguished, the wind may cause the fire to rekindle, making it more difficult to extinguish.

3. Application of RS and GIS in forest fire monitoring

3.1. The application principles of the RS and the GIS

Remote sensing technology uses the principle of electromagnetic wave radiation. Only objects with electromagnetic wave radiation characteristics can be used to study images obtained by remote sensing technology [7]. GIS is a technology and tool that uses computers to store and process geographic information. GIS is a kind of human-computer interaction that, with the support of computer software and hardware, inputs, processes, stores, and outputs various resource information and environmental parameters according to spatial distribution or geographical coordinates in a certain format and classification to meet application needs. Information system. Through the operation and comprehensive analysis of multi-element data, it can quickly and easily output the required information in graphics, images, numbers, and other forms to meet the needs of various application fields or research work. In forest fire rescue, improving efficiency and accuracy is the basis for accurately obtaining fire scene information. Therefore, to cooperate with firefighting assistance forces, it is necessary to build a rescue system related to remote sensing technology. The system needs to be composed of remote sensing satellites, mobile terminals, and servers. The remote sensing satellite collects data and images from the fire scene and then transmits the images to the fire command center. The mobile terminal relies on the network to communicate with the fire command center, mainly conveying fire information conveyed by the alarm person. The server is used to share data and information, that is, to communicate the data to other departments on time for data analysis. Figure 1 illustrates the basic principles of remote sensing technology.

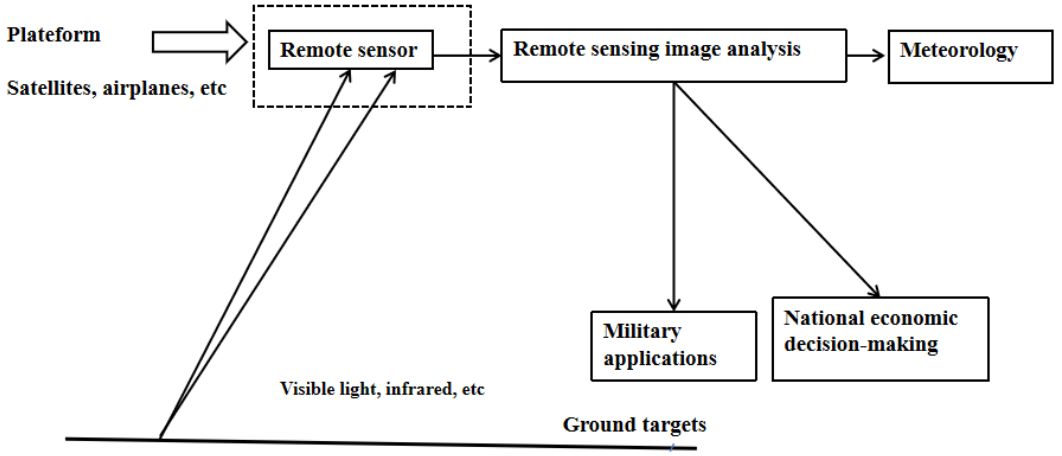

Figure 1. Basic principle of remote sensing [8]

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GIS also plays a huge role in forest fire rescue. Yang Peng et al. [9] used GIS to monitor forest fires in Shijiazhuang City, Hebei Province, China and used GIS to locate the basic geographic information data of Shijiazhuang City. The accuracy can reach the village level, and give the classification of ground coverage types, which facilitates the identification of forest fire points. Based on the national meteorological station in Shijiazhuang, the GIS system analyzed the climate type and forest resources and obtained the level of forest fire in Shijiazhuang city. Zhang Hongqun et al. [10] used the Arc GIS 8.3 system to study the forest area of Guangzhou. The software not only has the basic functions of GIS but also can meet the needs of the development of powerful professional functions, can meet most of the needs of the forest fire system, support a variety of map projection and real-time projection conversion, easily solve the real problems of different projections in the same work area.

The system has other benefits: fast data collection function, ArcGIS current version in the original digital map data collection and GPS data collection, provides grid vector, can extract the scan data of various maps; can graphics, images (aerial photos, satellite remote sensing data, map), tables, text, sound, video and other information sources comprehensive management, and the data can be corresponding processing. Convenient map query and indexing function, friendly and easy to understand the interface can easily query, retrieve the spatial and attribute data and conduct the corresponding analysis.; Virtual reality technology can generate different functional figures for 3-D and horizon analysis; beautiful and convenient map making.; Free interface customization, users can set up the user menu interface according to the requirements of different fields and the function library provided by the system, to develop the professional geographic information system in the corresponding field. These advantages make it more rapid, more accurate, more accurate, and more intuitive when analyzing fire.

3.2. Application of remote sensing-based fire monitoring in disaster management

Remote sensing technology plays an important role in fire rescue and command-assisted decision-making, and its operation is divided into three stages. The first stage is to determine the approximate location information based on the IP number of the alarm person. This process mainly uses the automatic connection between the mobile phone chip and the nearby base station. The communication operator can report the location information to the rescue department; the second stage is to obtain the fire location information. , sending its location information to the satellite receiving station, which further determines the specific location of the fire through data screening and positioning; in the third stage and after the server obtains the ground information, it compares the images to grasp the fire intensity and other information, and uses the GPS to plan the best rescue route.

During the specific implementation process, the server first extracts some key information from the image, such as flame area, height, color, smoke concentration, area, etc. Based on this information, the burning coverage area of the fire scene is calculated to match the corresponding fire rescue force; the required rescue equipment is matched according to the flame height; the fire intensity is judged according to the flame color, where different temperatures correspond to different colors of flames (600°C-dark red, 1000°Corange-red, 1100°C-orange, 1500°C-white-blue)

The color of the smoke can also be used to judge the intensity of the fire. Different concentrations of smoke show different colors, among which yellow-green smoke represents the release of toxic gases.

4. Suggestions

Forest fires are very frequent disasters, and fire protection work is an important component of social safety management. From the central government to various local governments, each year has put forward new requirements for fire safety management. In recent years, it has especially emphasized that it is necessary to use new models of modernization to promote changes in fire management. With the development of technology and information, there will be more and more new technologies and new models in terms of fire protection. Not only need to improve the fire monitoring technology but also to strengthen the people's awareness of self-rescue of the people's forest fires. For example, learn to quickly find a relative haven (the terrain is relatively flat, the vegetation is scarce, the distance is close to the fire line, and is located in the upper wind direction). Make Lin Huo's direction), cross the fire to the wind to

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escape from the wind (spray a certain amount of water on the clothes). After the forest fire occurs, the ecological recovery measures need to be restored, mainly including artificial seedlings and forests, artificial on-demand, and reducing engineering measures to reduce soil and soil loss and reduce forest fire risk measures. A region with mild and moderate damage to the fire, severe damage to the area, and artificial demand for forest land above three kilometers above sea level; for areas with long slopes of fire victims, you can set up sand dams to block and slow down soil and soil loss. , Reduce the damage caused by the loss of soil and soil to the downstream of the river, clean up the scope of the damage, and use value, which can remove the forest land for re-use. This can not only reduce the level of fire risk of forest land but also reduce the dependence of the energy consumption of residents on the unacceptable forest. In addition, it is recommended to vigorously develop artificial intelligence auxiliary remote sensing technology in the future. At present, the forest fire monitoring system still needs to perform artificial data screening and other work combined with artificial intelligence and remote sensing technology to develop a new monitoring technology system. , Machine learning and other technologies, combined with satellite remote sensing technology to monitor the research of Linhuo, have begun to develop, and it is also a new direction for the development of forest fire monitoring in the future. High-resolution satellites research in forest fire monitoring increases satellite data in forest fire monitoring to improve data quality.

5. Conclusion

Forest is one of the most important resources on the planet. It plays a major role and is an important foundation to ensure the sustainable development of human beings. Therefore, humans should better protect the forests and reduce the frequency of forest fires and the scope of disaster. The use of traditional monitoring technology is time-consuming and labor -intensive, consumes a lot of money, and accompanies great risks. This article introduces the cause of forest fires to explore the necessity of high-precision monitoring fires. At the same time, this article focuses on the application of remote sensing technology in forest fire monitoring and explores its advantages.

Studies have found that remote sensing technology has more advantages than traditional monitoring technology. The detection speed is faster and more accurate, without risk-free remote sensing technology. The electromagnetic wave radiation principle object is used. It has the characteristics of electromagnetic wave radiation. To cooperate with fire protection, the remote sensing technology needs to be matched with the rescue system. The combination of the remote sensing technology and the rescue system forms a fire monitoring system. Remote sensing technology provides technical support for forest fire monitoring, playing an important role in forest fire prediction, saving, and disaster evaluation. Chinese scholars have become increasingly deepened by the flexible research on the use of satellite remote sensing technology. Combining satellite remote sensing technology, aviation remote sensing technology, and grounding surveillance monitoring techniques have done a lot of research and exploration in the first three stages of the fire. However, there are still some problems in the application of satellite remote sensing technology in the application of spiritual fire monitoring. On the one hand, few satellites can provide high time resolution, high space resolution and full spectral information at the same time. On the other hand, the quality processing quality of various methods is difficult to accurately measure, and factors such as terrain and vegetation have a significant impact on satellite monitoring. To improve this situation, it is recommended to vigorously develop remote sensing technology assisted by artificial intelligence to reduce artificial pressure. At present, although the forest fire monitoring system still needs to carry out artificial data screening and other work, combining artificial intelligence and remote sensing technology, the development of a new monitoring technology system can share the artificial burden. Scholars such as deep learning and machine learning combined with satellite remote sensing technology have begun to develop, and it is a new direction for future forest fire monitoring. In addition, increase the time and space resolution of remote sensing satellites, increase the number of satellites used to monitor forest fires, increase the research strength of high -resolution satellites in forest fire monitoring, and increase the satellite data of forest fire monitoring. Key measures.

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