The status and development trends of land remote sensing

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SUMMARY

The land resource is a very important natural resource and the most basic resource necessary for human production activities and social development. The research of changes in land resources is the great significance to global climate change and sustainable development. At the same time, land resources vary greatly in different periods and different regions. This means that it is difficult to monitor land resources with a single method such as aerial photography, using UAVs, laser scanning or some other method of remote sensing, but in combination it is getting easier. Since the 1970s, remote sensing technology has gradually become an important means of monitoring land resources due to its advantages such as all-weather, wide-coverage, short repeated coverage cycles, and strong information acquisition. The article researches the development and applications of remote sensing technology in land resource monitoring. Also the article analyzes future development trends of land remote sensing technology that will be large-scale data fusion, cloud computing and deep learning.
Introduction

The land resources changes have extensive and far-reaching impacts on the structure and function of the earth's ecosystem and are closely related to the sustainable development of human society. The land resources have not only an important impact on food production, freshwater resources, forestry resources, local climate and other fields, but they have also a significant impact on global climate change. Since the industrial era, as much as 35% of greenhouse gas emissions have been caused by changes in land resources (Foley et al., 2005). At the end of the twentieth century, the Land use and land cover change (LUC) research proposed by the International Geosphere-Biosphere Program (IGBP) and International Human Dimensions Programme on Global Environmental Change (IHDP) and began to use deeper studies on the linkages between human activities and LUC. For improving the understanding and prediction of global land use and land cover change dynamics researches the impact of human activities on land cover changes. The LUC provides the reference for many independent projects researching land use/land cover change issues around the world (Yue Chang et al., 2011; Lambin et al., 1999). Changes in land resources are increasingly regarded as critical factors influencing global change. Since then, researchers around the world have carried out extensive research on land resources. Land resource monitoring has become a vital part of global environmental change and sustainable development (Turner et al., 2007). With the development of information technology, there are more and more applications of remote sensing technology in land resource monitoring. The accumulation of large amounts of remote sensing data and the emergence of cloud computing platforms provide us with opportunities to understand the dynamic changing nature of land resources from a new perspective.

The purpose of the article is to research the current state and future trends in land monitoring by remote sensing methods.

The Development and Current Status of Land Remote Sensing

The application of remote sensing technology in land resource monitoring is inseparable from the development of remote sensing platforms, sensors and methods. The traditional land resource monitoring uses field surveys, aerial and space photography and other methods to obtain various types, quantity distributions, changes and other attribute information of land resources, and finally, express this information in the cartographic form (Karpinsky & Lazorenko-Hevel, 2018). The emergence of remote sensing technology has increased the means of land resource monitoring. In the early stage, remote sensing technology was mainly used to obtain space images and information. Through field surveys, the corresponding relationship between actual features and data was established. Then, through professional knowledge, different types of land were identified, the area and quantity were calculated, and thematic maps were finally produced. The number of satellites and sensors is also increasing, and the performance is constantly improving with the development of information technology. These changes have improved the quality of remote sensing data and added more information. The time-series remote sensing databases began to form with the increase of remote sensing data. A large amount of dynamic change information about the quantity, distribution, composition, and type conversion of land resources began to be collected, and land resource monitoring research began to move toward dynamic change monitoring and the direction of rapid data update.

Since the 1990s, remote sensing technology had made breakthroughs in land resource monitoring at global and regional scales (IGBP and Earth observation: a co-evolution, 2015), and a series of global land cover products with uniform classification standards appeared.

In many studies, it is also possible to perform exploratory prediction and analysis of changes in land resources based on remote sensing image data. Munthali et al. used Landsat satellite imageries from 1991, 2001 and 2015, based on Cellular Automata (CA)-Markov Chain model to simulate and predict plausible LULC changes for Dedza district in Malawi for the years 2025 and 2035 (Munthali et al., 2020).
Future prospect

The remote sensing images are one of the main sources of information and analysis of land resource changes. Different sensors provide images with different resolutions and different temporal and spatial characteristics, which can identify different types of land resources. They generate a lot of data (Sidhu et al., 2018). Many countries and international organizations are committed to developing data standards related to remote sensing to improve the quality and sharing value of data with the continuous increase in the amount of data and the development of the concept of data sharing. The Federal Geographic Data Commission (FGDC) of the United States developed the United States Federal Geographic Information Standard, the Technical Committee 211 (ISO/TC 211) under the International Organization for Standardization (ISO) are responsible for formulating metadata standards in a broad sense and formal geographic information data international standards. The Open Geospatial Consortium (OGC) has developed industry specifications for interoperability between different data platforms and released a set of components for processing any type of sensor via the Internet to realize the collection, exchange and processing of sensor data (Kresse, 2008; Liping Di, 2003).

Although researchers can obtain a large amount of remote sensing data from some public data platforms. However, too much data has increased the difficulty of storage and calculation. The emergence of remote sensing data platforms based on cloud computing technology has alleviated the pressure in this regard, allowing researchers to more efficiently study the relationship and dynamic changes between data. Google Earth Engine (GEE) is the free cloud computing platform, accessible through the Explorer web application. It has a huge public remote sensing image data and other products; can perform high-speed parallel processing and machine learning algorithms. It has an application programming interface (API) library with a development environment and supports popular coding languages such as JavaScript and Python (Tamiminia et al., 2020, p. 158). GEE has gradually demonstrated its potential as more and more users join. Goldblatt et al. used GEE to produce high-quality built-up areas across space and time. It embodies the potential use of GEE for temporal large-scale analysis of the urbanization process (Goldblatt et al., 2016, p. 634). Some other studies also reflect the potential of GEE in land resource change. The GEE platform provides an unprecedented opportunity to improve our scientific understanding of the dynamic change process of land resources (Xie et al., 2019, p. 111317; Ge et al., 2019, p. 111285; Wang et al., 2020, p. 112002).

Deep learning is a new research direction in the field of machine learning which combines professional knowledge and concepts in statistics, biology, neuroscience, computer science and other fields, and is a very complex machine algorithm. The deep learning does not rely on manual extraction of data features compared with traditional algorithms, but directly extracts features from data, classifies and outputs results. The accuracy can be continuously improved with the growth of computing power and training data. In recent years, deep learning has been widely used in Internet search, artificial intelligence, image recognition, unmanned driving, medical research, natural language processing, etc., and has achieved many results. The remote sensing data is essentially a
kind of image data and the main task of remote sensing monitoring of land resources is to determine
the location and size of land cover changes by analyzing remote sensing images from different
sources at different times. In recent years, with the increase of remote sensing data, researchers need
to develop better image change monitoring algorithms to obtain more effective data. Therefore, deep
learning has been introduced into remote sensing data change detection, and many results have been
achieved (Khelifi & Mignotte, 2020). In Ukraine was proposed a multilayer Deep learning architecture,
which distinguishes Ukraine’s crop types by processing Landsat-8 and Sentinel-1A images, with an
accuracy greater than 85% (Kussul et al., 2017).

Conclusions

The modern remote sensing technology has been widely used in the field of land resource monitoring.
The land resource monitoring has developed from traditional field surveys to dynamic change
monitoring and rapid data update. In this work, some applications of remote sensing technology in
land resource monitoring are researched. The authors of the article have also predicted the future
development direction: with the continuous increase of remote sensing data, seamless large-capacity
remote sensing databases have begun to form, different countries and international organizations have
formulated data standards related to remote sensing, which allows different databases to be shared
between different users, bringing new data and discoveries; the emergence of seamless cloud
computing platforms will relieve researchers. It relieves the pressure of data processing and provides
a basis for automatic mapping and long-term land resource monitoring; the introduction of deep
learning improves the accuracy and speed of data processing and provides new possibilities for further
mining the value of remote sensing image data.

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References

Cover Change research progress. IOP Conference Series: Earth and Environmental
Science, 113, 012087. https://doi.org/10.1088/1755-1315/113/1/012087

https://doi.org/10.1126/science.1111772

Ge, Y., Hu, S., Ren, Z., Jia, Y., Wang, J., Liu, M., Zhang, D., Zhao, W., Luo, Y., Fu, Y., Bai,
https://doi.org/10.1016/j.rse.2019.111285

Goldblatt, R., You, W., Hanson, G., & Khandelwal, A. (2016). Detecting the Boundaries of
Urban Areas in India: A Dataset for Pixel-Based Image Classification in Google Earth
Engine. Remote Sensing, 8(8), 634. https://doi.org/10.3390/rs8080634

https://doi.org/10.1109/access.2020.3008036

the Photogrammetry, Remote Sensing and Spatial Information Sciences, 37, 1763–1768.


