Application of "3S" Technology in Land Resource Management

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Abstract. Land resource management is one of the most important ways to deal with the relationship between land resource and human being to improve land use efficiency and gain more benefits. "3S" technology refers to remote sensing (RS), global positioning system (GPS) and geological information system (GIS). "3S" technology is widely used in different fields generally as an excellent method and it has advantages to exploit in land resource management. Now as the population grows, the conflict between land resource and mankind extrudes with global resource shortage. The effort using "3S" cannot be ignored. This article explains the definition and ability of "3S" technology and analyze the application of "3S" in the Investigation of land resource, land environment dynamic monitoring, land evaluation, land consolidation and land planning. The author concludes the utilization of "3S" technology in land resource management and looks forward its development in the future from different perspectives. Informatization, intelligent and integration are three directions "3S" will make progress. This article takes some examples to illustrate how to help "3S" technology step forward in the future. Through these ways, the optimized "3S" technology has ability to overcome disadvantages and build up new use of the way. So the efficiency of land resource management will be improved obviously to achieve the sustainable use goal of land resource.

Keywords: 3S technology, GIS, land resource management, land resource allocation, land utilization.

1. Introduction

In the global context, natural resource emerges a trend of shortage on a global scale. Land resource as one of the basic living conditions of mankind and any other biont is also faced with serious shortage problem without doubt, especially in some specific areas. Therefore, as the development of society, relevant department must take the relationship between human and land resource into consideration to ensure the stable evolution of whole human society. Only by overall management, can the land resource issue be partial remission. "3S" plays an essential part in land resource management. As the innovative development of science technology, "3S" technology is becoming more and more popular in a lot of various fields and make great achievements gradually. There is no doubt that the application of "3S" in land resource management will achieve excellent goals. The use of "3S" technology is of remission. From data collection and detailed location information gathering to spatial data analysis, "3S" has ability to adjust the disposition of land resource and realize the optimal utilization of land resource. The discussion of the utilization way and different aspects of "3S" in land resource management is necessary.

There are not so much information and essays talking about the application of "3S" in land resource management. Many related essays just explain the application of "3S" technology on one hand such as land planning, land consolidation and land evaluation. There are few essays discussing the application of "3S" technology in different aspects in land resource management and most of them are ancient or incomplete. For example, Liu et al. [1] indicated how to use "3S" in land planning management which concluded the investigation, design, dynamic monitoring and law enforcement work except land evaluation and land consolidation. Unlike most of the existing essays, this article emphasizes the importance of the application of "3S" and discusses the application of "3S" technology in land resource management from different vital work aspects and links of work roundly.

This article aims to introduce the application of "3S" in land resource management to provide reliable and efficient bases for practitioners so that the efficiency of land use will be improved and sustainable utilization will be realized. The author introduces basic definition and information of "3S"

technology and what it can help firstly, and then talks about how to use "3S" in different aspects to make land resource management more efficient. At last, the author listed the advantages of "3S" technology and several development directions for further progress.

2. "3S" Technology

"3S" technology combines all three technologies including RS, GPS and GIS as an integrated technology. It collects data and deal with information depending on satellite technology and computer technique. In land resource management, GPS provides accurate position metrical data as a base of entire working process, and it provides large sets of data at the same time together with RS. With the great data analysis ability of GIS, the spatial data analysis results present essential information for lucubrate.

In detail, these three technologies interact with each other as Fig. 1. RS provide related data sets of specific area and the special remote sensing image information. GPS focuses on precise location of target objects and the update of spatial positioning. The two parts gather basic geographic information spatial data for next step. GIS makes full use of collected data and take advantage of its data analysis and spatial visualization ability, analyses the land resource information accurately and presents needed information. At the same time, it is also feasible to use GPS to search for thematic information for further analysis in GIS [1] (Fig. 1).

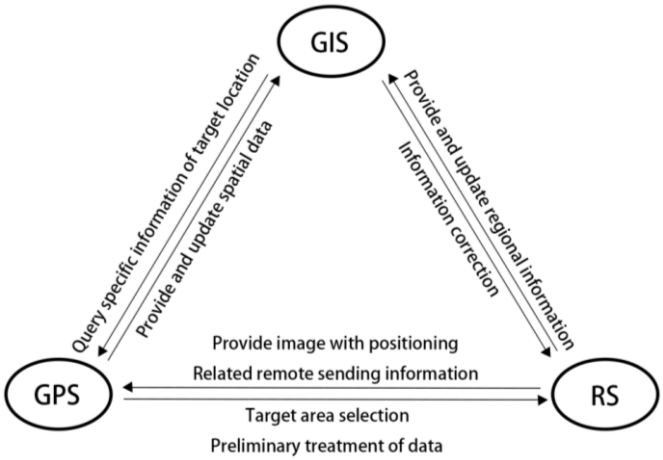


Figure 1. The inner relationship of "3S". (Photo credit: Original)

2.1. RS

RS refers to remote sensing and it is a frequently-used technology in land resource management. It receives different electromagnetic signal of all types of objects on the surface of the earth from outer space and upper air, detect and recognize various objects and phenomena on the surface in a great distance by means of scanning, photography, transmission and processing [2]. It mainly includes visible spectral remote sensing, infrared remote sensing and microwave remote sensing. RS has been used in a great amount fields containing disaster monitoring, natural resource survey, agricultural land monitoring and so on. It collects data about land information including land cover/land use and related spatial position, describing the characteristic of landform. Managers get comprehensive exact land information by rational utilization of RS to confirm that the way to improve the efficiency and benefit of land use is feasible.

2.2. GPS

GPS means global positioning system. It can obtain the geographical position, moving speed, accurate time and other information of objects in terrestrial space based on the satellite and radio, providing all-weather and global coverage services [3]. GPS is widely used especially in surveying and mapping industry which is the base of land resource management. By combining with computer

science technology, GPS works with great efficiency, high accuracy, wide coverage and strong anti-interference property. It provides safe and stable data about the state of development and change information of land resource for the specific projects of land resource management to enhance management status and improve working achievement.

2.3. GIS

GIS is a technology system that collects target data, analyses spatial data and describes related information with the help of computer technology [4]. GIS is able to mark the orientation and location of target objects in a short time by recognizing the longitude and latitude coordinates and corresponding geographical features, put the geographical location and geographic information into the first place [5]. Compared to RS and GPS, GIS emphasizes the summary, management and analysis of collected data information. Under normal circumstances, GIS gets data from RS and GPS which are both useful for the Geographic information analysis of GIS and catches the characteristic of target objects in two or three dimensions [6]. As a comparatively perfect geographic information monitoring system, GIS is of fairly strong timeliness. So it is available for managers to get latest overall data without delay to catch the information for land change and land resource dynamic monitoring.

3. Application of "3s" Technology

3.1. Investigation of Land Resource

Investigation of land use current situation is the first step of all land resource management course. As one important part of this work, data collection section can be improved by using "3S" technology. Technical staff dispose aerial image and satellite data caught by remote sensing technology and make a preliminary analysis to ensure the reliability and accuracy of the related data and location information, providing sufficient data support for follow-up work. Technical professionals analyze current land use and exploitation situation scientifically while parsing image data with computer technology, using GPS to carry out cadastral surveying work and finishing the drawing of cadastral. The personnel concerned enter information on land resources in different areas in an integrated manner to facilitate the investigation of the overall use of land resources [6]. In this process, RS and GPS ensure the accuracy and integrity of source data for deeper analysis using GIS. GIS provides a platform to manage all the collected data uniformly and build modelling while conducting spatial analysis.

Zheng et al. [7] discussed the technique process in the third National Land Survey in China (TNLS). They explained that in this survey, staff built up a buffer in GIS using RS image data and basic geographical profile for mottling. Jia et al. [8] detailed the data acquisition approaches of TNLS. He displayed the demanded resolution of different districts in RS image data and illustrate the use pattern of 3S in two different technical platform referring to Web (Global Wide Area Network) side audit distribution system and mobile survey APP.

3.2. Land Environment Dynamic Monitoring

In the past, land resource management only uses artificial methods to collect and type-in necessary data. This mode cannot promise the timeliness due to the human factor. It is impossible to implement dynamic monitoring and provide real-time data. Now with the help of GPS and RS, the timeliness can be improved when the change of land situation data can be disposed and saved, which is helpful to the land resource management [1]. Bo et al. [9] pointed out that massive data disposal methods continued to be improved and he designed the land resource dynamic monitoring system for Shanghai. Di Zu et al. [10] constructed the soil nutrient monitoring system based on the soil nutrient information scientifically combined with "3S" technology, computer technology and related spatial managing technology.

At the same time, 3S is also useful for the environmental dynamic monitoring. In China, the ecological problem of water and soil erosion has become more and more serious, how to monitor and

deal with this situation persistently has been one nonnegligible part of land resource management. Du Xuan [11] indicated that the traditional satellite image analysis method could not supply real time and precise data, so it is difficult to manage to key monitoring area. "3S" technology does not connect these three methods simply, but creates a new comprehensive and all-sided system using gathering data by a series of rigorous data interfaces. Therefore, it has ability to focus on concerned area and refresh latest information precisely and fleetingly, supporting relevant department to prevent the disaster in advance and govern the problem.

3.3. Land Planning

Land planning is a means aiming to keep resource utilization sustainable. It conforms to sustainable development and the concept of Sustainable Development Goals (SDGs), which can be helpful to reduce waste of resource and improve the efficiency of land resource use. Land planning is hard to be operated due to huge quantity of relevant data, and its complexity and fussiness influence the veracity of data in a traditional way [1]. Using "3S" technology can solve this problem with its systematic. Workers plan on the base of collected data to reduce the data flow among levels. The authenticity and effectiveness can be improved. Xue and Sun [12] explained the advantage of "3S" technology in urban planning. They pointed out that the application of "3S" included land dynamic monitoring technology and law enforcement supervision. Using GPS to measure alternative data and integrating GPS with GIS can improve initiative and immediacy of law enforcement inspection [13]. Li and Hong [14] discussed the application of "3S" in the whole process of country land planning and took Kafr Narai for an example.

Using "3S" technology build mathematical model and analyze the most efficient plan for distribution and utilization structure of land resource is a primary way in land planning [6]. It is general to establish thorough geographic information database in GIS and then proceed with spatial analysis based on different models. And using GIS for land resource survey data collation is one effective way to ensure the timeliness to related department and improve the intelligent and modern level of long-term planning [15].

3.4. Land Consolidation

Land consolidation is an activity that adjusts land resource in order to make it suitable for production and living. It is of great importance for the development of both city and country [6]. "3S" is vital to conduct land consolidation work. It relies on GPS and RS to finish the measurement of target land resource location and dynamic change information in order to make sure that staff will handle current land resource situation and land consolidation implementation status. So "3S" guarantees the effectiveness of land consolidation work and improve the quality of the whole process. Yang et al. [16] explained that in modern agricultural development mode, relevant department used "3S" to catch geographic information in target area and planned appropriate place to develop agriculture to obtain high standard and high-quality cropland. In this way, it is available to put the shape of cropland in order to keep pace with the development of modern mechanical agriculture and improve agricultural productivity. Liu et al. [17] mainly discussed surveying and mapping technology as a part of "3S". She emphasized strict control of surveying and mapping process and the use of GPS to monitor the land consolidation engineering. Xiong et al. [18] indicated the application of "3S" in different parts of land consolidation including scheme design, land use planning and monitoring, land resource evaluation, land consolidation construction and management and completion stage of project and explained how GPS-RTK technology worked.

3.5. Land Evaluation

Now land evaluation generally refers to assess and classify land resource by finding the discrepancy of land quality reflecting to the potential and suitability of land resource. As mentioned, GIS is the main tool which makes spatial data management and analysis much easier. In land evaluation, staff finish evaluation and rank division of land resource by its potential and suitability

and gather statistics of spatial change rules and characteristic. Using "3S" technology can complete the disposition of land resource while reducing the cost of manpower by establish land resource evaluation system. So "3S" saves resource and speeds up the work process in a way. Gao Yan [19] analyzed emphatically how "3S" worked in returning the grain plots to forestry quality evaluation. She stressed make full use of the diversification of "3S" and make quantitative analysis versatilely to promise the efficiency and quality of rating results. Liu et al. [17] discussed that using GPS to manage spatial data and analyze space information was one effective means to make full use of land resource as well as protect the land environment. Yang et al. [16] discussed that staff was able to appraise the land resource use situation in real time and filed related information to finish the next land resource evaluation process comprehensively and systematically with the development of "3S".

4. Future Development

As the computer network technology (CNT) develops, "3S" technology is improving accuracy step by step and becoming more and more information. Combined with CNT, management lifts the level of co-movement in different land resource planning departments. It reduces capital input and improve work efficiency [1]. At the same time, "3S" will average up the level of integration to adopt its good points and avoid its shortcomings. In practical application, all workers are trying to make "3S" conformity with related advanced technology to take advantage of various methods so that it will be more convenient to get accurate and perfect land information. It is the key that combine the connection between different items for optimal allocation rather than put them together simply. Only in this way, can workers build up intact integration land resource information system [15]. Besides, "3S" intelligent is also one of the development directions. There is more than one way to make it possible such as building a thorough land resource management system, making full use of the tone between database and "3S" and rational utilization of artificial intelligence. All of them will raise efficiency of land management work.

5. Conclusion

Now environmental issue and resource shortage problem protrude with time going on. "3S" technology is becoming more and more important in dealing with resource disposition and dynamic monitoring. As mentioned above, "3S" technology application in different links makes sense as was expected with the development of informatization. Its integration and intelligent also provide clear direction of development. Besides, matching up "3S" technology with relevant scientific research is also a method to advance rapidly. With the development of "3S" technology application in an all-around way, the benefits gained will be immeasurable. The rise of artificial intelligence makes it more unpredictable. As one of the most prominent advantages, the timeliness will be improved further when its practicability and universality grows rapidly. It is expected that in the future, combined with CNT and artificial intelligence, "3S" technology will reduce the workload of workers and cost of hiring staff due to this high efficiency integrated technology. In a completely new technological global context, the development of "3S" technology conforms to the historical trend of the time which reduce the degree of difficulty and improve the degree of automation to a certain extent. To sum up, the application of "3S" in land resource management will improve the scientific and rational management and promote the sustainable development of land resources.

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