

Application of GIS in Land Policy and Planning Strategies in Rural Revitalization

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Abstract

In recent years, there has been a growing emphasis on reviving rural areas in China, which has become a crucial strategic direction for the nation's economic and social development. Currently, rural revitalization is a major endeavor in China, and the successful implementation of land policy and planning strategies is crucial to its achievement. This study seeks to examine the use of Geographic Information System (GIS) in crafting land policy and planning strategies for rural rejuvenation. By harnessing GIS technology, a thorough evaluation and analysis of rural land resources can be undertaken, furnishing a scientific basis for formulating land policy. Furthermore, Geographical Information Systems (GIS) provide opportunities for spatial analysis, simulation, and decision support capabilities to implement rural land policy and planning strategies. Nevertheless, the use of GIS technology presents challenges and limitations in terms of data acquisition and technological implementation. To promote the sustainable development of the rural economy, future research efforts should concentrate on further enhancing the utilization of GIS technology in rural revitalization.

Keywords: GIS, rural revitalization, land policy, planning strategy, sustainable development

1. Foreword

In recent years, rural revitalization has emerged as a critical strategy for China's social development. The acceleration of urbanization and continuous progress in the rural economy make it crucial to utilize and plan rural land resources rationally for successful rural revitalization.

Nevertheless, several challenges and issues remain to be addressed in the implementation of rural revitalization policies. Therefore, this study intends to examine how Geographic Information System (GIS), a potent geospatial information processing tool, can help effectively aid and enhance land policy formulation and planning strategies within the context of rural revitalization. By conducting a thorough review of the latest literature in this field, this paper seeks to investigate the use of GIS in the context of rural revitalization. The integration of GIS with the wider initiative of rural revitalization can provide policymakers and researchers with a more extensive range of resources and guidance. The study's significance is its provision of an extensive comprehension of GIS's practical application in the ongoing efforts to revitalize rural areas. Additionally, this study gives concrete recommendations for formulating land policies and planning strategies.

By maximizing land resource utilization and planning, a sustainable development path can be created for rural revitalization, hence enabling further growth in the rural economy and overall societal progress.

2. Rural Revitalization and Land Policy

Implementing the rural vitalization strategy is a major decision and plan made since the 19th CPC National Congress. It is a major historical task for securing a decisive victory in building a moderately prosperous society in all respects and building a modern socialist country in all respects. It is also the overall focus of the work related to agriculture, rural areas and farmers in the new era (., 2018). With the rural revitalization strategy proposed, GIS technology is playing an increasingly vital role in land policy and planning. Firstly, it assists in the assessment and design of land use, giving rise to scientific programs and strategies for rural revitalization through spatial analysis and data integration. Secondly, GIS assists in developing and implementing rural land policies, helping make decisions about transferring land management rights and protecting farmers' interests. This promotes rural economic development and boosts farmers' income. Furthermore, GIS can be used to

manage and safeguard rural land resources by monitoring changes in land use and environmental indicators, enabling the rational allocation and protection of these resources.

2.1 Concepts and Goals of Rural Revitalization

Rural revitalization refers to a major strategy and process for accelerating rural transformation and urban-rural integration development by solving the principal social contradictions and prominent problems faced by rural development in a specific period (Liu, Y., 2018). China's economic growth has shifted from a stage of high growth to a stage of high-quality development (Ding, Q. L., & Ye, Y. M., 2020). As China progresses with economic development, an increased focus has been placed upon the revitalization of rural areas. A national strategy has been implemented with the aim of achieving comprehensive development of the rural economy, society and ecology. The primary objective of rural revitalization is to enhance rural infrastructure, promote the growth of rural industries, enrich the quality of life for farmers, and preserve rural environmental resources. This approach aims to enable harmonious growth between rural and urban areas. Through improving rural industries, increasing income levels in rural communities, enhancing rural infrastructure and restoring the rural ecological environment, the revitalization of rural areas strives to achieve balanced progress between urban and rural areas and socio-economic growth in rural regions.

2.2 The Impact of Land Policy on Rural Revitalization

Effective land policy is crucial for rural revitalization, significantly impacting farmers' income growth and the overall rural economy. The implementation of sound land policies enables optimal organization of land usage, leading to improved rural land management and development of the agricultural industry. Furthermore, effective land policies stimulate farmers, promoting the circulation and intensive utilization of land resources, ultimately benefiting the rural communities. Refining land policies requires adjusting and reforming mechanisms for transferring land contracts and management rights, revising land use tax policies and ensuring fair land expropriation and compensation policies, among other measures. These actions promote the rational allocation of rural land resources and increase farmers' land wealth, supporting the successful implementation of the rural revitalization strategy.

2.3 Evolution and Adjustment Trend of Land Policy

As the rural revitalization strategy progresses, land policy is subject to continuous evolution and adaptation. A crucial element of this policy is to ensure the protection of farmers' land rights and interests, securing fair and lawful land circulation. Additionally, it is imperative to encourage the efficient use of land resources and optimize the allocation of rural land. To adjust land policy, the government could implement a range of measures, including revising the systems for land contracts and management rights, strengthening land protection and usage management, and improving the mechanisms for land expropriation and compensation. Moreover, the use of GIS technology offers spatial analysis and evaluation, providing scientific support for land management and planning decisions.

Continuous improvement of rural land policies, optimization of rural land resource allocation, and the attainment of rural revitalization objectives will offer sturdy backing and direction in executing the rural revitalization approach.

3. The Basic Role of GIS in Rural Land Policy and Planning for Rural Revitalization

A Geographic Information System (GIS) is a system of computer software, hardware and data, personnel that make it possible to enter, manipulate, analyze, and present data, and the information that is tied to a location on the earth's surface. This system comprises of Software, Hardware, Data, and Personnel that make it possible to enter, manipulate, analyze and present information that is tied to a location on the earth's surface (Ali, E., 2020). It plays an important role in the land policy and planning of rural revitalization, and its system composition is shown in Figure 1. Through the spatial analysis function of the geographic information system, we can produce the geographic information that is difficult to obtain by conventional methods, and realize the management and auxiliary decision support under the support of the analysis function (HUANG Xingyuan, & MA Jinsong., 2008). GIS plays a critical role in various areas, including assembling and integrating land resource data, evaluating and analyzing land usage, providing decision-making assistance for land policy formulation and implementation, and visualizing and communicating land-related information.

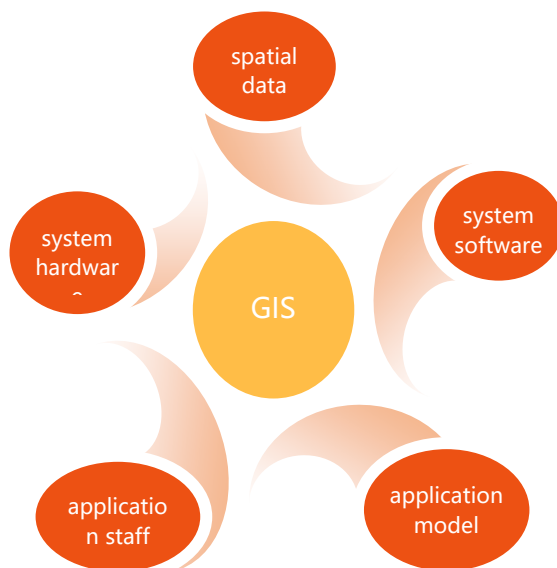


Figure 1. Schematic diagram of GIS components

3.1 Collection and Integration of Land Resource Data

Geographic Information Systems (GIS) provide essential assistance in collecting and integrating land resource data. By using GIS technology, we can efficiently gather, arrange and supervise relevant information about land use status, ownership and contract management. Regularly updating this data ensures a seamless integration and serves as a foundation for supporting the decision-making processes aimed at revitalizing rural areas.

3.2 Land Use Assessment and Analysis

Moreover, GIS plays a crucial role in appraising and analyzing land usage. Through the utilization of its spatial analysis capabilities, GIS enables the evaluation of land resources both quantitatively and qualitatively. This assessment encompasses various elements, including assessing land usage status, conducting suitability evaluations, and monitoring alterations in land utilization. Moreover, the examination of land usage characteristics and patterns provides a factual basis for informed land planning and decision-making.

3.3 Decision Support for Land Policy Formulation and Implementation

In addition, GIS provides decision support for the formulation and implementation of land policy. In order to realize the advanced function of providing auxiliary decision for land planning department depends on the establishment and application of planning model (Zhang, Xunhu., 2014). On the basis of selecting the appropriate planning model, the purpose of realizing the decision analysis system function should be achieved by establishing a clear demand target analysis, a reasonable system structure design and the definition of the module function (Wang, Y., & Zhang, Bei., 2015). Through the use of Geographic Information System (GIS), data can be analyzed and simulated to predict the impact and effect of land policies. Furthermore, GIS can aid in the development of land use planning and management techniques, optimize the structure of land usage, and enhance the efficiency of its use.

3.4 Land Visualization and Communication

Finally, Geographic Information Systems (GIS) play a crucial function in presenting and communicating land-related information, effectively disseminating it. By employing GIS visualization technology, land data can be depicted vividly using different visual aids, such as maps and charts, ensuring policymakers, decision-makers, and the public comprehend it intuitively. This promotes enhanced comprehension and active engagement in land policy and planning, facilitating public involvement, constructive discourse, and ultimately resulting in rational, transparent, and sustainable land decision-making processes.

To summarize, GIS is an essential player in land policy and planning within the sphere of rural rejuvenation. The uses of GIS technology span from gathering and merging data, to assessing and scrutinizing land, furnishing decision-making support for policy design and execution, as well as illustrating and conveying information about

territorial aspects. The rural revitalization strategy can be executed expediently with greater scientific exactness and productivity by leveraging the potential of GIS technology.

4. Technical Process and Principle of GIS Application in Rural Land Policy and Planning Strategy

4.1 The GIS Application Technology Process of Rural Land Policy and Planning Strategy

The technical process of GIS application for rural revitalization land policy and planning strategy is shown in Figure 2. Figure 3 shows the rural land policy and planning and utilization system. Below are its detailed processes, including the specific operation and tool use of each step:

detailed procedures:

A. Collect data on land policy and planning strategies:

-Find land policy documents, planning strategy reports, etc., on government websites, the websites of relevant departments or research institutions.

-Related data sources can also include statistical yearbooks, questionnaires, remote sensing images, and geographic data services.

B. Organize and clean the data:

-Organize and clean the collected data, such as removing duplicates, processing missing values, correcting formatting errors, etc.

-Data sorting and cleaning can be done using spreadsheet software (such as Excel).

C. Establish a spatial database:

-Create spatial databases using GIS software (e. g., ArcGIS, QGIS).

-Import the collated data to create the corresponding geographic element layers and attribute tables based on the data type.

-Set up attribute fields for each element to record relevant attribute information, such as plot area, land use type, etc.

D. Perform the spatial analysis:

-Use GIS software to select geographic elements within a specific region.

-Perform the spatial statistical analysis, such as calculating the number of plots, area statistics, distribution density, etc.

-Perform buffer analysis, create different radius buffer zones according to specific requirements, and study their influence range.

-Conduct superposition analysis and stack multiple layers to obtain the spatial relationship and intersection between different elements.

E. Conduct model building:

-Select the appropriate GIS model tools and methods according to the land policy and planning strategy requirements for rural revitalization.

-Set the model parameters, such as the transition probability matrix in the land use change model, the landscape index weights, etc.

-Run the model, generate the model output results according to the input data, such as future land use change prediction, ecological environment assessment results, etc.

F. Generate the analysis results and the model output:

-Collates and compiles the analysis results and model output data based on the results of spatial analysis and model construction.

-Make statistical reports, record the data analysis process, model parameter results and related output data.

-Generate the spatial distribution map, heat map, statistical chart, etc., and show the analysis results visually.

G. Making of visual maps and reports:

-Use the GIS software for data visualization processing, and select the appropriate rendering method and symbol style.

-Design the map layout according to the requirements, adding the title, legend, scale and other map elements.
 -Make thematic maps to highlight the spatial distribution and characteristics of elements related to rural revitalization.
 -Prepare special reports, present the analysis results and model output in a clear manner, and provide interpretation and suggestions.

Of course, the specific technical process may vary according to the project requirements, the data complexity, and the GIS software used. In practical applications, data quality control, accuracy verification, model calibration and other work may also be needed. Each step needs to be carefully designed and operated, and implemented in combination with specific tools and methods.

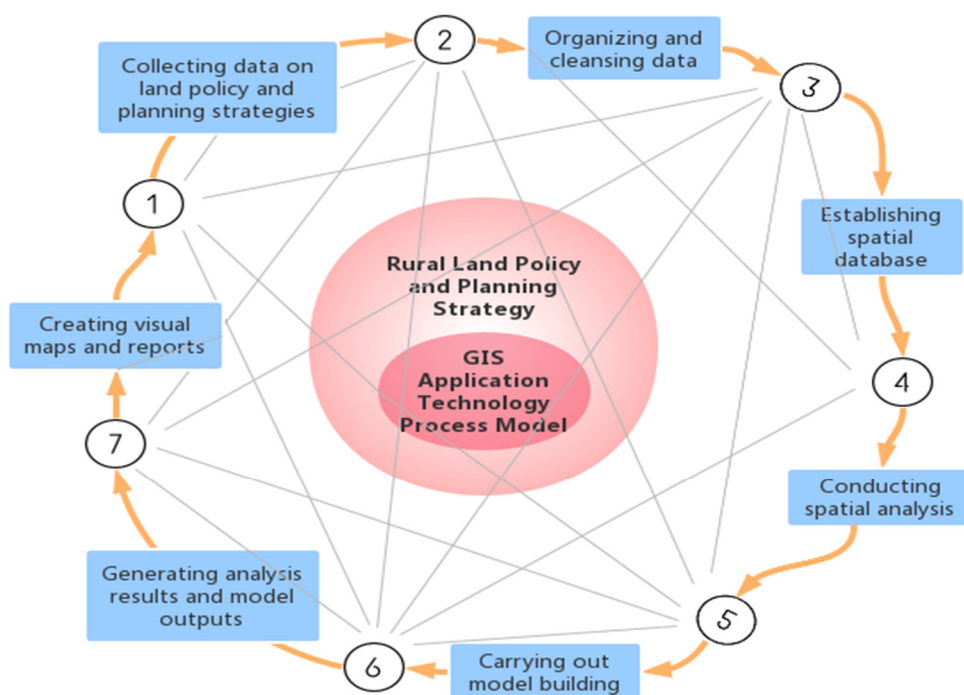


Figure 2. Technical process model of GIS application for rural revitalization

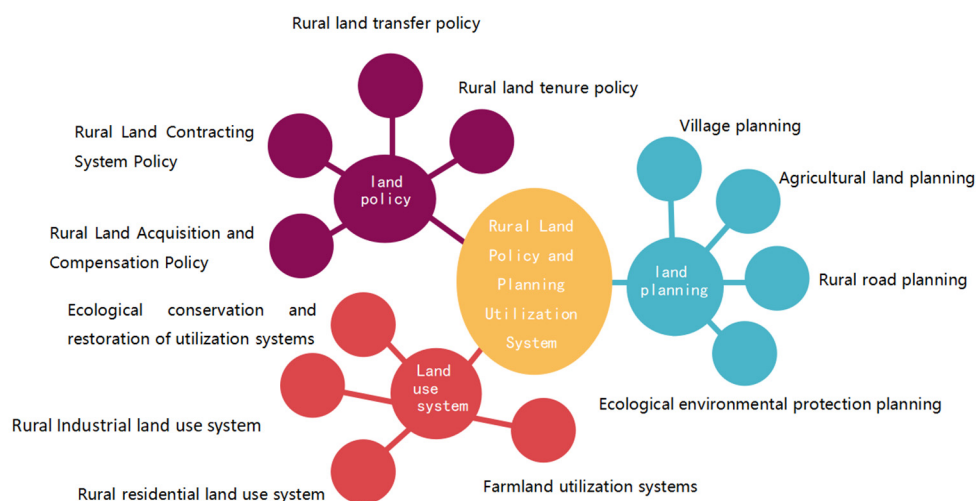


Figure 3. Rural land policy and planning utilization system

4.2 Principles of Rural Land Planning

(1) Sustainability principles: Rural land planning should pay attention to the protection and restoration of ecological environment, including the protection of water and soil resources, forests, wetlands, wildlife and plants, while encouraging sustainable agricultural production and rural economic development. This principle emphasizes the balancing of economic, social and environmental interests in land use and development programs.

(2) Comprehensive principles: Rural land planning needs to consider many factors, including land use, transportation, housing, infrastructure, cultural heritage protection, etc. Planning should bring these factors together and develop in coordination to achieve comprehensive and sustained rural progress.

(3) Principle of suitability: Rural land planning should determine the appropriate land use according to the characteristics and specific needs of land resources. For example, farmland should be used for grain cultivation, orchard construction or animal husbandry development, and rural development and traditional industries should be combined with them to maximize resource advantages.

(4) Principles of protection: Rural land planning should pay attention to the protection of farmland, water resources, ecological environment and other important rural resources. This includes avoiding over-development of farmland land, rationally planning water source protection areas, and retaining natural wetlands and forests. At the same time, the planning should encourage the conservation of land use and improve the efficiency of land use.

(5) Principle of social equity: Rural land planning should pay attention to the legitimate rights and interests of farmers, fair distribution of land resources, and improve the development and well-being of rural residents. This includes reasonable delineation of farmers' land use rights and rural residential land, ensuring that farmers enjoy equal opportunities and interests in land use and development.

(6) Health and safety principles: Rural land planning should pay attention to the health and safety of rural residents, and reasonably plan rural residential areas, farmland, transportation network, etc. Factors such as flood control, disaster prevention and traffic safety should be taken into account in the planning to ensure the life safety and quality of life of farmers.

(7) Principles of cultural heritage protection: Rural land planning should pay attention to the protection of rural historical and cultural heritage and traditional characteristics, and develop agricultural and rural tourism with local characteristics. In the planning, preserving traditional buildings, restoring ancient villages, and excavating farming culture can be considered to promote the combination of cultural inheritance and rural development.

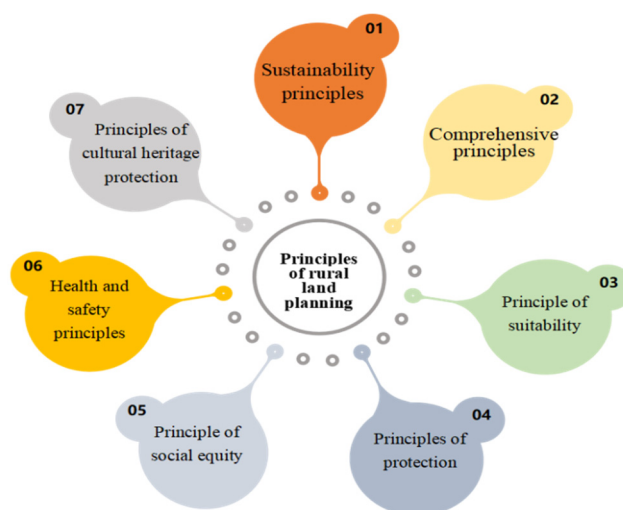


Figure 4. Principles of rural land planning

Figure 4 depicts rural land planning principles. The application and operation of these principles may vary depending on policies and practices in different regions and countries. Rural land planning must consider local features, social and economic requirements, and environmental protection criteria, engage relevant stakeholders throughout the planning process, and undertake scientific assessments and monitoring to ensure plan effectiveness and durability.

5. Specific Application of GIS in Land Policy and Planning for Rural Revitalization

5.1 GIS Support for Rural Functional Zoning

Firstly, rural function zoning represents a vital aspect of rural revitalization. GIS technology can facilitate the comprehensive analysis and assessment of rural regional characteristics. Based on regional superior resources and rural industrial development needs, diverse functional areas must be demarcated while ensuring a rational land use structure. By analyzing data on farmland distribution, natural ecological conditions and population distribution, it is possible to determine the optimal allocation of rural functions, including agricultural production, ecological protection, and leisure tourism zones. This can provide decision makers with a scientific basis for promoting an optimal allocation of resources.

5.2 GIS Optimization of Farmland Protection and Utilization

Secondly, safeguarding and exploiting farmland is a significant aspect of rural reinvigoration. Employing GIS technology allows for detailed examination and real-time monitoring of farmland resources, facilitating a comprehensive assessment and precision management of farmland. By creating a GIS optimization model for the protection and use of farmland, it is possible to analyze the impact of soil quality, water resources, climate conditions, and other factors on farmland use. This analysis can lead to the formulation of rational and scientifically sound policies for protecting farmland.

5.3 GIS Management of the Transfer of Contracted Rural Land Management Rights

The management of Geographic Information Systems (GIS) plays a crucial role in the transfer and management of rural land contracts. It serves as a valuable tool for providing spatial data support, decision assistance, and regulatory oversight. Through the collection and organization of geographic data, GIS enables the creation of detailed maps that accurately delineate and position transferred lands. Additionally, GIS technology facilitates feasibility analysis, planning, and design, offering decision makers a scientific foundation and valuable references for determining the scale, direction, and mode of land circulation.

Moreover, GIS management enables effective monitoring and oversight throughout the land transfer process. By establishing a connected database within the GIS system, dynamic supervision and evaluation of the transfer can be conducted, ensuring the legality and standardization of the process.

In summary, GIS management holds immense potential in the transfer of rural land contracts and management rights. The judicious use of GIS technology allows for precise positioning, decision support, and efficient monitoring and management of land transfers. This, in turn, enhances the efficiency of land resource utilization and promotes a more scientific approach to the transfer process. However, to fully leverage the benefits of GIS management, it is important to address challenges such as data quality and updates, privacy protection, and data security. Strengthening collaboration and cooperation between departments is also essential to promote effective management and sustainable development in the transfer of rural land contracts and management rights.

5.4 GIS-assisted Design of Rural Land Use Planning

In addition, rural land use planning is also one of the important means to promote rural revitalization. With the help of GIS technology, detailed investigation and spatial analysis can be carried out, and rural land use planning scheme can be formulated based on multiple factors such as population, environment and economy. Through GIS-assisted design, the rational distribution and optimal allocation of rural land resources can be realized, the efficiency of land use can be improved, and the sustainable development of rural economy can be promoted. At the same time, GIS can also provide spatial decision support for decision makers to help them to make more scientific and effective land use planning decisions.

In conclusion, GIS has wide application prospects in the land policy and planning for rural revitalization. Through GIS support of rural function zoning, GIS optimization of farmland protection and utilization, GIS management of transfer of rural land contract management rights and GIS assisted design of rural land use planning, scientific management and reasonable allocation of rural land resources can be realized and the smooth implementation of rural revitalization strategy can be promoted.

6. Challenges and Solutions of GIS in Rural Revitalization Land Policy and Planning

6.1 Problems of Data Quality and Update

GIS plays an important role in the process of rural revitalization. However, the field faces several challenges, among which data quality and update are one of the issues affecting the application of GIS in land policy and planning. Due to the relative difficulty of data collection in rural areas, the accuracy and completeness of the

data became the constraints. In order to solve this problem, it is necessary to strengthen the data collection and cleaning work, establish a sound data quality control mechanism, and update the data regularly.

6.2 Talent Retention and Technical Personnel Training and Improvement of Application Ability

The rural population is the principal driver of economic, social, and ecological development in rural areas through the efficient exploitation and utilization of resources, the effective management of businesses, and the facilitation of production and daily living activities. Population is the driving force behind rural revitalization (Long, H., Zhang, Y., & Tu, S., 2019). Some scholars have identified talent incentive mechanisms as the key factor in whether skilled individuals remain in rural areas. Secondly, the revitalization of rural talent is influenced by the development environment, talent training, management, and utilization mechanisms in rural areas (Pu, S., & Sun, W.-Y., 2018). Additionally, policy support and favorable salary packages are significant factors in attracting skilled individuals back to the countryside (Gao Qi., 2018). Therefore, it is essential to implement appropriate talent incentive mechanisms and improve policy support to retain skilled individuals in rural communities, leading to their increased commitment towards rural revitalization.

The development of technically skilled individuals and enhancing their application abilities is also a pressing issue that requires attention. As there is a shortage of human resources in rural areas, the limited presence of professional GIS experts hinders its application in land policy and planning. To address this issue, a number of actions must be taken. Firstly, the education and training of relevant professionals must be strengthened to produce more qualified GIS experts. Secondly, it is necessary to encourage the collaboration between universities, research institutions, and rural areas to promote the implementation of GIS technology in rural regeneration. Moreover, raising the profile and awareness of GIS technology in rural communities should be a priority through enhanced publicity and promotional efforts.

6.3 Cooperation and Information Sharing of the Participants

Furthermore, the collaboration and sharing of information among participants pose a significant challenge. The success of rural revitalization relies on the cooperation of multiple departments and stakeholders. However, the presence of information silos between different departments hinders effective information sharing. To address this issue, it is imperative to enhance communication and collaboration among various departments and establish a platform and mechanism for information exchange. Additionally, it is encouraged for all departments to integrate their data into the GIS system, enabling unified management and data sharing. This integration enhances the accuracy and efficiency of decision-making processes.

6.4 Privacy Protections and Data Security

Finally, privacy protection and data security are an issue that cannot be ignored. A large amount of personal and sensitive information is involved in GIS systems, so attention must be paid to privacy protection and data security. In order to solve this problem, it is necessary to focus on establishing a sound data privacy protection mechanism and strengthening the permission management and access control of data. At the same time, strengthen the cultivation of information security awareness and improve the importance of data security in rural areas.

To sum up, solving the challenges of GIS in rural revitalization land policy and planning requires multi-party cooperation and efforts. Strengthening data quality and update, the cultivation of technical personnel and application ability, the cooperation and information sharing of participants, privacy protection and data security are the key factors to achieve the goal of rural revitalization. By adopting corresponding solutions, the application of GIS will provide strong support for rural revitalization.

7. Conclusions and Prospects

7.1 Summary of the Main Study Findings

This study delves into the application of GIS in land policy and planning strategies for rural revitalization and draws the following conclusions:

(1) GIS technology has wide application potential in land policy and planning for rural revitalization. Through the spatial analysis and data integration capability of GIS technology, accurate and comprehensive land use information can be provided, which provides an important basis for decision makers to formulate scientific land policy and planning.

(2) In terms of land policy formulation, GIS can help government departments and decision makers better understand the distribution of land resources, environmental impacts and social needs, so as to formulate feasible policy solutions in line with the rural revitalization strategy. Through the auxiliary analysis and simulation of

GIS, the effects of different policy options can be assessed, and decision support can be provided for the government to formulate scientific land policies.

(3) In land planning, the application of GIS technology can provide accurate assessment of the current land use situation and potential, and help planners design a reasonable land use layout. Through the spatial analysis and optimization algorithms of GIS, the optimal land use scheme can be found to improve the comprehensive utilization of land resources and to promote the sustainable development of rural areas.

7.2 Outlook on the Application Prospect of GIS in Land Policy and Planning for Rural Revitalization

Looking into the future, we believe that GIS still has broad application prospects in the land policy and planning of rural revitalization. With the improvement of data collection technology and the establishment of data sharing mechanisms, GIS will provide more reliable support for land policy development and planning. By strengthening cooperation and information sharing among participants, GIS will provide more decision support and intelligent services for rural revitalization. On the premise of ensuring privacy and data security, the application of GIS in rural revitalization will be more robust and sustainable.

7.3 Study Limitations and Future Directions of Research

7.3.1 Limitations

(1) Limitations of data acquisition and processing: due to the difficulty in acquiring and updating land use data, it may have an impact on the accuracy of the research results.

(2) Limitations of technical and human resources: the application of GIS technology requires specialized knowledge and skills. Therefore, the limitation of human resources may affect the wide promotion and popularization of the application.

7.3.2 Further Research Directions

(1) in-depth research on the application of GIS in land policy and planning strategy in rural revitalization, exploring more application cases and experiences, and providing more specific and practical guidance for decision makers.

(2) to further develop and improve the application methods and models of GIS technology in rural revitalization, to improve the precision and stability of spatial data, and to enhance the reliability and accuracy of decision-making support. Among them, the development direction of GIS standardization has a very positive practical significance, which can greatly improve the quality and efficiency of related work (WANG Chuang., 2010).

(3) strengthen the integration and application of GIS technology with other related technologies (e.g. remote sensing technology, big data analysis, etc.) to improve the overall effect of land policy and planning in rural revitalization.

7.3.3 Theoretical and Practical Implications

(1) Theoretical Implications: This study provides theoretical guidance and scientific basis for land policy and planning in rural revitalization, expands the application scope of GIS in rural areas, and enriches the theoretical system of related research fields.

(2) Practical significance: The conclusions of this study can provide reference for government departments and decision makers to formulate rural revitalization policies and plans, promote sustainable development and optimize land resource utilization in rural areas, and achieve rural economic growth and social integration.

In conclusion, the application of GIS in land policy and planning in rural revitalization is of great significance. Further research can improve the effectiveness and accuracy of the application and provide more specific and practical guidance for decision makers to promote the implementation of rural revitalization strategies. However, there is a need to overcome the limitations of data access and technical human resources and to continuously improve the application methods and models in order to achieve sustainable development and optimize land use in rural areas.

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