Research on GIS application for comprehensive land management of the whole area --The example of Xinzhou Jiu Street's comprehensive territorial development[1]

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Abstract. The comprehensive land reclamation of the whole area is a systemic project to improve the production, living conditions and ecological environment of rural areas, promote large-scale agricultural operations, concentrated population living and industrial development, and promote the process of urban-rural integration. In addition to strictly following the technical specifications or standards set by the state, its preparation should also take into account the characteristics of the regional resource base and the control requirements of territorial spatial planning, and then carry out overall measures such as agricultural land, construction land consolidation and rural ecological protection and restoration, etc. To achieve this goal, it is necessary to make full use of the GIS platform. In this paper, we analyse the specific application scenarios and issues that should be noted in the comprehensive land improvement work of the whole area of GIS system.

Keywords: GIS technology, Integrated Territorial Land Management, Territorial Spatial Planning, Village Planning

1 Comprehensive overview

1.1 Development background

In December 2019, the Ministry of Natural Resources issued the Notice on the Launching of Comprehensive Land Reclamation Pilot Work in the Whole Area, proposing the deployment of pilot comprehensive land space reclamation projects across the country. in June 2020, the Ministry of Natural Resources issued the Implementation Points of Comprehensive Land Reclamation Pilot in the Whole Area, which clarifies the requirements around the protection of arable land and permanent basic farmland, the review of reclamation content, and other aspects of In April 2021, the De-

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partment of Ecological Restoration of Land Spaces issued the Outline for the Preparation of the Implementation Plan for the Comprehensive Land Reclamation Pilot Project to guide the preparation of the implementation plan. "The 14th Five-Year Plan has made the "Standardization of comprehensive land remediation in the whole area" a key element in the implementation of the rural construction initiative..

1.2 Concept interpretation

The comprehensive improvement of the whole area of land is in line with the premise of land spatial planning, the land in a certain area for the whole area of planning, overall design, comprehensive measures for the fields, water, roads, forests, villages and mines to carry out all elements of improvement, ecological protection and restoration of mountains, water, forests, fields, lakes and grass, the overall promotion of agricultural land consolidation, construction land consolidation and rural ecological protection and restoration, optimize the production, living and ecological spatial pattern, promote the protection of arable land and the economical and intensive use of land activities.

GIS, known as Geographic Information System, combines geography and cartography with remote sensing and computer science, and is a computer system for inputting, storing, querying, analyzing and displaying geographic data; GIS technology allows for the analysis and processing of spatial information, integrating the unique visualization effect of maps and geographical analysis functions with general database operations. The technology can analyse and integrate a wide range of data, and has strong data management functions. Applying it to the comprehensive management of the whole territory can improve the efficiency and quality of remediation and management[1].

2 Preparation Meaning and principles

2.1 Significance of preparation

(1) Strictly adhere to the red line of arable land to ensure food security

China's basic national condition is that there is little arable land per ca-pita, the quality of arable land is generally not high, and there are not enough arable land reserves. Arable land is the lifeblood of food production, and it is of great significance to protect arable land resources and adhere to the red line for arable land.The comprehensive rectification of the entire land area is an important means of optimism the layout of permanent basic farmland and an important initiative to strengthen the constructive protection of arable land. On the premise of protecting the ecological environment and idyllic scenery, comprehensive improvement of various types of agricultural land and idle construction land sites is carried out, and the comprehensive improvement of arable land, development of inefficient garden land, residual forest land, idle house bases and abandoned industrial and mining land is co-originated to optimism the layout of arable land, increase the area of arable land and improve the quali-

ty of arable land on the basis of which arable land is concentrated and contiguous, so as to create conditions for large-scale agricultural operations and modernized agriculture. Create conditions to lay a solid foundation for increased food production and income.

(2) Optimism spatial layout and improving land use efficiency

Through the systematic improvement of "mountains, water, forests, fields, lakes and grasses", we will co-ordinate and promote the consolidation of inefficient forests, grasslands and gardens, the consolidation of rural residential bases, abandoned industrial and mining lands and other inefficient and unused construction lands, combine the needs of township construction and industrial projects, and improve the degree of contiguity of fields in townships in accordance with the requirements for the adjustment and optimization of production, living and ecological spaces. In addition to the transformation of low-yielding fields, soil improvement, stripping and utilization of the cultivation layer, the construction and reclamation of rural residential bases, abandoned industrial and mining land and other inefficient and unused construction land, the construction of townships is organically combined with the construction of townships; the comprehensive management of river, lake and bank watersheds, the construction of soil pollution and erosion prevention projects are organically combined with the construction of township landscapes and greening.

(3) Assisting in the revitalization of the countryside and achieving prosperity in life

The implementation of comprehensive improvement of the entire land area is an important means to help revitalize the development of the countryside. Through the implementation of comprehensive territorial improvement, production, living and ecological space will be optimized to realize the concentration of residents, industrial clustering, land intensification and ecological livability in rural areas, improve rural infrastructure and public services and perfect the improvement of the human living environment in rural areas, laying a solid foundation for realizing the rural revitalization strategy, integrated urban-rural development and affluent living[2].

2.2 Implementation principles

(1) Ecological priority, green development

The implementation of comprehensive land improvement in the whole area should take the revitalization of the countryside as the general goal, take industrial revitalization as the core, actively practice the concept that green water and green mountains are the silver mountain of gold, follow the requirements of not expanding the scale of construction land, increasing the area of arable land, improving the quality of arable land and not breaking the ecological red line, give priority to ecological protection and restoration, effectively strengthen the protection of arable land, especially permanent basic farmland, and consolidate the security of food production and The foundation of agricultural and rural development. At the same time, it will improve the ecological environment of the countryside, effectively protect the historical and cultural resources and natural texture of villages, highlight the characteristics of agricultural resources and folk customs, and deeply explore local folk culture to form a beautiful

countryside with local characteristics, in conjunction with the improvement of the rural habitat.

(2) Planning-led and comprehensive management

Adhere to planning first, integrate multiple regulations, and strengthen the spatial use control of land. Under the leadership of territorial spatial planning and village planning, comprehensive planning, overall design, integrated management and multiple measures will be carried out, and comprehensive remediation means with "integrated connotation, integrated objectives, integrated means and integrated benefits" will be used for remediation. The integrated planning of agricultural land, inefficient construction land and ecological protection and restoration promotes the protection of arable land and the intensive and economical use of land, addresses the integration of land for the development of one, two and three industries, and improves the rural ecological environment.

(3) To promote in an orderly manner according to local conditions

According to the township's resource advantages and development reality, in accordance with the principle of "farming as appropriate, building as appropriate, retaining as appropriate, and consolidating as appropriate", the comprehensive rectification of agricultural land, inefficient and unused land and village construction land rectification, rural habitat environment rectification, pond, river and lake shoreline pollution control and ecological protection and restoration, etc., will be carried out in an orderly manner to promote the fragmentation of rural arable land, disorderly spatial layout, inefficient use of resources, miscellaneous habitat environment and ecological quality degradation, so as to ensure the effectiveness of the comprehensive rectification.

3 Specific application of GIS technology

The comprehensive land remediation of the whole area involves spatial calculation, information collection, data analysis and management, and the overall difficulty of land remediation is large. The application of GIS technology to the comprehensive land remediation project can spatially locate the land, grasp the new geographical information of the area, and effectively improve the quality of land remediation. Based on this, this paper investigates the application of GIS technology in comprehensive land remediation projects in the context of the practical work of the "comprehensive land remediation of the whole area in the Jiu street of Xinzhou District, Wuhan".

3.1 Analysis of current land resources

Before carrying out the comprehensive improvement of the whole area of land, the first step is to carry out an inventory of the current state of land resources, mainly from the three categories of agricultural land, construction land and ecological land, mainly using the data from the Third National Land Survey (hereinafter referred to as "three surveys") and the annual change data, these land data can be very convenient to read and analyze statistics through the GIS platform[3].

3.1.1 Analysis of the current situation of agricultural land.

Agricultural land refers to land directly used for agricultural production, including arable land, garden land, forest land, grassland and land for agricultural facilities and construction, with emphasis on the quality, scale and distribution of resources of each subdivision of the current arable land: paddy land, watered land and dry land. Taking the data from the three surveys of the Jiu Street in Xinzhou District, Wuhan City as an example (Tables 1, 2 and 3 below), the GIS operating system can be used to read and analyse the characteristics of the attributes of various types of agricultural land in conjunction with the needs of comprehensive improvement.

Table 1. Analysis of arable land quality classes

	Arable land class				
Land use category	**3**	**4**	**5**	Total (ha)	Percentage
Paddy	0.3	94.7	2190	2285	53%
Watered land	0.4	169.5	1620	1789.9	41%
Dry land	0.1	19.9	224.2	244.2	6%
Total	0.8	284.1	4034.2	4319.1	100%

Table 2. Analysis of slope levels of arable land

	slope levels of arable land					
Land use category	1	2	3	4	Total (ha)	Percentage
Paddy	1863.1	387.6	33.8	0.5	2285	53%
Watered land	1224.6	439.7	118.7	6.9	1789.9	41%
Dry land	45	132	63.9	3.3	244.2	6%
Total	3132.7	959.3	216.4	10.7	4319.1	100%

Table 3. Analysis of the current Garden composition

Garden Land type composition	Base period year	
	Area (ha)	Percentage
Tea plantations	454.58	66.50%
Orchard	36.25	5.30%
Other gardens	192.7	28.19%
Total	683.53	100%

3.1.2 Analysis of the current state of ecological land use.

Ecological land is a type of land use other than productive land and load-bearing land, which is mainly used to provide ecological services such as ecological products, environmental regulation and biological conservation, and plays an important role in maintaining regional ecological balance and sustainable development. The statistics focus on the distribution of resources of forest land, grassland, wetlands and terrestrial waters. Taking the data from the three surveys of the Jiu Street in Xinzhou District of Wuhan City as an example (Tables 4, 5，6 and 7 below), the GIS operating system

can be used to read statistics and analyse data on the attribute characteristics of various types of ecological land in conjunction with the needs of comprehensive improvement.

Table 4. Analysis of current Woodland composition

Forest Land Class Composition	Base period year	
	Area (ha)	Percentage
Tree woodland	2483.63	74.20%
Shrub land	107.61	3.21%
Bamboo woodland	20.66	0.62%
Other woodland	735.45	21.97%
Total	3347.35	100%

Table 5. Analysis of current Grassland composition

Grass Land Class Composition	Base period year	
	Area (ha)	Percentage
Other Grassland	25.47	100.00%
Total	25.47	100%

Table 6. Analysis of current Wetland composition

Wetland land type composition	Base period year	
	Area (ha)	Percentage
Inland mudflats	230.23	100.00%
Total	230.23	100%

Table 7. Analysis of current Terrestrial waters composition

Terrestrial waters land class composition	Base period year	
	Area (ha)	Percentage
Ditches	81.06	6.50%
River water surface	154.81	12.41%
Reservoir surface	112.31	9.00%
Pond surface	899.69	72.10%
Total	1247.87	100%

3.1.3 Analysis of the current situation of the construction site.

Construction land, the land on which buildings and structures are built, is land for urban and rural housing and public facilities, industrial and mining land, land for energy, transport, water conservancy, communications and other infrastructure, tourism land, military land, etc., paying a certain amount of investment, through engineering means, to provide land for various constructions. It is land that uses the carrying capacity or building space of the land and does not have the main purpose of obtaining

biological products. The statistics focus on the current situation of the use of urban and rural residential land, especially the distribution of idle and abandoned rural residential land, taking the data from the three surveys of the Jiu Street as an example (Tables 8 below), and the GIS operating system can be combined with the needs of comprehensive improvement to read statistics and data analysis on the characteristics of the attributes of various types of construction land.

Table 8. Analysis of the composition of the current building site

Land use composition of building sites	Base period year	
	Area (ha)	Percentage
Residential land use	1026.49	65.73%
Public Administration and Public Services	55.17	3.53%
Commercial Services	7.88	0.50%
Utilities	86.32	5.53%
Green space and open space	4.36	0.28%
Transportation land	226.92	14.53%
Warehouse land	1.71	0.11%
Industrial and mining land	112.11	7.18%
specially-designated land	40.68	2.60%
Total	1561.64	100%

3.2 Analysis of the control of territorial spatial planning

The whole area of land comprehensive improvement must be carried out in accordance with the township land space planning, where the control elements are mainly three zones and three lines, specifically including the control of agricultural space, ecological space and construction space, where the control of agricultural space is mainly the control of permanent basic farmland, ecological space control is mainly the control of ecological protection red line, and the control of construction space is mainly the control of urban development boundary.Take the Xinzhou Jiu Street Territorial Spatial Plan as an example, the area of permanent basic farmland protection for the whole street is 4296.60 hectares, and the ecological protection red line area is 1331.34 hectares.In the process of comprehensive land improvement in the whole area, the land within the ecological protection red line cannot be adjusted, but only ecological protection and restoration and environmental improvement can be carried out, while the total amount of permanent basic farmland should not be reduced and the quality should be improved.

3.3 Analysis of GIS application in the process of rectification and implementation

After completing the inventory of the current land resources, taking the township land spatial planning and village planning as the leader, and combining the development demands of the local government, enterprises and villagers in the township, when

starting to implement the comprehensive land remediation of the whole area, the use of GIS technology can assist land managers in the management of the remediation area, the calculation of the amount of land leveling works and the establishment of a more complete investment recovery cost mechanism; at the same time, it can also conveniently produce GIS technology can be used to assist land managers in managing the remediation area, calculating the amount of land leveling works and establishing a more comprehensive investment recovery cost mechanism. Specifically, GIS technology can be applied in the following three areas to implement comprehensive land remediation and management, which can effectively increase the ecological, social and economic benefits of land.

3.3.1 Comprehensive agricultural land management projects.

The main purpose of comprehensive agricultural land management is to effectively improve crop yields, field cultivation and the use of agricultural mechanization, which requires land leveling. The principle of balanced dredging and filling of the land is strictly adhered to when carrying out land leveling. In the calculation of land leveling volume, GIS technology can be applied, which can measure the elevation information in the topographic map of the land to which it belongs, calculate the earth area of the management area by simulating the ground condition of the area, calculate the leveling unit value according to the elevation value in the design, and finally the specific dredging and filling volume can be calculated, and the accuracy and precision of the calculation of the earth leveling volume will be improved[4].

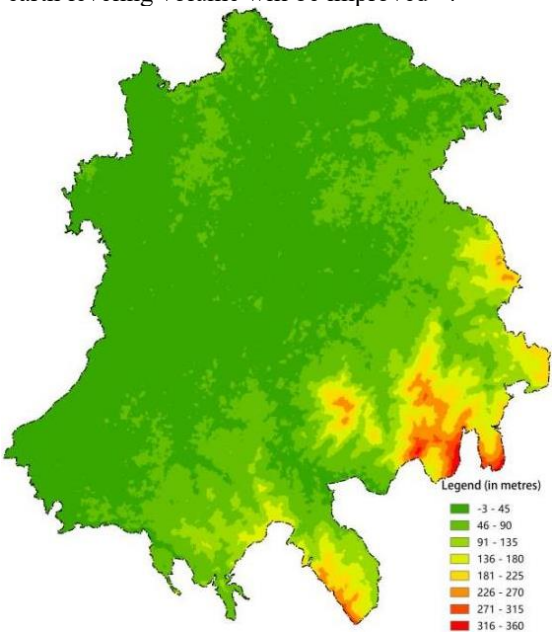

Fig. 1. Elevation distribution map of the whole area of Jiu Street

3.3.2 Ecological restoration and environmental remediation projects.

In the planning and design phase of the project in Jiu Street, ArcGIS software was used to interpret the 8 cm resolution DOM to determine the current status of the site and the works to be carried out on the site. Due to the complex topography of a hilly mountainous area such as Jiu Street, it is not easy to use traditional topographic maps to gain an intuitive overall understanding of the project area, and the use of the OSGB tilt photography 3D model can provide a more intuitive understanding of the elevation of the project area, which is an important reference for the placement of reservoirs, rock weirs and other projects(As shown in Figure 1 on the right). In the actual remediation process, through the GIS operation platform, for the project area with complex topography, it is possible to first combine high-definition images during the inland review to find out the suspected parcels of land in the project area, and focus on checking the suspected parcels of land during the site survey, which greatly improves the work efficiency[5].

4 Conclusion

The comprehensive land reclamation of the whole area is a systemic project to improve the production, living conditions and ecological environment of rural areas, promote large-scale agricultural operations, concentrated population living and industrial development, and promote the process of urban-rural integration. In the author's view, GIS technology should be fully utilized in the implementation process of comprehensive land improvement projects across the region to ensure the effectiveness of land improvement projects at all stages of planning, implementation and supervision, and to enhance the effectiveness of comprehensive land improvement construction and land management.

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