Construction and Application of Field Investigation Support Platform for Land Spatial Planning Based on GeoServer

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Construction and Application of Field Investigation Support Platform for Land Spatial Planning Based on GeoServer

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Abstract. Basic data and satellite images, such as topography, soil, cover type, social economy and so on, are very important for planning, and many of the data are scattered among multiple Internet resources and researchers. At present, geographic information system and Internet technology are developing rapidly. Many institutions have published a large number of thematic maps related to resources and environment on the Internet, and can realize the aggregation of these Internet maps in GIS software through WMF, WMTS and other protocols. Relying on the rapid development of cloud virtual server in recent years, the technology and economic feasibility of deploying WebGIS server to distribute proprietary data thematic map are greatly improved. With the help of cloud server, this paper constructed WebGIS service with the assistance of GeoServer and published thematic map information on OpenLayers as the client, so as to provide basic information related to natural environment and social economy for territorial space planning.

1. Introduction
From the development of network and computer technology in the 1990s, a geographic information system deployed on the Internet has emerged, which is WebGIS. WebGIS is a decentralized geographic information network service, with good interoperability to achieve the previous need for a large amount of data to achieve the function [1]. The Open Geographic Information Systems Association (OGC) then defined a consistent understanding of geographic information representation, discovery, access and processing at different levels, forming the basis for OpenGIS norms [2] of the OpenGIS specifications, the three most important implementation specifications for geographic information services are network map services (WMS), network element services (WFS) and network coverage services (WCS) [3].

With the rapid development of GIS and Internet technology, many agencies have published a large number of thematic maps related to resources and environment on the Internet. A preliminary analysis shows that thematic map information that is already common on the Internet includes high-resolution DEM, high-resolution satellite imagery, global soil coverage, land use and land cover databases. Most of these data resources can achieve information aggregation through WMF/WMTS and other ways, and some resources can be downloaded and released free of charge. At the international level, OpenGIS played an active role in sustainable urban planning [4, 5]. New requirements were put forward for the construction of the “five-level, three-level, four-system” land and space planning during the period 2020-2035 [6]. As a result, relying on the rapid development of cloud virtual server in recent years, the technical and economic feasibility of publishing own data thematic map by
deploying WebGIS server has been greatly improved, which can provide a rapid solution for the collection and analysis of basic data for land and space planning.

2. Systems Architecture Design
This article is based on the GeoServer server under the OpenGIS specification, can return to the loaded appropriate map according to the user request, develop the language for the system with the Java and realize the map loading function with the OpenLayers as the client. The main structure of the system is shown in the following figure 1.

![Figure 1. The overall structure of the system.](image)

The sections are structured as follows:

- Cloud server: a server configured without the need to purchase hardware, which is the basic system supporting a range of components, such as GIS server systems, geospatial databases and data encryption services.
- WebGIS server: a platform for GeoServer servers to classify, upload, publish and preview geospatial data after configuring Java and Tomcat on the cloud server side. Support vector data, raster data upload, and support through the WMS/WMTS implementation of remote website map hanging service.
- Data encryption system: according to the requirements of the relevant national security level protection, the construction of security guarantee system ensures the physical security, network security, data security, application security, access security during the operation of the system [7].
- Web browser: used as a client to connect WebGIS, running on a Web server that can invoke map data published by the WebGIS server [8]. At the same time, the migration to the mobile side is carried out, using the mobile side APP to provide a convenient, comprehensive and credible auxiliary platform tool for land science researchers to query geographic information.

3. Data Sources
Data bases are divided into two categories: natural data and socio-economic data. Data types of natural data and socio-economic data are divided into raster data and vector data. Natural data include DEM elevation, hydrology, annual average precipitation, vegetation type, soil type, terrain and geomorphology type throughout the country. Socio-economic data include data on major crop types, cropping systems, administrative divisions, highways, national highways, provincial roads, township village roads and railways. Basic coverage of data types required for territorial and spatial planning and field surveys [9].

4. Design of Functional Modules
The system has the following functions.

4.1. Data Storage and Update
At present, agriculture, forestry, natural resources management, urban construction, transportation and
other departments have accumulated massive data and documents needed for land and space planning, and present the characteristics of diversification (paper, pictures, Auto CAD, Shape documents), so it is urgent to use modern information means to manage these data [10]. Use up-to-date information on land, minerals, tourism, geology, environmental protection, government daily work, etc. [11] to keep the data current by updating it in real time [12]. The structure of data source is shown in figure 2.

![Data sources for the system.](image)

**Figure 2.** Data sources for the system.

4.2. *Layer Overlay Function*

Through layer overlay operation, multiple layers can be displayed simultaneously in the map interface with different transparency. The replacement function can replace the sequence of layers to achieve the effect of replacing the base map.

4.3. *Basic Map Functions*

Enlarge, shrink and locate the base map on the client side [13].

4.4. *Thematic Analysis Function*

Many map data seem to be complete but need a complex process of analysis and processing, can choose the corresponding fields, select a single element classification, grading display, play a role in highlighting a certain element on the map. Consistent with the desktop GIS, WebGIS also provides analysis services for map elements, including map scaling, positioning, distance measurement, and map data analysis processing capabilities. With the help of relevant commercial plug-ins, a series of visual static and dynamic display of data can be realized.

5. *Application Cases*

5.1. *Auxiliary Field Environmental Analysis*

By using the map published by the WebGIS server, we can analyze the topography and land use of a certain area. Figure 3 is the image generated after superimposed on DEM and land use type map.

![DEM, map generated by overlaying land use type maps.](image)

**Figure 3.** DEM, map generated by overlaying land use type maps.
5.2. Supporting Planning Decisions
At present, the management of natural resources is mostly interpreted at the macro level, and the practice of systematic application is less [14]. Therefore, based on practical cases, this paper introduces the practicability of the platform from the aspect of township land and space planning. The spatial planning of township land is an important part of constructing the spatial planning system of hierarchical sub-regional land, and it is an important link to establish and perfect the spatial planning system of urban and rural integration [15]. The territorial and spatial planning of villages and towns includes the whole-area planning of villages and the special planning for the protection and restoration of ecological, water and farmland systems. During the planning process, a series of planning work can be simplified and efficient by means of WebGIS.

Township land and space planning requirements combined with population scale, construction land scale, construction scale, ecological red line, permanent basic farmland and other restrictive indicators, according to the "two districts and three lines" principle, and the implementation of strategic white land requirements.

At the desktop GIS system, this requires a large amount of data support, occupied space and data types are too large to organize. In the planning results-based management process, both paper and electronic data are required to be submitted, uploaded to the planning results information base, and a series of reviews, including two districts and three lines, are conducted. The review process uses WebGIS, to compare project results with the underlying data released by the WebGIS, avoiding missing data and reducing workload.

5.3. Village Planning Land Check
Guidelines for Village Planning in Beijing issued by the Beijing Municipal Planning and Natural Resources Commission [16]. It is necessary to form the data of land use status and check the existing land use data according to the data of land use status. The specific work idea is to check and compare the existing land use change data with satellite remote sensing image and topographic map, and verify it by field survey.

Satellite remote sensing image data as the base map, uploaded to the WebGIS server and released. At the time of planning, the satellite remote sensing images released GIS the desktop are taken as the base map, compared with the land use change survey data and marked the parts of the difference. After field investigation and verification, the land use change survey map is modified according to the verification results, and the land use status map is obtained. Figures 4 and 5 are the comparison between the land-use change chart and land-use type chart of the same plot.

**Figure 4.** Survey of land use changes in A villages in 2016.

**Figure 5.** A village land use status chart.

After comparing the survey map of land use change in A village with satellite remote sensing image, it was found that there were buildings in the area of basic farmland, and after on-site verification, it was found that a public toilet had been built in the area of basic farmland with an area of 79 square meters. Obviously, the building is not in line with the plan and will be specially marked for inclusion in the late demolition list. Figure 6 shows the change points found in the field through changes.
Figure 6. Land use change survey and satellite remote sensing image comparison.

6. Conclusion
With the progress of remote sensing technology, the data specification of map data is expanding, the difficulty of data storage and the requirement of computer performance are becoming higher and higher [17]. With the development of land and space planning at all levels, the demand for multi-source data acquisition and analysis is becoming more and more urgent. With the progress of WebGIS technology and its popularization and application, the operation of classifying and aggregating Internet big data and its own data with the help of GeoServer server has the advantages of fast, light and multi-function, which can provide a quick solution for the basic data acquisition and analysis of grass-roots land and space planning.

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