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Article

Design and Implementation of an Environmental Planning Analysis Platform based on the "Three Lines One Permit"

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Abstract: Currently, an interactive environmental planning analysis system platform based on " Three Lines One Permit " (TLOP) is being developed to support environmental planning, construction project approval, and the application of TLOP outcome data in Guangzhou. The main objective is to provide governments, businesses and the public with environmental planning analysis tools to determine the site of construction projects. The platform is using the system architecture of the browser and server. Its core functions are interactive environmental planning analysis tool for construction project and the results display tool supporting map viewing. It provides users with a large number of detailed geospatial data and TLOP results data access and environmental planning analysis functions. This article describes the system architecture and implementation of the system platform and has a case study illustrating the system functionality. At present, the platform has been deployed and trial-operated. The content of the analysis framework is constantly expanding. This promotes the matching of environmental planning and analysis with local conditions. This will implement the application of TLOP and improve the efficiency of project construction and the level of ecological environment planning and management.

Keywords: Three Lines One Permit; web-based interactive analysis; online environmental planning analysis platform; EIA approval; Web-GIS; geospatial data; Guangzhou

1. Introduction

Various environmental problems, such as resource scarcity, energy crisis, environmental pollution and climate change, remain key constraints and challenges affecting the sustainable development of the world[1-2]. Especially in today's complex international context, these crises are particularly prominent. For many developing countries, including China, how to coordinate the solution of ecological degradation, environmental and spiritual pollution and resource overexploitation is an influential topic in the context of economic and social development[3-5]. The intersection and interaction of various basic environmental issues increase the complexity and difficulty of problem solving. Environmental regulations [6], environmental protection planning assessment[7-8] and environmental function zoning[9-10] and other methods have played a significant effect, but there are still many problems remain, such as complicated cross-media pollution control [11], difficult to implement higher administrative requirements [10], and low efficiency of isolation and segmentation policy[12-13].

To further integrate environmental management, China has for the first time established a comprehensive and spatially differentiated environmental zoning-based regulatory system nationwide – the "Three Lines One Permit" (TLOP) policy. The main outcomes of TLOP include a set of ecological and environmental protection objectives, a set of regulatory modules (primary and integrated), and an Environmental Permit List (LEP). Its purpose is to guide the development of regional spatial planning in terms of ecology and environment by establishing spatial redlines, determining the scale of development through environmental and resource control, and promoting emission control and reduction through environmental standards. The practice and implementation of TLOP in the

Yangtze River Economic Belt demonstrates its importance in China's environmental protection [14-16].

Guangzhou is located in the northern part of the Pearl River Delta. This is the transition zone from the Nanling Mountains to the Pearl River Estuary, and is the core city of the Pearl River Delta urban agglomeration. At present, Guangzhou is in a critical period of "moving from building a national central city to an international metropolis". It aims to build a beautiful and livable flower city, which is prosperous, civilized and harmonious, green and low-carbon, a vibrant global city, and a modern international metropolis[17-18]. Guangzhou's economy will still maintain a medium-high growth rate. However, the country's economic development, social welfare, and environmental protection are not coordinated enough. Ecological space occupation, resource and energy consumption, and pollutant emissions will continue for a long time. The contradiction between urbanization and ecological land protection is prominent. The carrying capacity of resources and the environment has reached or exceeded the upper limit. Regional and composite air pollution has not been effectively addressed. And the pollution of urban water bodies is still relatively heavy[19-20]. It is urgent to guide the planning of urban ecological environments, to choose suitable sites for construction projects, and to optimize the layout of urban space continually, to strengthen ecological environmental protection, to maximize ecological space, and to ensure the safety of human settlements through the TLOP.

However, there are many kinds of information involved in the TLOP. It will cost a lot to use it for ecological environment planning and site selection for construction projects. It is difficult to support the rapid development of the city and the efficient construction of enterprises by relying on manual review alone. There is no visualization method that can present these vast and complicated data to the decision-makers in a way that allows them to rapidly grasp the basic information of the project and be able to come to a conclusion about compliance with the comprehensive policy plans. And at the same time, enterprises, social groups and the public cannot enjoy the results fairly and conveniently. Therefore, on the basis of the results data of TLOP, it is necessary to use geographic information system (GIS) analysis tools to build a spatial decision support system to serve government departments, enterprises, technical units, the public, etc. Realize the decision-making mechanism for construction site selection[21].

In this article, we introduce an environmental planning analysis platform based on TLOP. This platform supports the application of Guangzhou's TLOP results in providing environmental planning analysis for construction project site selection. An interactive construction project planning analysis tool is the key part of the platform, which is a set of network-based GIS planning tools that can be used to help guide future project investment and environmental planning.

First, the platform system is innovative in that the concept of environmental zoning management has been implemented in planning and management. Analyze the construction projects by using the established differentiation rules, such as red line for ecological (RLEC), bottom line for environmental quality(BLEQ), upper-limit for resource use(ULRU), and list of environmental permits for human activities(LEP). Assess the feasibility of the construction project and implement a refined system of environmental space management .Secondly, it carried out the complex analysis of multiple factors and fields in the TLOP, and formed a unified analysis and evaluation system on the management unit in the form of spatial superposition analysis of the regional bottom line for environmental quality, total amount control, resource and environment capacity, environmental risk, resource and environment carrying capacity and other factors, which can effectively support the improvement of spatial planning in data and technology. The third is that the interactive construction project environmental planning analysis tool provided for users has strong comprehensive, complex and scientific analysis ability. It has simple operation process and efficient and professional analysis results. It also has strong scalability, allowing users to customize their expansion, enrichment and upgrading[22-23].

The rest of the article is as follows. Section 2 discusses the overall design and system structure of the environmental planning analysis system based on TLOP. In section 3, through the site selection analysis of a new construction project, the interactive construction project planning analysis tool is introduced in detail. Then, the last two sections discuss the advantages and disadvantages of the system, as well as the future prospects of the platform.

2. Design and Methods

The environmental planning analysis platform introduced in this paper includes GIS tools customized for the results data of TLOP - the results display tool and the interactive construction project environmental planning analysis tool. The results of TLOP can be displayed and accessed by integrating remote sensing and GIS spatial analysis. And it explores the application of TLOP results data in the planning and management of construction projects. The platform uses a browser/server model and is divided into four levels. These four levels are composed of network interface, application layer, service layer, and data layer[24-25].

As an environmental planning management and analysis tool, it assists planners and managers in making decisions. It also shares the results of environmental planning with the public, enterprises, environmental groups, etc. Therefore, the platform requires the following features. First of all, the system needs to support TLOP results data storage and query. The second is that the platform can provide online rendering of vectors and raster datasets as needed. Third, the platform has powerful spatial analysis capabilities to support the spatial analysis capabilities in the environmental planning analysis tool for construction projects. Fourth, when the platform analyzes construction projects, it includes comprehensive environmental planning, environmental management and other contents, and provides users with professional environmental planning analysis services. Next, I will describe the system architecture and the selected software (geoserver, postgresql).

2.1. System structure

As the first layer in the platform, the browser side provides a user interface for displaying and accepting user requests and completing interactions. The user interface consists of four parts: a tab bar, a layer bar, an attribute bar, and a map view. The tab column enables the free switching of five tabs on the RLEC, BLEQ, ULRU, the integrated environmental management unit and environmental planning analysis tool. Among them, the first four belong to the results display tool for the TLOP results data display. The LEP is displayed on the integrated environmental management unit. The last one is the environmental planning analysis tool for construction projects. It is used to interact with users to achieve environmental planning analysis of construction projects. The layer bar achieve layers visibility and selection by checking the layer list. The attribute bar displays the statistics for the layer and the attribute information and governance requirements for the selected features (control units). In the map view, the superposition space display of the TLOP results data and the administrative division map, remote sensing map and topographic map is realized. The map tools in the map view provide users with basic GIS operations (zoom in, zoom out, ranging, side, basemap switching, etc.). The client uses Vue.js and OpenLayers[26-27].

The server structure is divided into three layers, consisting of the first layer "business layer", the second layer "service layer", and the third layer "data layer". The business layer includes two business components: the results display tool and the construction project environmental planning analysis tool. The service layer includes vector publishing services, spatial query services, spatial analysis services, data services, management requirements analysis services, basemap retrieval services, and information retrieval service for construction projects. The data layer contains the data used in the platform, such as RLEC data, BLEQ data, ULRU data, LEP data, environmental management requirements data, etc. One module at each layer has a combination of modules at the next level, for example, the business of the achievement display tool needs to be composed of vector publishing

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services, spatial query services, data query services and other services. Services require one or more types of data.

As an open source map server that complies with the OGC open standard, Geoserver supports ESRI Shapefile and PostGIS, Oracle, ArcSDE and other spatial databases for spatial information storage. The results of TLOP are mainly the vector data of each element and comprehensive control partitions, together with the corresponding management requirements. The platform uses Geoserver as a vector and raster data publishing tool[28-30].

PostgreSQL with PostGIS extension not only supports all geospatial data stores, but also has powerful spatial analysis functions. It is used to store data applied by the platform, including vectors and management requirements data. *This platform has been further developed based on its built-in spatial analysis, spatial relationship comparison, and spatial operator to meet the platform's spatial analysis needs[31-32].

The overall design of the system is shown in the figure below:

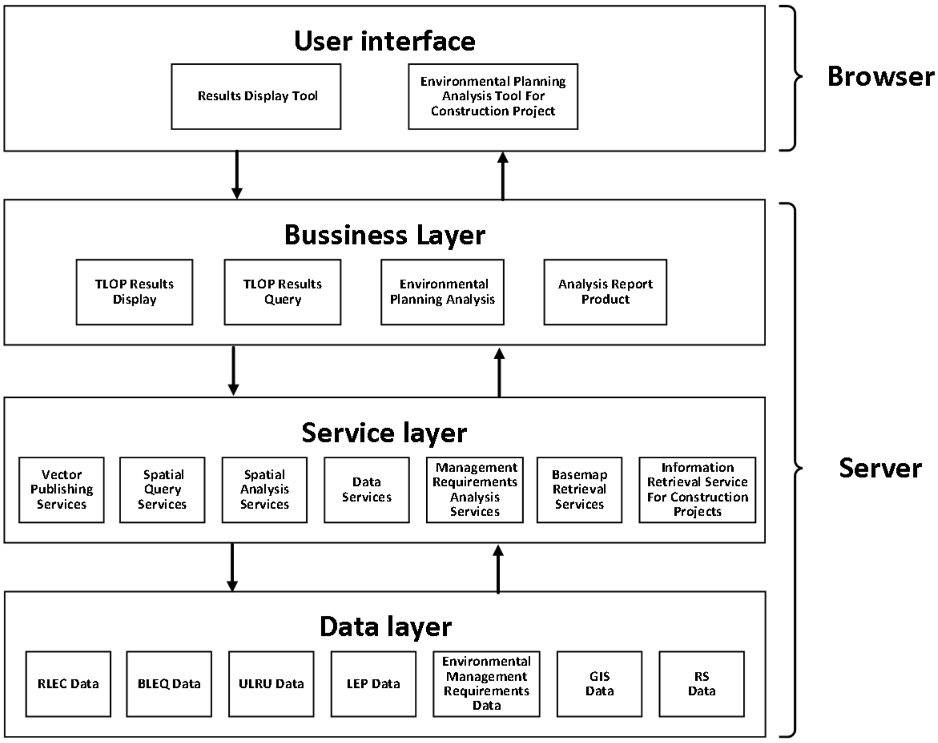

Figure 1. System Architecture of the environmental planning analysis platform, including the results display tool and Interactive environmental planning analysis tools for construction projects.

2.2. Results display tool

In order to display the existing TLOP data results, we have designed a results display tool for the platform. It allows users to view and query the TLOP data in layers, including each element and comprehensive environmental management unit. In addition, it provides their basic information, management requirements and other attribute information.

According to the structure of TLOP, the results layer is placed under the four tabs of the RLEC, BLEQ, ULRU, and the integrated environmental management unit, and the fifth page is the environmental planning analysis tool for construction projects (Fig.2. 4). The user decides which layers to display in the map display area (Fig.2. 5) by checking in the layer bar (Fig.2. 2). The management partition unit is displayed as a polygon, and different types of management partitions are displayed with different colors. After clicking the mouse in the map display area, the selected management unit is highlighted and the attribute information of the management unit is shown in the attribute bar on the right side of the map view, which is divided into the feature attribute bar (Fig.2. 6) and the management requirement attribute bar (Fig.2. 7). For example, if you select the Integrated

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management unit layer and click the management unit in the map view, the management unit becomes a highlighted color. The management requirements of this management unit are displayed in the properties bar on the right side of the map view. Click the mouse button to view the name, code, area, type, environmental objectives, environmental management requirements and other attribute information of the management unit.

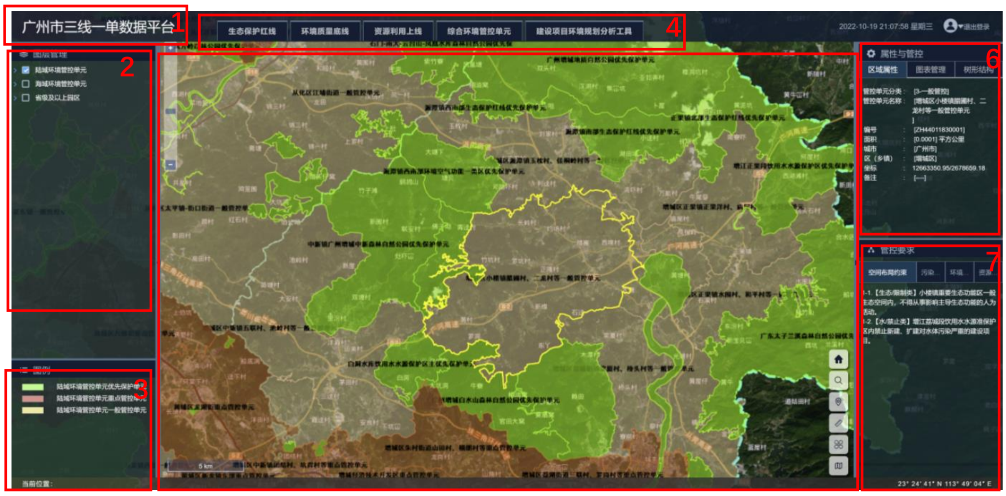

Figure 2. The user interface. 1 is the name of the platform, 2 is the layer bar, 3 is the legend column, 4 is the page sign column, 5 is the map display area, 6 is the feature attribute column, and 7 is the management requirement attribute bar.

2.3. Interactive environmental planning analysis tools for construction projects

The environmental planning analysis tool for construction projects fully accounts for the requirements of EIA approval. It obtains relevant project information (including geospatial data and attribute data) through user self-upload or docking with the local EIA approval system, and supports EIA decision-making by combining GIS maps and relevant results data of TLOP. Then assist administrators to make scientific, quantified, comprehensive and efficient decision-making on the EIA approval of construction projects.

The environmental planning analysis tool for construction projects has four analysis functions, namely RLEC analysis, BLEQ analysis, ULRU analysis, and LEP analysis. The four types of analysis are all positive analyses, which correspond to the respective management requirements of the three lines and one permit in the TLOP. The user can select all or any matching analysis according to their needs. The resulting analysis report lists all the management requirements and results of the analysis. When all the requirements are met, it proves that the construction project fully meets the requirements of the TLOP and can be constructed. Otherwise, it is defined as no pass, and a rejection is given.

By comparing and analyzing the construction project with each management requirement, it can be determined whether the project fulfills the requirements. In this tool, the specific content of each management requirement is sorted out one by one. Analysis rules such as prohibited items, restricted items, and encouraged guidance items are extracted and formulated. As the management unit's requirements are complex, the information provided by the EIA approval system cannot be fully covered. And some requirements are unquantifiable or vague, which the computer cannot determine by itself, and must be manually entered by users. Allowing users to enter all the information required for management requirements before performing the analysis can lead to complex and unnecessary operations. Therefore, the platform divides the analysis of management requirements into two parts. One is the analysis of general requirements, which is quantifiable and the judgment logic is simple and feasible, such as the type of construction project, the amount of pollutant discharge, etc.. These requirements can be compared by automatically obtaining information from the project environmental impact assessment system. In addition to this, there is also the analysis of complex differentiation and fuzzy judgment benchmarks, such as that of the construction process and the production process of an enterprise. In this tool, the rules will be formulated into a questionnaire and returned to users for completion. Users upload and submit the questionnaire to the tool for comparative analysis to obtain the results. It improves the scientific accuracy of the analysis while also reducing the amount and complexity of user operations.

2.3.1. Analysis of red line for ecological conservation

The RLEC usually includes significant areas with important ecological functions such as important water source conservation, biodiversity maintenance, soil and water conservation, wind and sand fixation, and coastal ecological stability, as well as sensitive and fragile areas of ecological environment such as soil erosion, land desertification, stony desertification, and salinization. In accordance with the basic requirements of "ecological function is not reduced, the area is not reduced, and the nature is not changed", strict management is implemented. According to the spatial geographical location of the construction project, the RLEC and ecological space , check whether the construction project has a spatial conflict with the RLEC or be in an important ecological space, etc.. Then analyze whether the location of the construction project is reasonable, and analyze and calculate the conflict area. Give approval to the construction project that is not developed within the RLEC and the important ecological space, otherwise it will not be approved.

2.3.2. Analysis of bottom line for environmental quality

In the BLEQ, in accordance with the principle of continuous optimization of water, atmosphere and soil environmental quality, the environmental management unit of each element has formulated differentiated management requirements according to its own environmental carrying capacity and ecological environment quality status, relevant planning and functional zoning, including clear environmental quality objectives, emission targets and related pollutant discharge management requirements. The spatial and geographical location of the construction project is analyzed by means of spatial conflict with the water environment management zone, the atmospheric environment management zone, and the soil environmental risk management zone. Extract the management requirements corresponding to each element management unit with space conflicts. Using the information input by the user or retrieved from the EIA approval system, compare and combine the information to make an intelligent judgment. When all the management requirements of a construction site are met, the project is approved, otherwise it is denied.

2.3.3. Analysis of upper-limit line for resource use

To ensure ecological safety and improve environmental quality, the environmental management unit of each element of the ULRU, in accordance with the principle "only value-added, not depreciated" of natural resource assets, has developed differentiated management requirements according to its own natural resource endowments and to its natural resource development plans, which include the total amount, intensity, and efficiency of resource development and utilization. Through the spatial and geographical location of the construction project, the spatial conflict analysis is carried out with the high pollution fuel prohibition zone, the mineral resources exploitation control zone, and the shoreline resource control zone. Extract the corresponding management requirements of each element control unit with spatial conflict, compare and combine the project information input by the user or retrieved from EIA approval system to conduct the intelligent judgment. Approval will be granted when all management requirements of the construction site have been met. Otherwise, the project shall be refused.

2.3.4. Analysis of list of environmental permits for human activities

The analysis of the list of environmental permits for human activities is also known as environmental access analysis or integrated environmental management unit analysis. Because the integrated environmental management unit establishes a one-to-one

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connection based on spatial matching with the LEP. The LEP limits the access requirements of every integrated environmental management unit. A forward retrieval of "unit-requirement" is possible. The access requirements of each environmental management unit are divided into four dimensions, namely spatial layout constraints, pollutant emission control, environmental risk prevention and control, and resource development efficiency. In each dimension, there are differentiated management requirements that meet the actual local ecological environment and environmental planning requirements. The environmental planning analysis tool for construction projects sorts out the specific content of each control requirement of each environmental management unit in the four dimensions. It refines and formulates analysis rules, such as prohibited, restricted, and encouraged guidance items. After determining the spatial conflict between the construction project and the integrated environmental management unit, the environmental management unit where the construction project is located or has a spatial conflict with the construction project is viewed. Intelligent judgment is carried out by comparing and combining the project information entered by the user and retrieved from the EIA approval system. Analysis of whether the project meets the requirements of the location and environmental management unit, and printing the report as a reference. When all of the management requirements of the construction site are met, the project is approved, otherwise it is denied.

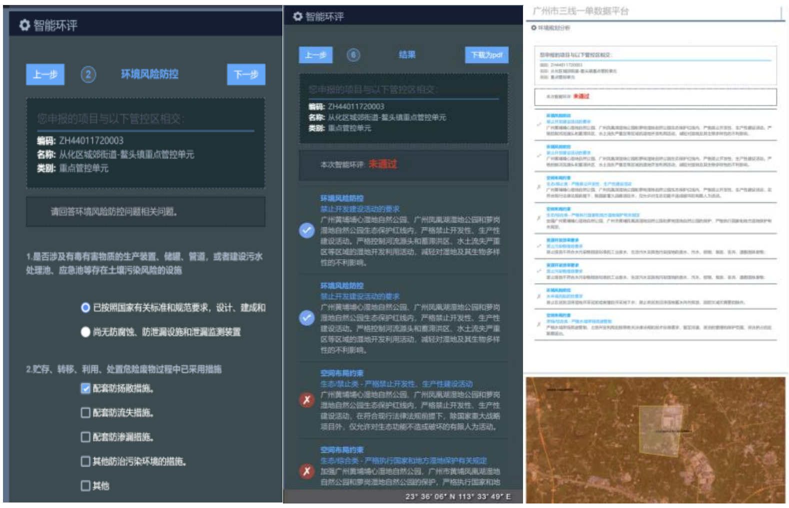
3. Results and Implementation

The diagram provides an example of an interactive construction project planning analysis tool. Fig. 3 illustrates how the user selects what will be analyzed and then overlays the analysis content based on the single and multiple selections of the layer. Click on the "Select Vector File" button (Fig. 3). Select the vector file of the construction project in the file selection dialog box that appears, and upload the spatial geographic information of the project. The geographical location of the project is displayed on the remote sensing map or administrative division map for users (Fig. 4). Then click "Click and Query" (Fig. 4) to implement spatial analysis and obtain the attribute information and management requirements of the feature units and units in each analysis content (layer) that have spatial conflicts with the construction project. At the same time, return to the conflict area and display it on the map (Fig. 5). Click "Next" (Fig. 5) to start the questionnaire survey (Fig. 6a), which consists of questions abstractly extracted from the rules of the management requirements of the conflict element unit. After filling in the questionnaire information by users, the project information obtained in the questionnaire and the information retrieved from the environmental assessment approval system are compared and analyzed with the management requirements of the conflict management unit. Get analysis results and generate analysis reports (Fig. 6b). Click "Download as pdf" (Fig. 6b) to save and download the analysis report (Fig. 6c). Fig.7 shows all the steps.

Figure 3. User interface for interactive construction project planning analysis tool.

Figure 4. Display of the uploaded construction project.

Figure 5. Display of conflict result.



a b c

Figure 6. (a) is questionnaire survey, (b) is analysis results, (c) is analysis report.

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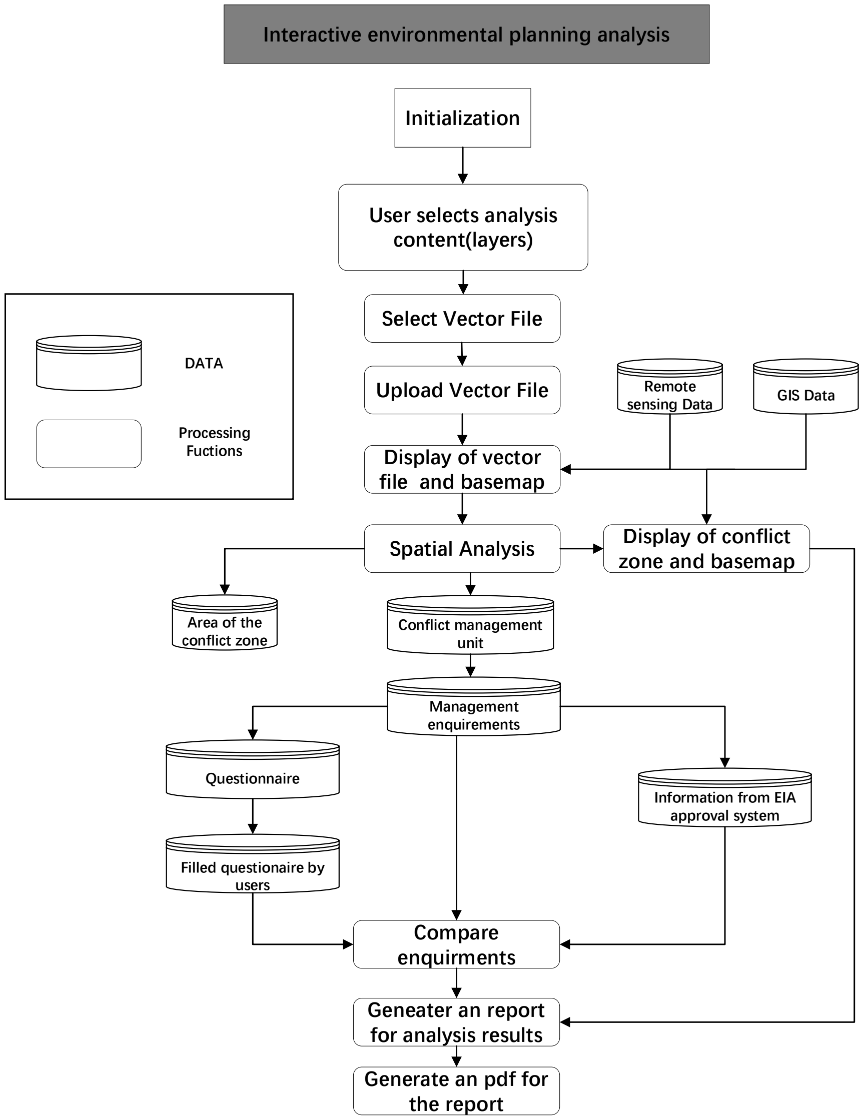

Figure 7. Interactive environmental planning analysis tools for construction projects process model, including all the steps required to implement an Environmental Planning Analysis online.

4. Discussion

The environmental planning and analysis platform based on TLOP has several advantages. First of all, TLOP is an invaluable starting point for promoting the fine management of environmental space. It is also an effective means to implement environmental space management and strengthen source prevention and process supervision. The platform is based on the results of TLOP, combined with the actual situation in China. It uses GIS and remote sensing technology to provide the display and query functions of the integrated environmental management units and units of each element. Then, formulate a specific set of rules to carry out the ecological environment access analysis of the project. This will judge the feasibility of the EIA approval of the construction project, and implement the refined and differentiated management of the integrated environmental management units. It facilitates environmental quality management, environmental governance, pollutant discharge permits, environmental evaluation, etc.

In second place, in terms of ecological environment spatial planning, it focuses on the concept of ecological spaces and the concept of red lines for ecological protection. However it lacks a unified accounting system for key links such as the regional bottom line for environmental quality, total volume control, and resource and environmental capacity. At the same time, there is a lack of effective management platforms for key work such as environmental quality deadline standards, environmental risk assessment, resource and

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environmental carrying capacity monitoring and early warning. Through the environmental planning and analysis platform, the ecological environment zoning management system is proposed. The bottom line for environmental quality and the upper limit for resource use are zoned and managed. Special attention is paid to the list of environmental permits for human activities that are given by the integrated management units. These permits can be used to improve spatial planning on data and technology.

Third, the innovative core of the interactive environmental planning analysis tool for construction projects lies in the integration of spatial analysis, TLOP management requirements and user experience. This enables a comprehensive, efficient, professional, scientific and transparent analysis framework to provide support analysis for management, planning and environmental impact assessment decisions. The analysis framework also has a high degree of scalability. The different laws, policies, planning documents, management objectives, and environmental data are input to the analysis framework, as a new analysis layer, or extracted into the existing four analysis methods, in order to expand the analysis content of the existing framework. Plan and analyze the project to meet the needs of new areas and protect the environment. Improve the comprehensiveness of planning analysis tools, complexity and scientificity by continuous upgrading. This conceptual framework of incorporating multiple components into TLOP is very effective in dealing with complex environmental issues, diversified functions, and the balance between economic development and environmental protection.

The current version has a disadvantage. In the environmental planning analysis tool for construction project, the four kinds of analysis are all forward analysis. Using project information provided by users or other systems, identify the spatial geographical location and the management unit involved first. Then, extract the management requirements for analysis and judgment. Part of the information needs to be provided by the user through interaction. Following the analysis judgment, the result and report corresponding to the analysis will be provided. The analysis report that will only point out those management requirements that are unmet and possible directions for improvement for the user to refer to and modify. It however cannot provide detailed suggestions such as plot and area information along with specific production process improvements to help the user land the project.

5. Conclusions

This platform system is a set of environmental planning analysis systems developed independently based on the TLOP results. It uses administrative divisions, remote sensing maps and topographic maps and other base maps and TLOP results to superimpose. Furthermore, the platform provides a quick and easy method for multilayer data display and interactive attribute retrieval, such as RLEC, BLEQ, ULRU, LEP and integrated environmental management unit. Under the framework of TLOP results, the platform system extracts the requirements for environmental planning, environmental governance and environmental management in the RLEC, BLEQ, ULRU, LLEP. These requirements are the constraints of environmental planning analysis. The bottom layer of the platform system uses the GIS spatial analysis function to match and contrast the constraints with the construction project information in space. This platform improves the comprehensiveness, scientificity, and accuracy of information acquisition and planning analysis for construction projects based on user interaction, gives the results of environmental planning analysis for construction projects, and provides guidance on how to accomplish construction projects.

The Interactive Construction Project Environmental Planning Analysis Tool provides a consistent, transparent and equitable environmental planning tool for managers, planners, investors and the public. For managers, the tool increases their productivity by increasing their means of regional environmental management and construction project approval. For planners, the tool enriches the content and means of their planning, increasing the comprehensiveness and accuracy of their results in environmental aspects. The tool supports investors to have a clear understanding of environmental problems encountered in project construction, implementation and operation in advance before the project is invested, which will avoids risks, reduces losses, and indirectly improves the friendliness of the region to investment and business. The tool is also for the public. The regional environmental policies, planning, risks and other information are easily displayed in front of the whole society, so that the public can better fulfill their obligations and exercise their rights and interests.

With the release of their own TLOP results in every provinces in China, the whole of China has basically completed the preparation of TLOP. Then with the vigorous promotion of the national government and the Ministry of Ecology and Environment of the People's Republic of China, the application of data based on the results of TLOP will continue to deepen. The design of this system applies the TLOP results data in the fields of environmental planning, environmental impact assessment and approval, and environmental management. It provides a new comprehensive, efficient, professional, scientific and transparent environmental planning analysis framework, which can simplify procedures, improve the efficiency of management, planning and environmental impact assessment agencies. And it has the important reference significance for the construction of the TLOP results data application platform in the other provinces and cities.

With the research of global sustainable development, how to balance ecological environmental protection and social and economic development will become the focus of global researchers and various government management in the coming period. In China, the technical achievements of TLOP show the effectiveness and importance of comprehensive environmental supervision, and the zoning system and environmental permit list will become the scientific basis for development activities and pollution control. With the construction of the "Belt and Road", China will share more experience in social development and environmental protection with the world. The concept and technical achievements of TLOP will also provide efficient and practical solutions to countries with the same problems and help them build a local integrated environmental management system. The environmental planning and analysis platform based on TLOP will assist in the implementation of the TLOP system.

At present, the developed platform cannot provide further optimization site selection analysis and detailed improvement suggestions after the analysis results are not passed. In the future, we will add detailed local land use data of plots, construction technology and production process of construction project, etc. Add the optimization site selection analysis function and improvement suggestion function, when the environmental planning analysis results are not passed, search for eligible environmental management units or plots in the whole area. And gives detailed and specific improvement suggestions for project implementation and production process. Simplify the analysis work and improve the efficiency of the implementation of construction projects.

References

1. Ascensão, F., Fahrig, L., Clevenger, A. P., Corlett, R. T., Jaeger, J. A., Laurance, W. F., & Pereira, H. M. (2018). Environmental challenges for the Belt and Road Initiative. Nature Sustainability, 1(5), 206-209.
2. Kinzig, A. P., Ehrlich, P. R., Alston, L. J., Arrow, K., Barrett, S., Buchman, T. G., ... & Saari, D. (2013). Social norms and global environmental challenges: the complex interaction of behaviors, values, and policy. BioScience, 63(3), 164-175.
3. Fu, B.-j., Zhuang, X.-l., Jiang, G.-b., Shi, J.-b., Lu, Yi, h., 2007. Feature: environmental problems and challenges in China. Environ. Sci. Technol. 41 (22), 7597–7602.
4. Qin, Y., Curmi, E., Kopec, G.M., Allwood, J.M., Richards, K.S., 2015. China's energy-water nexus – assessment of the energy sector's compliance with the "3 Red Lines" industrial water policy. Energy Policy 82, 131–143.
5. Tian, X., Hu, Y., Yin, H., Geng, Y., Bleischwitz, R., 2019. Trade impacts of China's Belt and Road Initiative: From resource and environmental perspectives. Resour., Conserv. Recycl. 150, 104430.
6. Kumar, P., Saroj, D.P., 2014. Water–energy–pollution nexus for growing cities. Urban Clim. 10, 846–853.
7. He, J., Bao, C.-K., Shu, T.-F., Yun, X.-X., Jiang, D., Brwon, L., 2011. Framework for integration of urban planning, strategic environmental assessment and ecological planning for urban sustainability within the context of China. Environ. Impact Assess. Rev. 31 (6), 549–560.

 doi:10.20944/preprints202212.0556.v1

8. Li, W., Xie, Y., Hao, F., 2014. Applying an improved rapid impact assessment matrix method to strategic environmental assessment of urban planning in China. Environ. Impact Assess. Rev. 46, 13–24.
9. Fang, Q., Zhang, L., Hong, H., Zhang, L., Bristow, F., 2006. Ecological function zoning for environmental planning at different levels. Environ. Dev. Sustain. 10 (1), 41–49.
10. Xu, K., Wang, J., Wang, J., Wang, X., Chi, Y., Zhang, X., 2020. Environmental function zoning for spatially differentiated environmental policies in China. J. Environ. Manage 255, 109485.
11. Cheng, R., Li, W., 2019. Evaluating environmental sustainability of an urban industrial plan under the three-line environmental governance policy in China. J. Environ. Manage 251, 109545.
12. Jiang, S., Lu, Q., 2018. New measure of environmental protection in China. Lancet Planet. Health 2 (12), e517.
13. Liu, L., Zhang, B., Bi, J., 2012. Reforming China's multi-level environmental governance: lessons from the 11th five-year plan. Environ. Sci. Policy 21, 106–111.
14. Wang, Z., Li, W., Li, Y., Qin, C., Lv, C., & Liu, Y. (2020). The" Three Lines One Permit" policy: an integrated environmental regulation in China. Resources, Conservation and Recycling, 163, 105101.
15. Wang, H., Guo, X., Liu, T., & Xu, H. (2022). Framework and function of "Three Lines and One Permit": A preemptive and integrated policy for the environmental impact assessment system in China. Environmental Impact Assessment Review, 94, 106763.
16. Luan, C., Liu, R., Peng, S., & Li, W. (2021). Improving integrated environmental zoning from the perspective of logic scoring of preference and comparative advantage: A case study of Liangjiang New Area, China. Journal of Cleaner Production, 325, 129350.
17. Liu, S., Yu, Q., & Wei, C. (2019). Spatial-temporal dynamic analysis of land use and landscape pattern in guangzhou, China: exploring the driving forces from an urban sustainability perspective. Sustainability, 11(23), 6675.
18. Zhu, Z., Lang, W., Tao, X., Feng, J., & Liu, K. (2019). Exploring the quality of urban green spaces based on urban Neighborhood Green Index—A case study of Guangzhou City. Sustainability, 11(19), 5507.
19. Xu, J., Zhao, Y., Sun, C., Liang, H., Yang, J., Zhong, K., ... & Liu, X. (2021). Exploring the variation trend of urban expansion, land surface temperature, and ecological quality and their interrelationships in Guangzhou, China, from 1987 to 2019. Remote Sensing, 13(5), 1019.
20. Zhang, Y., Hu, Y., & Zhuang, D. (2020). A highly integrated, expansible, and comprehensive analytical framework for urban ecological land: A case study in Guangzhou, China. Journal of Cleaner Production, 268, 122360.
21. Ghaemi, P., Swift, J., Sister, C., Wilson, J. P., & Wolch, J. (2009). Design and implementation of a web-based platform to support interactive environmental planning. Computers, Environment and Urban Systems, 33(6), 482-491.
22. Zhou, X. Y., Zheng, B., & Khu, S. T. (2020). Simulation platform of human-environment systems for water environment carrying capacity research. Journal of Cleaner Production, 250, 119577.
23. Siles, G., Voirin, Y., & Bénié, G. B. (2018). Open-source based geo-platform to support management of wetlands and biodiversity in Quebec. Ecological informatics, 43, 84-95.
24. Sun, M., & Zhang, J. (2020). Research on the application of block chain big data platform in the construction of new smart city for low carbon emission and green environment. Computer Communications, 149, 332-342.
25. Bayat, B., Crespi, A., & Ijspeert, A. (2016, November). Envirobot: A bio-inspired environmental monitoring platform. In 2016 Ieee/Oes Autonomous Underwater Vehicles (Auv) (pp. 381-386). Ieee.
26. Passaglia, A. (2017). Vue. js 2 Cookbook. Packt Publishing Ltd.
27. Perez, A. S. (2012). OpenLayers cookbook. Packt Publishing Ltd.
28. Iacovella, S. (2014). GeoServer Cookbook. Packt Publishing Ltd.
29. Kommana, K. (2013). Implementation of a Geoserver Applicatoin For GIS Data Distribution and Manipulation.
30. Dai, Y., Duan, Z., & Ai, D. (2020, August). Construction and application of field investigation support platform for land spatial planning based on GeoServer. In Journal of Physics: Conference Series (Vol. 1621, No. 1, p. 012059). IOP Publishing.
31. Corti, P., Kraft, T. J., Mather, S. V., & Park, B. (2014). PostGIS cookbook. Packt Publishing Ltd.
32. Shukla, D., Shivnani, C., & Shah, D. (2016). Comparing oracle spatial and postgres PostGIS. IJCSE, 7, 95-100.