

Cloud Server-based Questionnaire System for Cultural Services in Blue-green Spaces

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ABSTRACT

Parks are important carriers of urban blue-green space and cultural services, which are vital to beautify the city and improve the quality of life of residents. Constructing a questionnaire system for cultural services in blue-green spaces is of great significance for evaluating and studying the supply of regional cultural services and quantifying residents' cultural needs. In this paper, we take Zhengzhou city park as the evaluation object, and based on AliCloud server ECS and WebGIS technology, combined with drone orthophoto and real-life three-dimensional model, we make the questionnaire survey system of blue-green space cultural service to collect residents' social value preference and suggestions for the park. Respondents enter the system through any device with internet access, browse park pictures and profiles, and participate in the online questionnaire survey, and the collected data on residents' value preferences can be used to assess the value of the park's cultural services by methods such as the SoIVES model. The system solves the shortcomings such as heavy workload and low response rate of distributing questionnaires in the field. The system integrates a variety of digital technologies and improves the questionnaire survey method, which can effectively improve the efficiency and quality of the questionnaire survey and analyze the problems and deficiencies of the park with the opinions of the respondents, so as to provide the management with references for optimization and standardization, and to promote the enhancement of the quality of cultural services.

KEYWORDS

Cultural services; Service evaluation; UAV aerial survey; WebGIS; SoIVES model; Cloud server; Urban green space; Blue-green space

1. INTRODUCTION

Parks are important carriers of urban blue-green space[1] and cultural services, and in addition to providing residents with a place for leisure and relaxation, they can also enhance the urban landscape and improve the living environment, and large-scale municipal comprehensive parks can even drive the development of tourism[2, 3]. In addition, parks are part of the urban ecosystem, helping to purify the air, absorb rainwater, provide habitat and maintain urban biodiversity[4]. Conducting park cultural service evaluation can reveal the level of cultural services in parks, provide reference for government departments, and help decision-makers understand the mismatch between the supply and demand of blue and green spaces and social values in the region, so that they can propose appropriate improvement policies and measures to create a livable urban ecological environment. Evaluating whether a park meets the needs of nearby residents involves a number of subjective and objective factors, ranging from measuring the amount of multiple infrastructures to assessing the subjective opinions of different groups of people on their personal needs such as aesthetics and education[5].

Among them, residents' subjective opinions have been collected in the past mostly through offline questionnaires[6, 7], but offline surveys can only find some of the people to be interviewed in a specific location, and the respondents may not be representative of the entire target population, leading to biased samples. Organizing and implementing offline questionnaires requires a lot of time and human resources, which is costly. After the offline questionnaire survey is completed, the data need to be manually entered and organized, which consumes a lot of time and effort, is prone to errors, and prevents timely access to and analysis of the survey results.

Online questionnaires can save the cost of printing, distribution and retrieval, and enable quick statistics and summarization. However, there is often a lack of real-world reference in the completion process, and respondents may have a biased understanding of the questions, affecting the accuracy of the results. WebGIS can integrate geographic data and geographic analysis tools into web pages and deploy WebGIS using cloud servers to enable users to browse, query, analyze and share geographic information[8] through browsers under any network node, and to work without installing GIS software when dealing with non-GIS professionals. WebGIS has been widely used in various fields, such as municipal[9], industrial, and environmental management. WebGIS has been widely used in municipal, industrial[10, 11], environmental management[12, 13] and other fields. Drone aerial surveys and WebGIS technology provide a real-life geographic environment reference, which provides a new opportunity to carry out online questionnaire survey activities.

Based on the above considerations, this paper synthesizes the use of UAV aerial surveys, WebGIS, cloud servers and other technologies to develop a questionnaire survey system based on cloud servers for blue-green spatial cultural services. Respondents can access the system to fill out questionnaires through browsers at any network node, referring to the real-world environment and related data provided by WebGIS to improve the reliability of questionnaire survey results.

2. STUDY AREA AND AERIAL SURVEY DATA ACQUISITION AND PROCESSING

2.1. Study Area

In this paper, Jingshui District, Erqi District, Zhongyuan District, Guancheng Hui District and Huiji District of Zhengzhou City are selected as the study areas (Fig. 1). Zhengzhou, as the capital of Henan Province, has experienced rapid economic development in recent decades, with its GDP exceeding one trillion dollars for many years, and its city and population size expanding continuously, with a population of more than 10 million at present. Although the urbanization process of Zhengzhou has brought about urban development and economic growth, it has also led to ecological and environmental problems such as excessive urban noise, heat island effect, air pollution, etc. Urban high-rise buildings continue to occupy the blue and green space, and the lack of outdoor recreation programs for residents, which affects the quality of human environment and urban life.

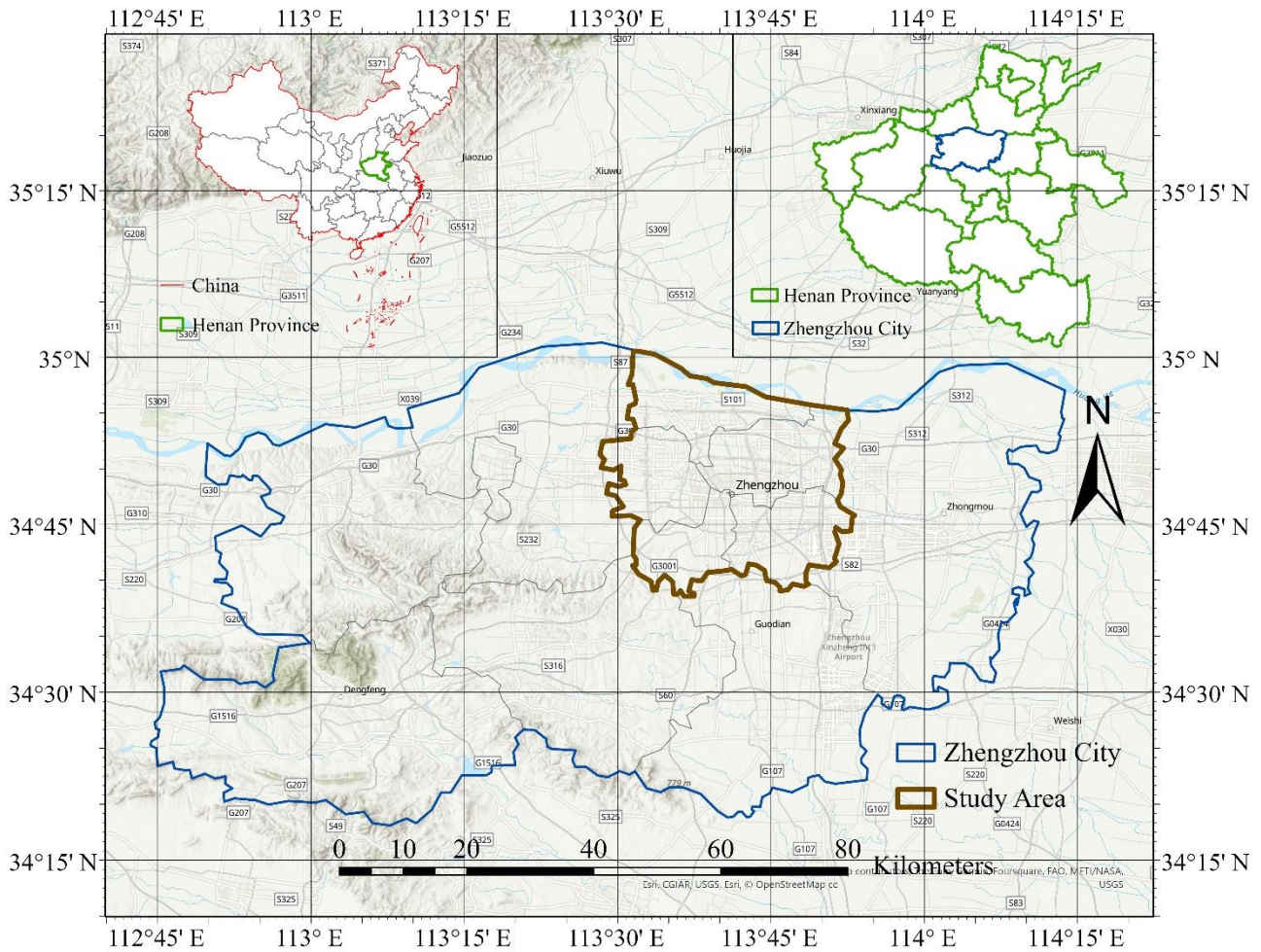


Figure 1. Diagram of the Study Area

2.2. Image Data Acquisition

In this paper, a DJI M3E UAV is utilized to collect images of parks in five administrative districts of Zhengzhou City. Firstly, Baidu map and Gaode map software are used to collect the location of parks, and the flight area is expanded by 10-20m according to the area and plan shape of the parks; the height of the surrounding buildings is integrated to set the altitude, and the default altitude is 100m (corresponding to the resolution of 0.0279m on the ground), and the altitude of some parks adjacent to high-rise buildings is increased appropriately; the overlap rate of the flight direction is 80%, and the overlap rate of the side direction is 70%. In this paper, a total of 103 parks were flown, with a cumulative flight area of 64.7km².

2.3. Image Data Processing and Archiving

In this paper, DJI Zhitu software is used to process UAV images, and the efficiency of this software in reconstructing orthophotos and 3D models has a great advantage over ContextCapture, Metashape and other software, and the reconstruction can be started with one click by selecting the type of operation (orthophoto, 3D model), coordinate system and output format[14]. In order to reduce the intensity of web rendering and server load, this paper resampled the resolution of the orthophoto to 0.2m*0.2m, and the measured 0.2m resolution image can accurately recognize various features, which can satisfy the demand of the subsequent online questionnaire survey (Fig. 2).

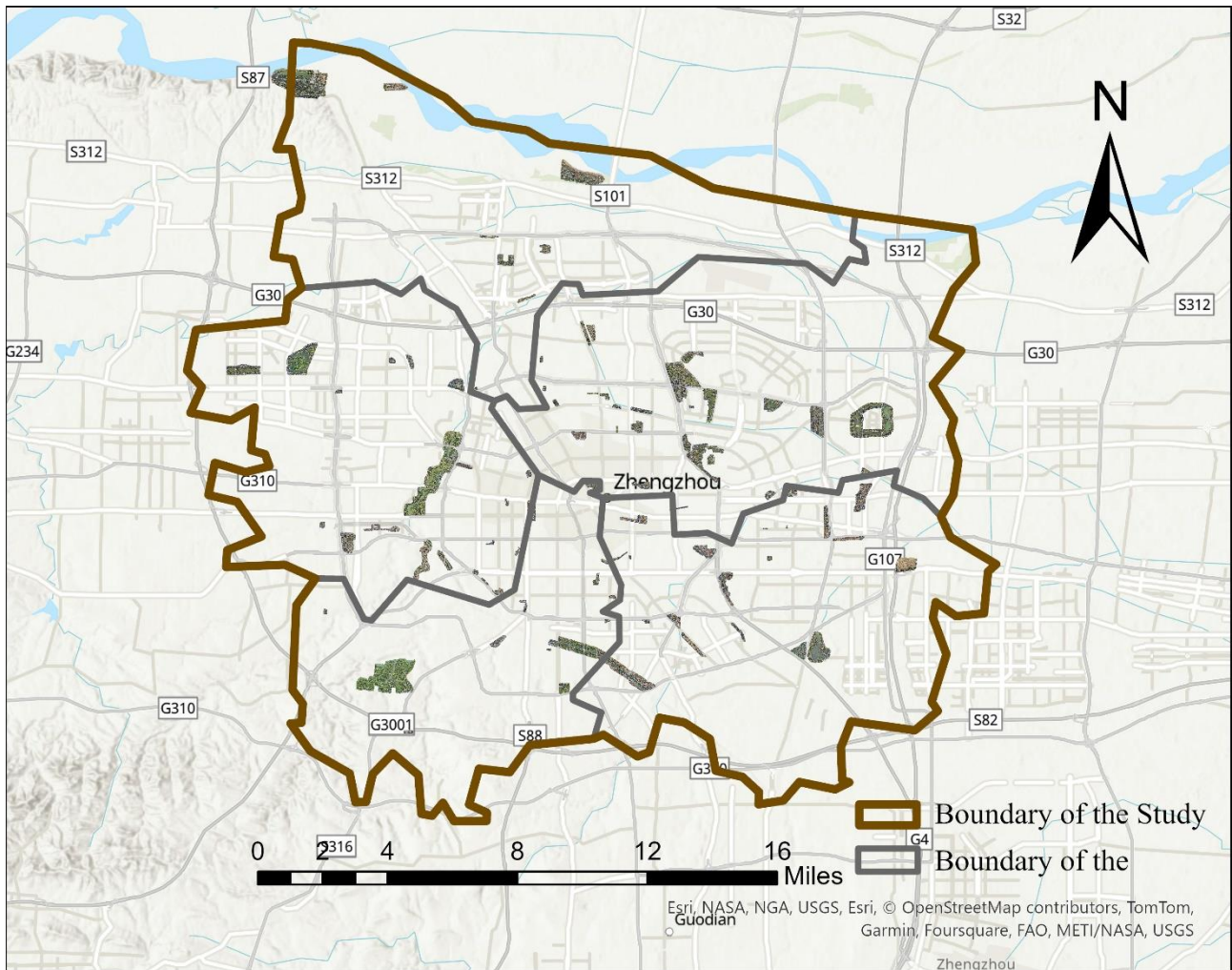


Figure 2. Images and Distribution of Zhengzhou Aerial Park

3. WEBGIS SERVICE PUBLISHING AND QUESTIONNAIRE SYSTEM DEVELOPMENT

3.1. GIS Server Construction

Supermap Software Group has a complete system of GIS products, the products used in this paper include Supermap iDesktop and Supermap iServer. iDesktop software is a GIS software similar to ArcGIS Pro, which integrates 2D and 3D geographic information data management and analysis functions. iServer is a kind of GIS server, which is used for storing raster, vector, 3D model and other data for front-end webpage to call. In this paper, the GIS server construction process is as follows:

- 1) 3D model monolithization. The 3D model itself does not have attribute information, you need to draw the vector surface, add the attribute information of the park, fit the vector surface to the model surface and change the transparency to achieve the effect that the 3D model itself has attribute information.
- 2) S3M format conversion. Supermap iServer can only publish 3D models in a specific format (S3M), which need to be configured in iDesktop for UAV aerial surveys produced in OSGB format, generating scp configuration files and then generating S3M 3D cache slices through the tilt-in function.
- 3) Publish 3D model to iServer. After registering an iServer account, log in to the management website and publish REST-3D service and REST-data service through the Quick Publish Service

Tool. The orthophoto is 2D data, which can't be directly published to 3D service, you need to generate 3D cache slices and publish them to REST-3D service, and you can view the above data in the service management after publishing.

3.2. Publishing WebGIS Services and Secondary Development Using Cloud Servers

WebGIS services can be published and secondary developed using local servers or cloud servers. Alibaba Cloud Server ECS (Elastic Compute Service) is one of the cloud computing services provided by Alibaba Cloud, which provides users with scalable virtual cloud servers, allowing them to create and manage virtual server instances in the cloud to meet various computing needs[15]. Local servers and cloud servers have been widely used in meteorology[16], industry[17, 18], emergency management[19], etc. ECS also has mature security mechanisms such as firewalls, which provide security technical support for developers with weak back-end skills. At the same time, ECS has a high degree of freedom and control, and can replace the server's operating system and hardware configuration. Developers who are unfamiliar with Linux and other systems can replace them with Windows Server systems, which reduces a lot of learning costs.

In this paper, the WebGIS server is deployed to the AliCloud server ECS (Fig. 3), unlike the local server where the hypermap software and database are directly deployed, this process requires the use of software such as Pagoda Panel to build a web server to achieve visualization and interoperability functions. In addition, in order to meet the needs of the cultural service evaluation system, it is necessary to utilize JavaScript language for the secondary development of WebGIS. In this paper, we have developed the functions of spatial calculation and attribute information query. The spatial calculation includes distance, park area and green area calculation. Attribute information query includes the type and number of park facilities.



Figure 3. Principles of Webgis Publishing on Cloud Servers

The AliCloud server publishing WebGIS process is shown below:

- 1) Upload iServer to cloud server. Transfer data from the built GIS server via protocols such as FTP, SCP, SFTP, or via software such as Cloud Drive.
- 2) Build a network environment. Installation of the Pagoda Panel allows for the quick setup of the network environment, including account passwords, IP addresses, and so on. Place the GIS database in the developed website source folder, and the respondents can access the IP address through the browser to call the GIS data and functions, and operate the WebGIS interactive interface.
- 3) Production of questionnaires. Tencent Questionnaire Star was used to produce the questionnaire and publish it in WebGIS. The questionnaire content was designed according to the characteristics and types of parks to provide social value survey data for the SolVES model to assess the blue-green space in Zhengzhou City.
- 4) The Supermap iClient for Cesium provides a variety of packaged libraries for WebGIS, which need to be developed and utilized in conjunction with HTML, CSS and JavaScript languages. Respondents click on the area of the park, the model will be highlighted and pop-up window (Fig. 4), the content of the pop-up window is displayed by calling the attribute information of the 3D model, contains the basic introduction of the park and the link to the questionnaire, respondents browse the

drone aerial imagery, the park profile and the sky map, which is able to give more objective feedback on the experience of the park, and provide data for the assessment of the social value of the blue-green space in Zhengzhou City. The web link is shown below.

<http://8.130.73.240:5500/examples/webgl/zzpark.html>. (Link valid until April 26, 2025).

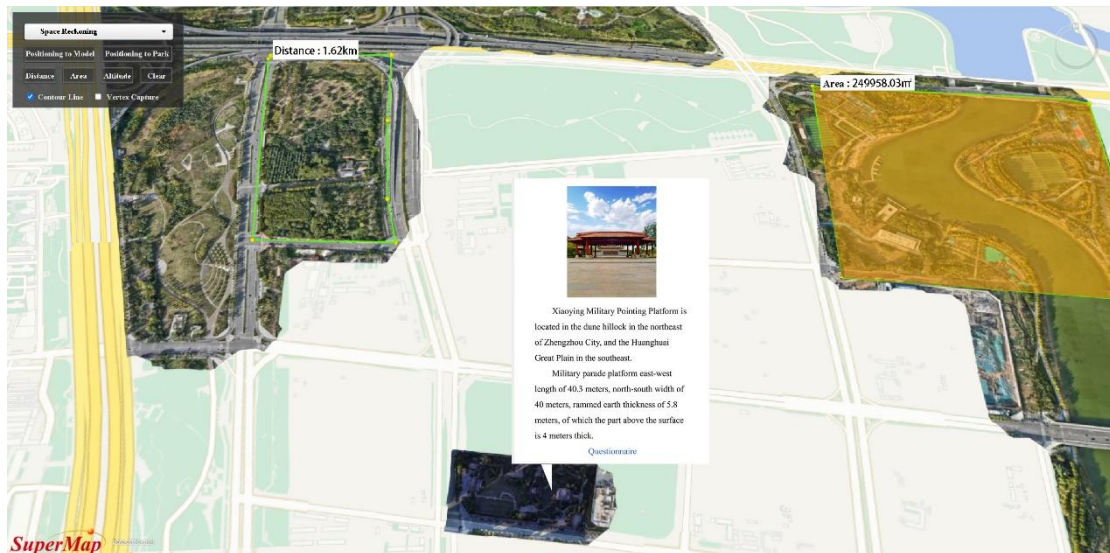


Figure 4. Secondary Development Function Display

4. ASSESSING THE VALUE OF CULTURAL SERVICES BASED ON THE SOLVES MODEL

4.1. Questionnaire Content

This paper collects public value and preference data through an online questionnaire[20], which is used to quantitatively analyze the subjective experience feelings of different types of people towards the park, and includes three main elements: (1) A survey of visitors based on demographic characteristics, including the gender, age, education, and income of the questionnaire subjects. Which involves more sensitive personal information issues, such as income, when conducting the questionnaire design to give fuzzy intervals to reduce the resistance of the respondents to the questionnaire survey in order to get the real information. (2) Survey respondents' recreational characteristics and feelings, including frequency of play, season of play, time of day, and recreational satisfaction. Visitors' recreational characteristics and recreational feelings can be used as the basis for subsequent research groupings. (3) Determine the type of social value and value allocation. First, determine the types of social values according to the park characteristics, including aesthetic value, recreational value, biodiversity value, etc., and then arrange for the respondents to assign a certain amount of value points to the types of social values that they think are important according to their own feelings, and mark the location of each type of value point.

4.2. SOLVES Model

In this paper, we use the SOLVES model to analyze the social value preference data obtained from the questionnaire survey and other environmental layer data to determine the location and intensity[21] of respondents' assignments to the types of social values of the parks, and to assess the social value of the blue-green spaces in Zhengzhou City. The SOLVES model consists of three sub-modules[22]: social value, value transfer, and mapping, where the mapping module provides automated mapping functions for the outputs of the social value module and the value transfer module. The mapping

module provides automated mapping function for the output of social value module and value transfer module[23]. The social value module transforms the value of different types of ecosystem cultural services and their related elements into measurable values, and takes into account factors such as spatial distribution, weight distribution, and prediction error, so as to realize a comprehensive and accurate assessment of the value of ecosystem cultural services, and the ecosystems that have been applied include villages[24], national forest parks[25], etc. The running process of the SolVES model is shown in Figure 5. The social value module will generate lambdas file during the running process, the research area which lacks the original survey data can use the lambdas file to simulate the original survey data of the area, and combine with the environmental layer data of the area to assess the social value index through the SolVES model value transfer tool.

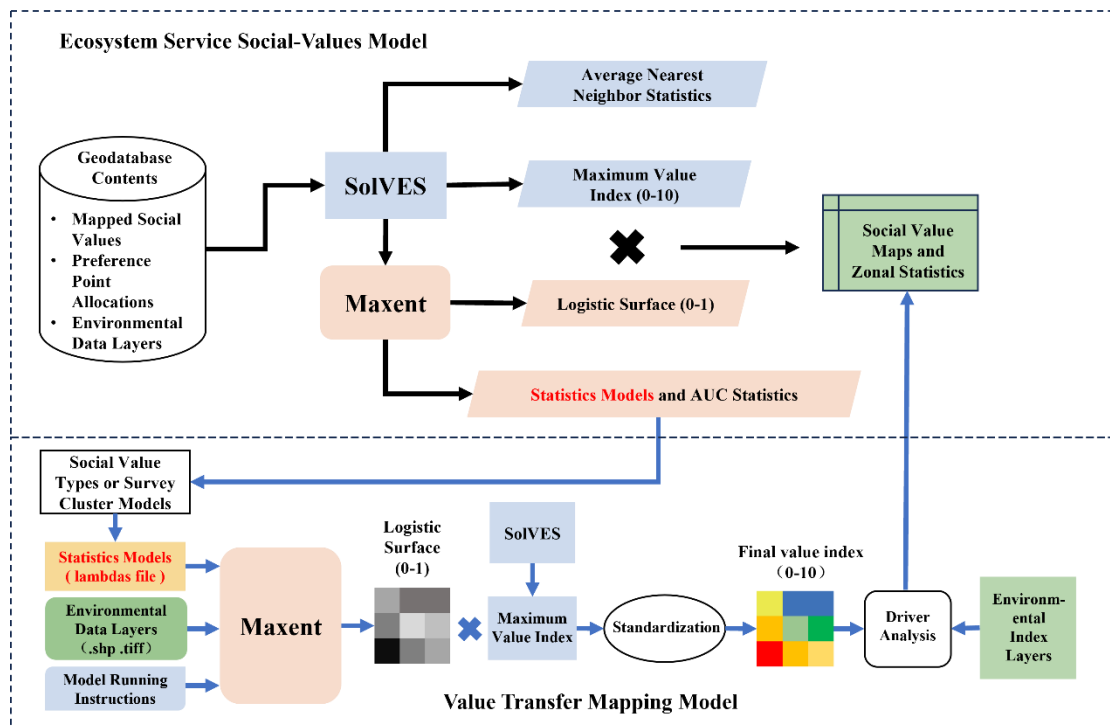


Figure 5. The Image Solves Model Run Flow

5. CONCLUSION

In this paper, various technologies such as online questionnaires, drone aerial surveys, WebGIS and cloud servers are used in a comprehensive way to develop a WebGIS blue-green space questionnaire survey system based on cloud servers. The questionnaire collects feedback and satisfaction from respondents about the park's cultural services, including information on service quality, facility conditions, and event organization, providing multi-dimensional data that helps to gain insight into respondents' needs and feelings. Orthophotos and 3D models of the parks are produced by drone aerial surveys and published using WebGIS to provide real-world references for respondents to fill out the questionnaire, thus obtaining more accurate and reliable social value preference data. Combining the social value preference data with the SolVES model for further spatial analysis and value model construction enables a more comprehensive assessment of the distribution and impact of cultural services in different regions, and allows for the analysis of the differences in cultural services between different regions or parks, helping decision makers to better understand the distribution and coverage of services. The cloud server bridges the gap between the cultural service questionnaire and the respondents, which not only saves a lot of hardware and software purchasing costs, but also enables the addition of unofficial data such as drone aerial survey images to WebGIS. The cloud server-based cultural service evaluation system combines artificial intelligence and big data analytics

to analyze and mine respondent feedback and geographic data more deeply, providing more precise insights. Subsequently, by fusing various environmental sensor data and big data technology, it can realize intelligent park management, intelligent city management, promote smart city development, improve the accuracy and intelligence of cultural services, and optimize public resources.

CONFLICTS OF INTEREST

The authors declare that they have no conflict of interest.

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