CLASSIFICATION AND IDENTIFICATION OF ARTIFICIAL LAKES BASED ON NATIONAL GEOGRAPHIC-CONDITIONS DATA

Zhiwu Zhou[a], Shengyuan Jing[a]*, Yinxi Gong[a], Hui Zhao[a]

[a] National Geomatics Center of China, Beijing, China

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ABSTRACT

In recent years, the issue of violations or over-exploitation in artificial lake projects have attracted gradual concern. In the initial stage, in order to determine whether there are violations or over-exploitation in the artificial lake project, it is necessary to accurately identify the status of artificial lakes. Because of the relative lack of water resources along the Yellow River, issues such as the contradiction between supply and demand as well as the protection of ecological environment have become increasingly prominent. Besides, the situation of development of artificial lakes along the Yellow River has become serious, increasing the pressure of utilizing water resources along the Yellow River. Therefore, the identification of status of artificial lake is of great significance in ecological supervision of the Yellow River.

Under this context, this paper takes the Yellow River as the research area. Based on the land cover data in the multi-temporal geographic national conditions, using spatial analysis, automatic identification and manual differentiation etc., to develop a rapid classification system of artificial lakes to classify the artificial lakes along the Yellow River, tracking and analyzing its annual changes, and finally establishing an artificial lake classification database and an artificial lake change database. Realizing the effective identification and supervision of changes in the artificial lake. Through experiments and analysis of existing data, this paper summarizes a set of indicators for determining the characteristics of artificial lakes, and proposes a set of effective artificial lake identification approaches. It provides an important basis for the follow-up supervision of artificial lake, and also establishes a basic framework for identifying other surface geographic-conditions, which has important theoretical and practical significance in the application of national geographic-conditions data.

1. INTRODUCTION

An artificial lake is a kind of lake that people have planned and purposefully excavated and constructed, rather than being produced in the natural environment. The main manifestations are landscape facilities and water storage devices.

With the development of our country's economy and society, the city's requirements for the ecological environment have further improved. Some cities have begun to launch artificial lake projects, mainly including the construction of landscape parks along rivers and lakes, wetland parks and other artificial landscape facilities. Among various artificial lake projects, some artificial lakes developed in accordance with local conditions have improved the urban environment(Ziyu, 2015), promoting the harmonious development of economy, society and environment. However, there are also some projects that fail to follow the approval procedures, illegally divert water, and occupy cultivated lands illegally, destroying the original ecological environment and seriously affecting the sustainable development of the ecological environment(Shaofeng et al., 2016; Wei and Jun, 2005).

National geographic-conditions is the sum of the basic conditions and characteristics of the natural environment and natural resources closely connected with geographic space(Deren et al., 2012). In 2015, China completed the first national geographic-conditions survey and obtained the first high-precision geographic national information of landscapes, forests, water, fields, lakes and grasses within the territory. In 2016, we began to conduct national geographic-conditions monitoring(Chaofei, 2018; Fangting et al., 2020). At present, five versions of geographic national database for 2015-2019 have been built, and it provides effective data support for the identification of artificial lakes. Aiming at the phenomenon of illegal development of artificial lakes, this article intends to use national geographic-conditions survey data and national geographic-conditions monitoring data to identify, extract and analyze changes in artificial lakes on an yearly basis, so as to improve the scientific and timeliness of decision-making. It can also effectively supervise the utilization and development of natural resources, which has important theoretical and practical significance in ecological environment protection, cultivated lands protection, and promotion of harmonious social development(Fangting et al., 2018).

2. RESEARCH AREA AND DATA SOURCE

2.1 Overview of the Research Area

The Yellow River is the second largest river in our country. It is the cradle of the Chinese nation, and it is an important river in Northwest and North China(Songgui and Bingyan, 1996). The Yellow River plays a very important role in our country's economic and social development and ecological security (Jinliang, 2020; Yellow River Conservancy Commission, 2013). The ecological protection and high-quality development of the Yellow River Basin has become a major national strategic requirement (Jinliang, 2020).

The ecological environment of the Yellow River Basin is special, and the water resources are relatively poor. With the rapid development of economy, the social activities in the Yellow River Basin are active, making the Yellow River's water resource carrying capacity, supply and demand contradiction, ecological environment and other problems increasingly prominent (Junbiao et al., 2012; Xi-yuan and Li-fang, 2006). And the pressure of securing the supply of water for the industrial and agricultural production as well as for the living water grows greater(Changming et al., 2020; Xiao et al., 2011; Xueping et al., 2007; Yanli and Shuzhen, 2001). In recent years, cities along the river have diverted water from the Yellow River to build artificial lakes, which has increased the pressure on water resources utilization in the Yellow River Basin. At the same time, in the process of building artificial lakes, illegal activities such as "digging fields to create lakes" and "digging lakes to create landscapes" appeared occasionally. The Ministry of Natural Resources or other departments have repeatedly requested rectification of abovementioned issues. In light of these factors, the Yellow River Basin is selected as the research area of artificial lake identification. With the analysis of national geographic-conditions data, the artificial lakes in the Yellow River Basin is identified efficiently and accurately. This method will improve the level of data utilization, providing basis and reference for subsequent decision-making.

2.2 Data Source

National geographic-conditions data include three types of data: landform of the earth surface, land cover and important element data of the national geographic-conditions. Each type of data is identified by a unique geographic information classification code (Bibo et al., 2017; Office of the State Council for the 1st General Survey of National Geographic Conditions, 2013a; Office of the State Council for the 1st General Survey of National Geographic Conditions, 2013b). The data can effectively reflect the spatial distribution and development of resources, environment, ecological and economic factors (Yan, Z.et al., 2016). Therefore, the main data sources used in this paper are as follows:

1. Land cover data of the China's first national geographic-conditions survey in 2015.
2. Land cover data of the national geographic-conditions monitoring in 2019.
3. Point of Interest (POI) data of Mapworld in 2019.
4. Element data of the national geographic-conditions monitoring in 2019.

The main data source of this research method is national geographic-conditions data. The main types of data are shown in Table 1.

Database name	Data type	Data name	CC/ Dataset name	Data description
National Geographic-conditions Data	Land Cover Data	Water Surface	1001/ Land Cover Dataset	The coverage of liquid water surface in rivers, canals, lakes, reservoirs, ponds and sea surface
	Element Data	Urban Comprehensive Functional Units	1140/ Urban Dataset	Residential areas, industrial and mining enterprises, unit courtyards, leisure and entertainment area, scenic spots, sports venues
		HYDA	Water Network Dataset	High water boundary of rivers, lakes, reservoirs and ponds
Mapworld Data	POI			Hood and beverage, sports and leisure, real estate community, shopping, life services, medical and health, hotels, tourist attractions, culture and education, transportation facilities

Table 1. The data situation

In the land cover data of the national geographic-conditions data, the water surface (Classification Code: 1001) classification includes the coverage of liquid water surface in rivers, canals, lakes, reservoirs, ponds and sea surface. The data can meet the requirements of artificial lakes extraction.

The element data of national geographic-conditions include the urban comprehensive functional unit data (Classification Code: 1140) in the urban area dataset, and the hydrosphere data (HYDA) in the water network dataset. Among them, the data of urban comprehensive functional units include residential areas, industrial and mining enterprises, unit courtyards, leisure and entertainment area, scenic spots, sports venues and other information. The hydrosphere data (HYDA) includes the high water boundary of rivers, lakes, reservoirs and ponds.

The point-of-interest (POI) data of Mapworld mainly includes food and beverage, sports and leisure, real estate, shopping, life services, medical and health, hotels, tourist attractions, culture and education, transportation facilities and other information.

3. ARTIFICIAL LAKE IDENTIFICATION INDICATORS

The water surface data in the land cover data includes all natural water surface and artificial water surface. Therefore, it is necessary to filter the artificial water surface according to the POI data and the element data of the national geographic-conditions.

In this paper, a suspected artificial lake is defined as a spot with area of more than 5,000 square meters and within 1.5 kilometers of the POI or national geographic-conditions element data.

The suspected artificial lake spots were compared with the national geographic-conditions monitoring images. According to

checking whether there are obvious artificial shoreline, artificial dike, artificial excavation trace and other obvious artificial facilities and structures around the map spot, the suspected artificial lake map spots are classified. The classification standard is shown in Table 2.

Type	Classification		Classification description
Artificial Lake	Artificial lake digging	Artificial landscape	A park, landscape, etc. with obvious artificial decoration
		Reservoir built by digging	Regularly shaped reservoirs with obvious artificial dams and shorelines
		Pond	Within the farmland village, regular puddles and fish ponds with traces of manual excavation
		Others	Other water surfaces with artificial traces
	River damming	Landscape River	Obviously artificial river course in the city
Non-artificial Lake	Reservoir, natural lakes, course/canals		Natural, non-artificial water area

Table 2. The classification standard of the artificial lake

For the map spot identified as artificial lake, it is necessary to determine whether the map spot is a changed map spot. The main basis is that there is a spatial morphology difference before and after the map spot changes, which is not caused by a position shift. Further analysis of the change patterns can be divided into two categories: completely added and partially added. If the newly increased water surface area from 2015 to 2019 is more than 9 times larger than 2015 water surface area, the map spot can be determined as completely added artificial lake. If the newly increased water surface area from 2015 to 2019 is less than 9 times of 2015 water surface area and more than 1 times of 2015 water surface area, the map spot can be determined as partially added artificial lake.

4. ARTIFICIAL LAKE EXTRACTION SCHEME

According to the above data and the setting of artificial lake identification indicators, this paper adopts the combination of ArcGIS spatial analysis and manual differentiation to establish artificial lake identification classification database and carry out statistical analysis on related data. The detailed technical scheme process is shown in Figure 1.

1. Data pre-processing. Based on the results of the land cover data of the national geographic-conditions monitoring in 2019 ,the research extracts the water surface map spots with an area of more than 5000 square meters as the basic data for artificial lake identification;
2. Automatic identification of suspected artificial lake. Based on the POI data of Mapworld and element data of the national geographic-conditions monitoring, the water surface map spots, which have POI data in the area of 1.5 km, are extracted as the suspected artificial lake;
3. Manual classification and verification. The artificial lake is differentiated artificially according to the artificial lake identification indicators based on the national geographic-conditions monitoring images in2019. Combined with the spatial form, location and surrounding environment of the suspected artificial lake, the artificial lake is determined comprehensively. The map spots identified to be artificial lakes are integrated according to the spatial proximity relationship and names, and the salty, sweet and bitter lake in the water network data set are eliminated to obtain the final artificial lake dataset for 2019;
4. Analysis of changes of the artificial lake. The artificial lake data is superimposed with the China's first national geographic-conditions survey data in 2015. By comparing the spatial form, location relationship, and area changes of the artificial lake before and after the change, the change of the artificial lake is identified, and the new artificial lake dataset for 2015-2019 is formed.

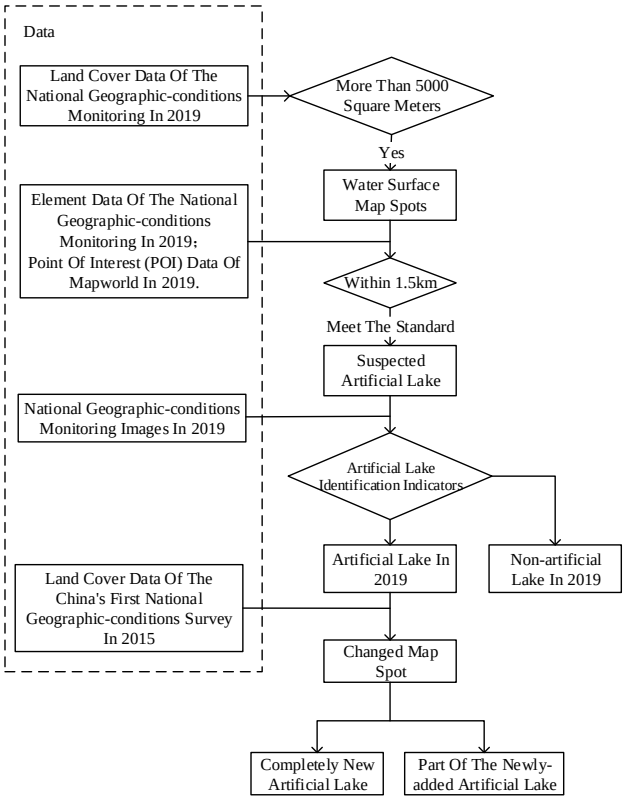

Figure 1. Flow chart of artificial lake identification and classification scheme

5. RESULTS AND ANALYSIS

According to the above technical scheme and artificial lake identification indicator, this paper uses ArcGIS and Python script to batch process the artificial lake map spots covered by the

surface, and extracts the suspected artificial lake map spots.

Because the classification and differentiation of artificial lakes requires the support of remote sensing images, and the task amount of artificial lake manual differentiation is large, this paper uses Python batch processing to output remote sensing image and water surface pattern vector data as image files, and develops a web-based rapid classification system for artificial lakes. In this system, the artificial lake shown in the picture is classified according to the identification indicator of artificial lake, and the classification information is submitted. A complete set of artificial lake type database is established through the rapid classification system of artificial lake. The identification of artificial lake classification through this system saves data loading and file reading time, and improves the speed of manual differentiation. Typical classification results are shown in Figure 2.

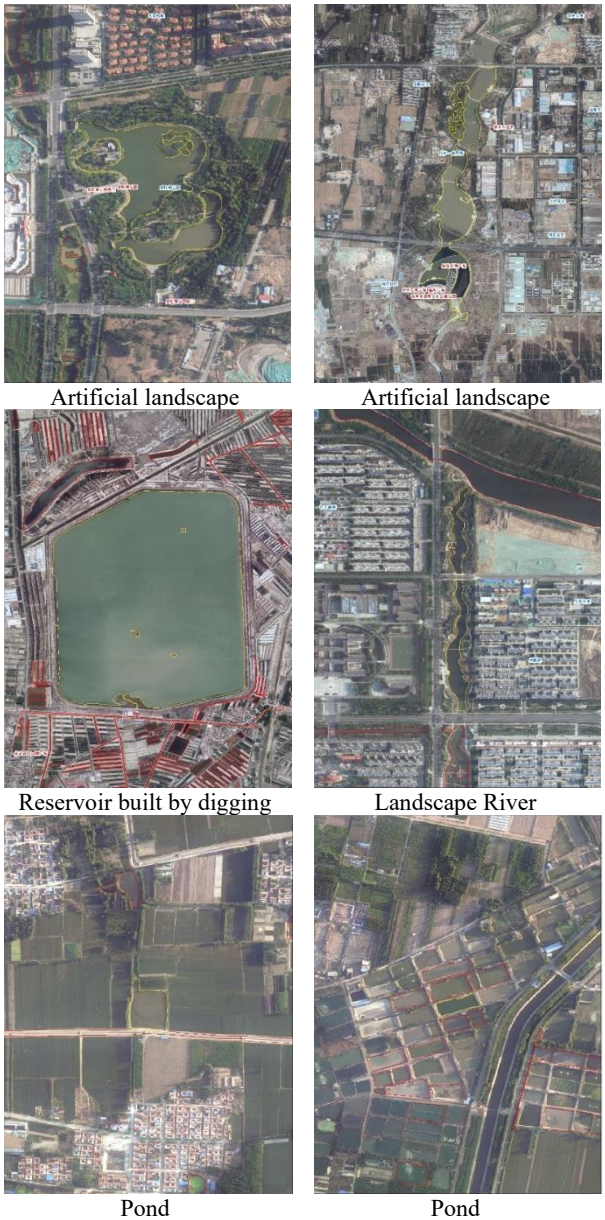

Figure 2. Schematic diagram of typical artificial lake classification

Through the analysis of the manual differentiation results, it can be seen that according to the proposed artificial lake identification indicators, the characteristics of artificial landscaping, reservoir built by digging, and landscape river are relatively clear, and the distinction can be better completed. However, the determination of pits and ponds is still relatively vague, and the distinction between puddles and fish ponds needs to be further clarified.

After determining the artificial lake data in 2019, the study superimposes it with the land cover of the China's first national geographic-conditions survey water surface data in 2015 to obtain the change part, and output the change result as a picture. Through the artificial lake rapid classification system, the spatial change relationship is identified, and it is determined that it is partly new, completely new or unchanged. The results of the artificial lake change are shown in Figure 3. The blue area is the water surface range in 2015. The green area is the water surface range in 2019. And the red area is the intersection range of the data in 2015 and 2019. According to the spatial position relationship of the two-year data, the changes of the artificial lake can be determined. In Figure 3, there is almost no red intersection area between a and b, so it is determined as a completely new artificial lake. The red intersection area of c and d is more obvious, the green area is larger, and there is a significant spatial position change compared with the blue area, so it is determined as a part of the newly-added artificial lake.

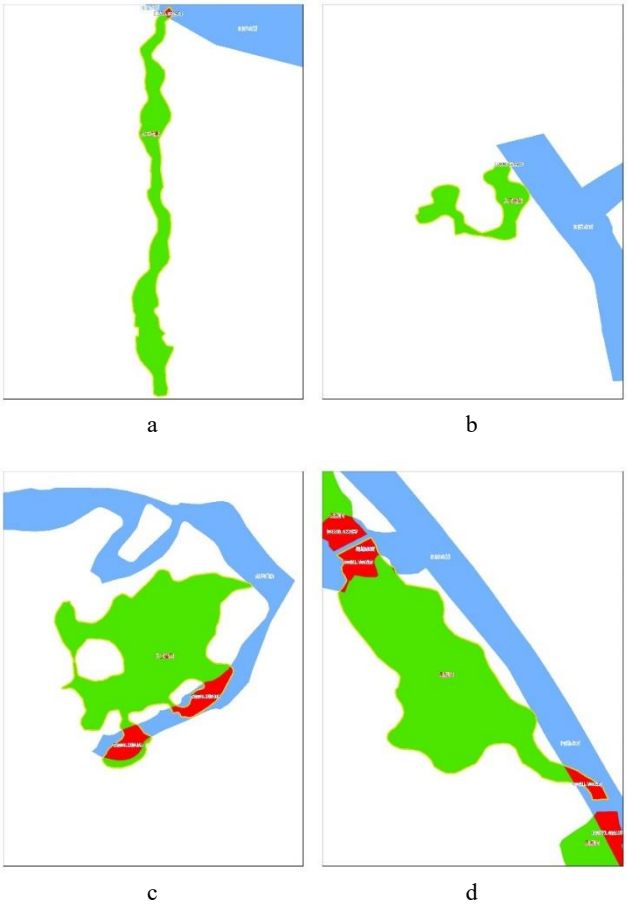

Figure 3. Schematic diagram of artificial lake change determination

In order to get the change information of artificial lake better, the change time of artificial lake is analyzed by multi-temporal image of the national geographic-conditions monitoring. The

typical change is shown in Figure 4. Through the result analysis of the change time, the change time of the artificial lake can be obtained. At the same time, the land use status before the area change can be obtained, so that it can be determined whether there is any violation of the artificial lake project.

2017 2018 2019

Figure 4. Change time of artificial lake

Through the analysis and verification of the experimental results, the artificial lake extraction scheme proposed in this paper can better support the extraction and change analysis of artificial lakes in a large area. The artificial lake extraction and classification results are more accurate. This method improves the speed of data pre-processing, uses an artificial lake rapid classification system to browse and classify pictures, establishes an artificial lake classification database, and improves the speed of data reading and storage of artificial lake classification attributes. It can be seen that the artificial lake identification indicator and the artificial lake extraction scheme proposed in this paper can quickly extract and classify the artificial lake within the research scope, and analyze the change of the artificial lake. The results of identification, classification and change of artificial lake are more accurate.

6. CONCLUSION

Aiming at the over-exploitation and illegal development of artificial lakes in the field of natural resources in recent years, this paper provides an artificial lake extraction method based on national geographic-conditions data. This method can quickly identify and classify the changes of artificial lakes in a large area, and provide an effective data for natural resource investigation and monitoring. This method applies national geographic information to the investigation and monitoring of natural resources, and gives full play to the role of geographic national conditions data, which is of great significance to the supervision of over-exploitation of artificial lakes.

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