Construction and Application of the Information Platform for Coastal Surveying and Mapping in the Pearl River Estuary Based on WebGIS

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Abstract. With the continuous development of remote sensing technology, more diverse and detailed remote sensing data are widely used in the field of ecological environment monitoring, and at the same time, new data application and processing methods are born by virtue of its high resolution, high precision and high timeliness. In this regard, taking the coastal morphology of the Pearl River Estuary as the research object, according to the actual project requirements, this paper designs and develops a set of information platform for coastal surveying and mapping of the Pearl River Estuary based on WebGIS, so that users can quickly complete the loading, extraction, analysis and calculation of remote sensing data. The platform will focus on the extraction and analysis of Landsat, TM and ETM images from 1990 to 2020 in three directions, namely, the coastline of the Pearl River Estuary, the tidal flat area and the planned land use of the Pearl River Delta, so as to obtain the process, characteristics and laws of temporal and spatial changes and achieve the purpose of dynamic monitoring of the ecological environment in this area. The results show that the green space and water area in the Pearl River Estuary have been decreasing continuously in the past 30 years, and the trend of coastline change is obviously correlated with the trend of tidal flat change. It is necessary to strengthen the ability of ecological environment detection and risk prevention in the Pearl River Estuary and promote the comprehensive management of the Pearl River Estuary.

Keywords: WebGIS; remote sensing technology; Pearl River estuary coast; dynamic detection; computer application

1 Introduction

The Pearl River Delta, located in the south-central part of Guangdong Province, is a delta where river networks and residual estuaries coexist. The landforms of the Pearl River Estuary include hilly platform, hilly mountain, alluvial plain and coastal plain, and also contain a large number of coastal beaches distributed in the coastal zones of the West and North deltas and the coastal zones of Lingding lay and Huangmao sea estuaries. The diverse biological species in the Pearl River Estuary not only provide convenient conditions for the development of aquaculture industry, but also carry the

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exchange of materials, energy and information in the landing sea. It is an important wetland ecosystem in China and an important part of the global "blue carbon" system. [1]

However, with the rapid development of economy and the acceleration of urbanization in the Pearl River Estuary, the natural coastline and tidal flat wetlands in the Pearl River Estuary have experienced certain consumption and destruction, resulting in the variation of coastline and estuary morphology, and the use and coverage of coastal land have also shown corresponding changing characteristics, thus affecting the ecological environment of the Pearl River Estuary. Therefore, it is of great significance to actively carry out dynamic change monitoring, evolution law analysis and formation mechanism research in the coastal zone of the Pearl River Estuary. In view of this, according to the research progress of dynamic change monitoring of coastal zone by means of remote sensing and GIS at home and abroad, combined with the analysis of spatial change of coastline of Duogelan Lake and Prespa Lake by using Landsat image and GIS technology by Arse Kuzmanoski[2] and others; evolution analysis of the coastline of Taman Bashan Delta on the north coast of Kenya based on satellite images made by Daniel newton Aketch[3] and others; as well as the stability evaluation scheme of the central coastal coastline of Suzhou proposed by Zhao Bingxue [4] and others, this paper puts forward a set of construction scheme of surveying and mapping information platform based on WebGIS, and puts forward a complete workflow and implementation means for realizing the dynamic monitoring of coastal ecological environment. By interpreting and processing the remote sensing data of the Pearl River Estuary from 1990 to 2020, it compares the tidal flat area in different periods and the change trend of the planned land use in the Pearl River Delta, and provides the necessary theoretical basis and decision support for the ecological environment protection of the Pearl River Estuary in the future.

2 Data sources and platform construction

2.1 Data overview

The research data in this paper are obtained from the geospatial data cloud (www.Gscloud.Cn), with the rank number of 117031. The data in 1990 were obtained from Landsat5Tm satellite digital products, and the data from 2000 to 2020 were obtained from Landsat8 Oli_ Tirs satellite digital products. As shown in Figure 1, 1-1 is Landsat-5 TM image in 1990, 1-2 is Landsat-8Oli_Tirs image in 2000, and 1-3 is Landsat-8Oli_Tirs image in 2020.

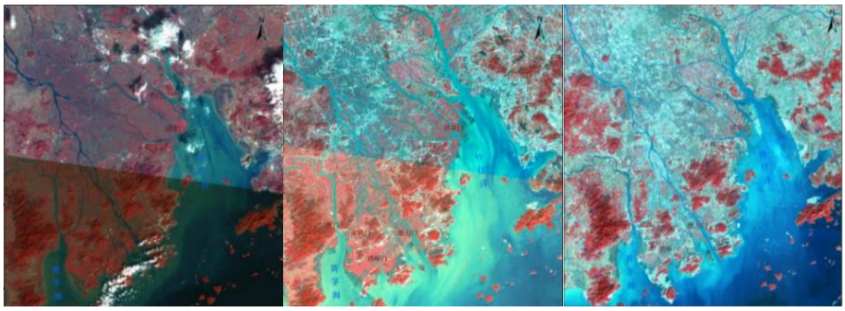

Fig. 1. Remote sensing images of the Pearl River Estuary (1-1, 1-2, 1-3 from left to right)

The accuracy evaluation of remote sensing image classification and recognition results adopts statistical method based on confusion matrix, and Kappa coefficient is used as evaluation index. Kappa coefficient is a comprehensive reflection of the matching degree between the classification recognition map and the reference map, and its calculation result range is -1~1, but kappa usually falls between 0~1. It can be divided into five groups to represent different levels of consistency: 0.0~0.2 represents extremely low consistency, 0.21~0.40 represents general consistency, 0.41~0.60 represents moderate consistency, 0.61~0.80 represents high consistency, and 0.81~1 represents almost complete consistency. The classification accuracy and Kappa coefficient of the Pearl River Estuary in each year are shown in Table 1. [5]

Table 1. Classification accuracy and Kappa coefficient of each year

Time	1900	2000	2010	2020
Classification accuracy	92%	91%	90%	91%
Kappa coefficient	89.38%	88.64%	88.45%	89.49%

2.2 Platform construction

The Pearl River Estuary coastline mapping information platform is built with WebGIS framework as the core, and its overall structural framework is divided into three parts: presentation layer, business logic layer and data service layer. Figure 2 shows the structural frame of the platform. In the overall development environment deployment of the platform, the configuration of ArcGlS Server needs to be coordinated with the remote sensing image processing platform ENVI IDL. Set the cache directory, job directory, output directory and other items under ArcGIS Desktop, and also establish SDE Geodatabase in ENVI software to complete their integration and connection. [6] For the Web project of the presentation layer, Javaweb technology is needed to complete it, and ArcGIS API for JavaScript, jQuery and other components are introduced to complete the data communication between the front end and the back end by combining init.js and dojo.js class library, so as to achieve the acquisition and response of user requests.

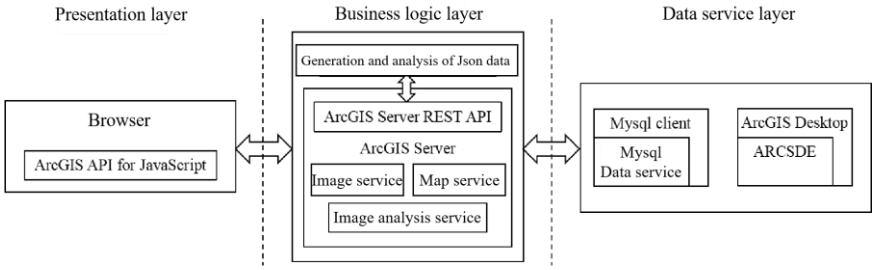

Fig. 2. Platform structure framework

3 Functional implementation

3.1 Extraction and analysis of the Pearl River Estuary coastline

After logging in to the platform, users can extract the waterline by preprocessing many remote sensing images such as radiometric calibration, atmospheric correction, orthorectification and geometric registration according to the data processing flow of the platform. Based on the waterline extracted from the remote sensing image, the measured data or high-resolution images are verified and modified by visual interpretation method, and the accurate and complete interpretation results close to the actual feature information are obtained. The extracted results are combined with GIS technology for overlay mapping, and finally the general process of its change is integrated and compared. [7]

In the process of extracting the coastline of the Pearl River Estuary, two parameter variables, the ratio of coastline structure and the intensity of coastline change, will be introduced to describe the changing trend of natural coastline and artificial coastline and the changing situation of coastline in the annual time range respectively. Formula 1 is the calculation method of coastline structure ratio, L1 is the natural coastline length and L2 is the artificial coastline length. Formula 2 is the calculation method of coastline strength, LCIij is the change intensity from the first year to the j year, Li is the specific length of the coastline in the first year, and Lj is the specific length of the coastline in the j year [8].

$$LSV=\frac{L_1}{L_2} \tag{1}$$

$$LCI_{ij}=\frac{L_j-L_i}{L_i\left(j-i\right)}\times 100 \tag{2}$$

In this paper, the object-oriented analysis method is adopted, and the object composed of multiple adjacent pixels containing more semantic information is taken as the processing unit, which can realize a higher level of remote sensing image classification and target feature extraction in the development of a system. Moreover, based on the strong absorption characteristics of water area in mid-infrared band, this paper

establishes corresponding rules, extracts and obtains the water area in Landsat remote sensing images in 1991, 1995, 2001, 2005, 2009, 2015 and 2020, and obtains the change results of the coastline of the Pearl River Estuary according to GIS spatial calculation, as shown in Figures 3 and 4.

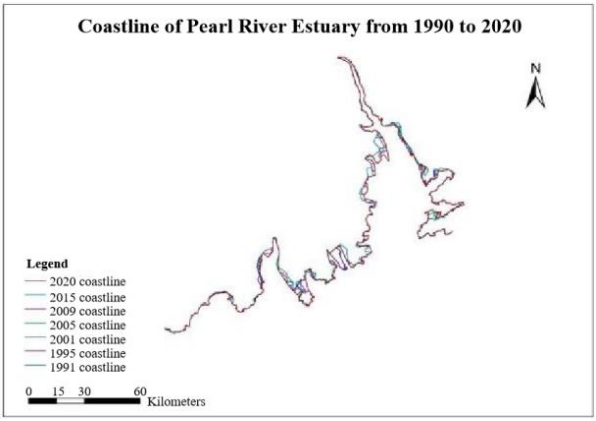

Fig. 3. Change of Pearl River Estuary coastline

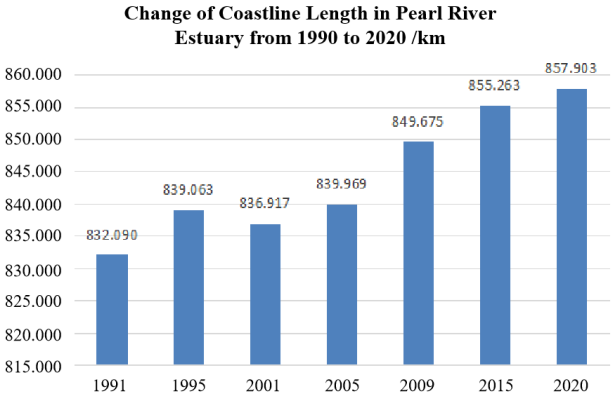

Fig. 4. Change value of Pearl River Estuary coastline

According to the analysis of the coastline of the Pearl River Delta region from 1991 to 2020, ① the coastline with great changes is mainly concentrated near the estuary of Badakoumen, especially in the south of Zhuhai, the south of Guangzhou and the Qianhai area of Shenzhen; ② on the east and west banks of the Lingdingyang Ocean in the Pearl River Estuary, there are great differences in the spatial position of the coastline, with little change on the east bank and relatively complete coastline; the coastline of the west bank changes greatly and the coastline is broken; compared with the west coast, the coastline on the east coast of the Bay Area shows horizontal movement. Through the analysis of the graph, the trend of coastline change can be obtained, which provides the basis for subsequent data processing and analysis.

3.2 Analysis of temporal and spatial characteristics of tidal flat area change in the Pearl River Estuary

For the extraction of tidal flat area in the Pearl River Estuary, users can use the FeatureTo Polyline function of ArcToolbox under the platform to convert the isobath into polysemy and assign related fields, and at the same time, use the Up-date function to compound the extracted tidal flat polygon and isobath polygon into the same layer, and then get the classified calculation results of tidal flat area in the Pearl River Estuary through Calculate A rea. [9] Similarly, after extracting the tidal flat area from Landsat satellite remote sensing images, users can intuitively see the changing process of the tidal flat in the Pearl River Estuary, as shown in Figures 5 and 6.

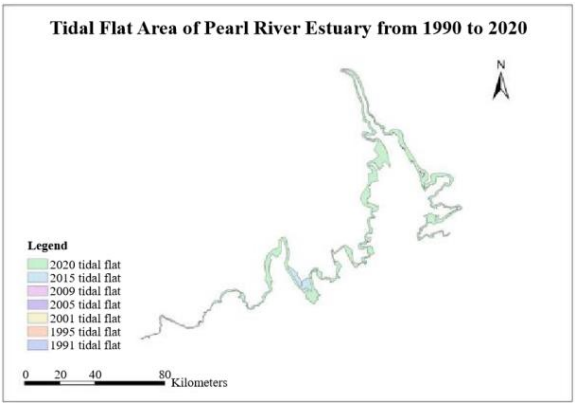

Fig. 5. Change of tidal flat area in the Pearl River Estuary

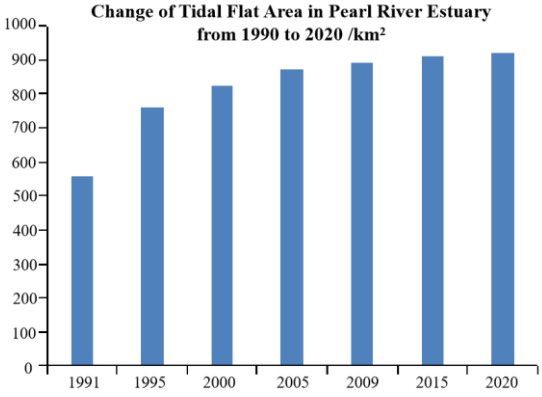

Fig. 6. Change value of tidal flat area in the Pearl River Estuary

According to the data of tidal flat area change in the Pearl River Estuary, during 1990-1995, the overall change of tidal flat area in the Pearl River Estuary began to increase, because the economic level began to increase during this period, and the

coastline was extensively reformed, which led to the increase of tidal flat area. During 1995-2005, the tidal flat area was pushed to the sea, which was mainly affected by human reclamation, and the area continued to grow. From 2005 to 2010, the coastline continued to advance toward the sea on the basis of 1990-2005, and the advancing speed began to be flat. Land reclamation was the main influencing factor for the change of beach area during this period. During 2010-2020, beaches and coastlines continued to push towards the sea, reaching a historical peak in 2020.

3.3 Analysis of land use change in Pearl River Delta

The platform can support users to complete the dynamic study of land use in the Pearl River Delta, and complete the qualitative and quantitative explanation of the change rate according to the results of spatial analysis and calculation. Referring to "Classification of Land Use Status" and the current land use status in the Pearl River Delta, two-level classification criteria are selected to classify the land use in the study area. [10] At the same time, according to the principle of remote sensing image interpretation, it is decided to divide the structural distribution in the study area into six categories: farmland, grassland, woodland, artificial surface land, water area and other land. The interpretation map of land use dynamic change in 1990, 2005 and 2020 is shown in Figure 7, and the relevant statistics are shown in Table 2 and Table 3.

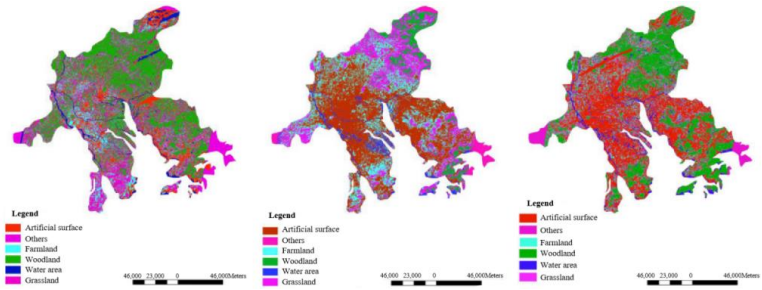

Fig. 7. Interpretation map of land use dynamic change in the Pearl River Delta (from left to right, 1990, 2005 and 2020 respectively)

Table 2. Statistical table of area of various land types in 1990, 2005 and 2020

1990	code	Area/km^2	2005	code	Area/km^2	2020	code	Area/km^2
Woodland	1	6642.686	Woodland	1	1286.275	Woodland	1	5108.739
Grassland	2	4441.848	Grassland	2	3639.716	Grassland	2	1910.785
Farmland	3	2922.984	Farmland	3	4326.658	Farmland	3	2495.61
Water area	4	894.658	Water area	4	813.04	Water area	4	999.224
Artificial surface	5	3202.514	Artificial surface	5	8154.873	Artificial surface	5	7730.627
Others	6	687.86	Others	6	571.988	Others	6	547.566
Total area	18792.55		Total area	18792.55		Total area	18792.55	

Table 3. Dynamics of land use types (%/a)

Land use type	1990-2005	2005-2020
Woodland	-5.38%	9.81%
Grassland	-1.20%	-3.17%
Farmland	3.20%	-2.82%
Water area	-0.61%	1.53%
Artificial surface	10.31%	-0.35%
Others	-1.12%	-0.28%

According to statistics, during the period of 1990-2020 in the Pearl River Delta region, a large number of woodland and farmland flowed into artificial surface land, but only a small amount of artificial surface land was converted into farmland and woodland. Some waters and aquaculture land flow into artificial surface land. The increasing area of artificial surface land shows that the expansion of artificial surface land is the main manifestation of the spatial dynamic expansion of the Pearl River Estuary. Compared with 1990-2005, the change rate of artificial surface land in 2005-2020 is higher, which reflects the progress of urbanization rate.

4 Conclusions

In order to optimize the application effect of remote sensing technology in the field of ecological environment monitoring, this paper combines remote sensing technology with geographic information system technology to build a surveying and mapping information application service platform. Through the application demonstration of the coastline of the Pearl River Estuary, tidal flat area and planned land use in the Pearl River Delta, the platform analyzes the reasons for the continuous decrease of green space and water area in the Pearl River Estuary in the past 30 years, and the correlation between the coastline structure ratio in the coastline change parameters and the change index in the process of land use change, which provides data support for the subsequent ecological environment detection and risk prevention construction in the Pearl River Estuary. In the follow-up research, based on the deficiency of data application analysis in the current research, we will continue to improve and deal with it, and further improve the coastline length, coastline structure ratio, coastline change intensity and land use spatio-temporal change model, so as to provide necessary reference for ecological environment protection and planning and development.

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