Dynamic Change Monitoring of Coastal Environment Based On Domestic GF Images

Pengfei Li, Mutao Huang* and Jinmeng Wang

School of Hydropower and Information Engineering, Huazhong University of Science and Technology, NO. 1037, Luoyu Road, Wuhan, Hubei, China.

*Corresponding author

Abstract. Based on independent GF remote sensing images, DEM data, GIS data and other data resources and computer technology, this paper developed a B/S version of the coastal zone environmental dynamics monitoring system for on-line monitoring of coastal land type changes. This paper selects the coastal zone of Wenchang City in Hainan Province as a research object, and uses remote sensing technology and post-classification change monitoring methods to perform online pre-processing and change monitoring for the GF remote sensing images of 2016 and 2018, and demonstrates the obtained coastal land change results in the form of graphs. By analyzing the graphs display results, can clearly understand the changes in the land types of the coastal zone, and effectively provide the basis for government departments to govern the sea environment.

1. Introduction

As a boundary area formed by interaction of ocean and land, the coastal zone is the region with the highest degree of economic development, the most frequent use of resources, and the most fragile ecological environment in China. In recent years, with the development of social economy, humans have carried out different development activities on the coastal zone, causing the resources and environment of the coastal zone to change constantly, and many problems that are not conducive to sustainable development to emerge. Therefore, real-time monitoring of the coastal zone is needed to facilitate timely, accurate and efficient access to various land use information, so as to realize scientific management and effective utilization of coastal resources.

At present, there is no uniform and strict definition of the coastal zone in China, and there is no uniform standard for the width of the coastal zone, varying with the coastal geomorphology and research purposes. The main criteria for the division of coastal zones are as follows:①Natural signs: determining by obvious land marks or other marks;②Administrative boundaries: using the existing administrative divisions of the country such as provincial boundaries, municipal boundaries or county boundaries;③Political borders: mainly using the maritime boundaries set by the United Nations Convention on the Law of the Sea;④Any distance: using the arbitrary distance method by many countries to determine the boundary of the coastal zone in the direction of the land or the sea;⑤Environmental unit: demarcating the boundary of the coastal management area based on the selected environmental unit. In this paper, the range of the coastal zone selected is: a strip-shaped area extending 500 m to the land side and 500 m to the sea with the coastline as the boundary.

Due to complex terrain of the coastal zone and difficulty in obtaining data, it is very difficult to obtain the change information in time by using traditional monitoring methods. Remote sensing technology has the advantages of high efficiency and rapidity, providing a convenient modern method for
monitoring the dynamic change of the coastal environment. Based on WebRS, Node.js, IDL and other
technologies, this paper develops an online coastal zone environment dynamic change monitoring
system, which can realize rapid image preprocessing, image interpretation classification, image change
monitoring and other processes, and demonstrates the results of the changes in the form of graphs in
the user interface, is convenient for users to use, provides technical support for the dynamic change
monitoring of the coastal zone, and provides a support platform for ecological environmental
protection.

2. Study Area
The study area shown in figure 1 is located in the north of Wenchang City, Hainan Province, adjacent
to the South China Sea to the east, bounded by Qiongzhou Strait to the north, and across Dongzai
Port to the west facing Qionghai City. Its geographical position is 110°33’18”~110°57’38” E, 19°56
’39”~20°10’4” N. The sea area is vast and the coastline is 83.25km long. There are more than 20
large and small harbors in Dongzai, Mulan and Paqian. The shoreline is straight and is a typical
coastal sandy coast.

3. Data Sources and Data Processing

3.1. Data Sources
According to the needs of remote sensing monitoring and the actual image available, two remote
sensing images of GF2 in the same area of Jinshan Town, Wenchang City, Hainan Province were
selected, which were December 2016 and September 2018 respectively. The GF2 remote sensing
image has panchromatic and multispectral, and the spatial resolution is 0.8 m and 3.2 m respectively.
and the GF2 satellite payload technical indicators is shown in table 1. In addition, the reference image
of 0.2 meters in Wenchang City in 2012 was also selected.
Table 1. GF2 satellite payload technical indicators.

| parameter              | 0.8m resolution panchromatic / 3.2m resolution multispectral camera |
|------------------------|---------------------------------------------------------------------|
|                         | panchromatic                                                         |
|                         | 0.45-0.90 μm                                                         |
|                         | 0.45-0.52 μm                                                         |
|                         | 0.52-0.59 μm                                                         |
|                         | 0.63-0.69 μm                                                         |
|                         | 0.77-0.89 μm                                                         |
| spectral region         | multispectral                                                        |
| breadth                 | 45km (two camera combination)                                        |
| revisit period          | 5 days                                                              |
| covering the period     | 69 days                                                             |

3.2. Data Processing

3.2.1. Image Preprocessing. During the acquisition process of the remote sensing image, due to the influence of aircraft attitude, height, speed and rotation of the Earth, the image is geometrically distorted relative to the ground target. This distortion appears as squeeze, twist, stretch, and offset of the actual position of the pixel relative to the ground target. In remote sensing image processing, remote sensing image preprocessing is required before remote sensing image application and remote sensing image mapping. Preprocessing can correct and eliminate deformations caused by photographic material deformation, objective distortion, atmospheric refraction, earth curvature, earth rotation, terrain fluctuation and other factors during remote sensing image imaging through a series of mathematical models. The deformations are generated when the geometric position, shape, size, orientation, and the like of objects on the original image are inconsistent with expression requirements in a reference system. Remote sensing image preprocessing mainly includes orthorectification, radiometric calibration, atmospheric correction, image registration, image fusion, image cropping, and image mosaic.

3.2.2. Classification of Image Interpretation. Image interpretation classification refers to a process of using interpretation marks and practical experience and knowledge to identify feature information from remote sensing images and represent them on a geographical base map. The interpretation and classification methods used in this paper mainly include ISODATA unsupervised classification, SVM (Support Vector Machine) classification and object-oriented classification. The ISODATA unsupervised classification is based on the theory of clusters and is a method of clustering statistical analysis of images by computer. It does not need to acquire prior knowledge in the classification process, and only relies on the distribution of spectral features of the ground features on the image to achieve classification. SVM (Support Vector Machine) classification is a process of identifying other unknown categories of pixels with sample pixels of the identified category. It needs to acquire prior knowledge before classification, select a certain number of samples for training in different categories, compare the trained samples with each pixel, and divide the pixels according to certain rules to complete the classification of remote sensing images. Object-oriented classification uses an edge detection image segmentation algorithm based on Sobel operator. It continually iteratively merges adjacent objects according to the spectral information and spatial information between adjacent objects in the image, and merges adjacent objects that meet certain conditions into one object. The images are then classified according to the spectral characteristics and spatial information of the selected samples.

3.2.3. Image Change Monitoring. Remote sensing image change monitoring is a technique for quantitatively analyzing and determining the process and characteristics of feature changes based on remote sensing images of the same region in different periods. At present, modern remote sensing
technology has entered a new stage of development, can provide earth observation data in a fast, dynamic, multi-temporal, multi-platform and high-resolution manner. With the satellite obtaining high-resolution, multi-temporal and high-precision massive earth surface information all weather, all day and all round, how to use remote sensing images for change monitoring and how to automatically acquire relevant theories and techniques of changing regions from remote sensing data is an important direction and field for the development of remote sensing technology in the future, and is of great significance. In this paper, the post-classification change monitoring method is selected. The post-classification change monitoring is to respectively classify the two time-phase remote sensing images that have been registered, and then to compare classification results to obtain the change monitoring information. The post-classification change monitoring uses the features of texture, geometry and objects, and can better obtain the change information of land types.

4. Result Analysis

4.1. Classified Statistical Analysis
Classification statistical analysis is divided into statistical analysis of classification accuracy and statistical analysis of classification results. The statistical analysis of classification accuracy is to use the statistical method of the pie chart to perform secondary analysis and statistics on the classification accuracy confusion matrix, directly showing the accuracy of classification results, and making it easy for users to evaluate the effects of the classification. The statistical analysis of classification results mainly uses statistical tables and histograms to statistically analyze the results of various land types after classification. Users can intuitively obtain the regional classification results, as well as the number of pixels and land area of each land type, providing convenience for users to analyze and apply the classification results. In this paper, the accuracy of SVM classification results and object-oriented classification results in Wenchang City in 2016 were selected for demonstration. The accuracy of object-oriented classification is 83.7%, and the accuracy of support vector machine classification is 96.5%. By comparing and analyzing the two classification results shown in figure 2, it can be seen that the classification results obtained by SVM for this research area are better. Therefore, selecting the classification results of the two years obtained by the SVM classification for post-classification change monitoring can obtain more reasonable land type change information.

![Figure 2. The display of object-oriented classification result precision (left), the display of SVM classification result precision (right).](image)

4.2. Analysis of Change Monitoring Results
The statistical analysis of the change monitoring results mainly uses the form of land use transfer matrix and histogram to statistically analyze the changes of various land types on the same area in different periods. The land use transfer matrix can directly reflect the distribution of land types in different periods and the process of mutual transformation of various land types. The histogram mainly shows the distribution of land types in different periods. Users can intuitively obtain the distribution results of various land types in the region, the number of pixels of land types, the land area
and the mutual transformation process of various land types, so that users can have an intuitive and quantitative understanding and analysis and application of the change of land-use. According to the results shown in figure 3, the area change of land types in the research area from 2016 to 2018 can be seen. Compared with 2018 and 2016, the seawater increased by 0.338 square kilometers, the sandy land decreased by 2.747 square kilometers, the cultivated land increased by 2.409 square kilometers, the building land increased by 0.169 square kilometers, and the woodland decreased by 0.529 square kilometers.

![Statistical analysis of post-classification change monitoring results for 2016-2018](image)

**Figure 3.** The histogram display of post-classification change monitoring results.

5. Conclusion
From the change monitoring results, it can be concluded that the land area of the study area decreased from 2016 to 2018, because some beach areas were reduced and eroded due to human activities. Therefore, it is necessary to scientifically and effectively manage the coastal zone, and rationally layout the nature and scope of the use of waters. In this paper, only the post-classification change monitoring method is selected for research. Although some progress has been made, it is necessary to combine with the direct comparison method and other change monitoring methods for comparative analysis, and select more suitable research methods to obtain more reasonable monitoring results. Through effective monitoring of coastal zones, it can provide theoretical basis for government departments to conduct comprehensive coastal zone management, better serve urban construction.

Acknowledgments
This work was financially supported by the National Natural Science Foundation of China under Grant No. 51579108, the National Key R&D Program of China under Grant No.2017YFC0405900, the Fundamental Research Funds for the Central Universities under Grant No. 2017KFGXJ203.

References
[1] Wu Quanyuan, Hou Zhihua, Pang Jiewu, Jiang Chunling, Zou Min, Yang Shengjun. Remote Sensing Dynamic Monitoring on Changes of the Costal Zone in Longkou City During the Past 20 Years. Geo-Information Science, 2007(02):106~112.
[2] Wen Wei, Zhao Shuxuan, Wang Chunxiao, Wang Qian. The Research on Dynamic Monitoring Index System for Hainan Costal Zone. Geomatics &Spatial Information Technology, 2013, 36(07):177~179.
[3] Zhao Rui, Zhao Peng. Defining and International Comparing of the Conception and Scope of Coastal Zone. Marine Economy, 2014, 4(01):58–64.
[4] Wu Jisheng. Study on Landscape dynamics of the northern coastal zone in wenchang city, Hainan. Northeast Normal University, 2006.
[5] Bai Jueying, Xu Weijie, Guan Mingli, Zhou Li. Study on Landsat Images Land Use Dynamic Monitoring Methods of Coastal Zone. Bulletin of Surveying and Mapping, 2016 (2):84-86+119.