

STUDY ON DYNAMIC CHANGES OF MANGROVES BASED ON IMAGE INTERACTIVE INTERPRETATION SYSTEM

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ABSTRACT:

Mangrove is an important indicator of biodiversity (Feoli, 2001), its conservation is very important to protect the ecological balance of sea and coastline. More than 90% of the mangrove vegetation species of China in Hainan, and they are about half of the world. But, in recent years, some of mangrove forests haven't been protected well, and result in decreasing. How to monitor the dynamic changes of mangrove is a crucial problem to the conservation of mangrove ecosystem. For management department, it is necessary to know that the distribution, the amount and the dynamic changes in different periods of time. However, it is a difficult task for ground surveying because many mangrove forests grow in the beach of granule sediments in the bottom of sea. And the traditional ground surveying is not so efficient for the decision management and its protection because of the long period and the large expenses. Moreover, it can't provide the historic information by ground surveying. While remote sensing technology can quickly provide the dynamic macro-information for the objects on the surface of the earth, and it can deduce the historic information from the old remote sensing images and the background information. In our study, multi-temporal remote sensing images and its background sources was employed to complete investigation of the dynamic changes of the mangrove forest for Hainan Island in three different periods of time. This paper presents its principal methods and procedures.

1. INTRODUCTION

Mangrove-forest is a vegetation community formed by a variety of mangrove vegetation species Growing in the intertidal areas and estuary mouths between land and sea. Mangroves can provide critical habitat for a diverse marine and terrestrial flora and fauna. Mangrove forest beaches have an abundant nutrition and a good ecological environment for the marine creatures, for example, fishes, shrimps, crabs and spiral shells. Mangrove forests are one of the most productive and biodiversity wetlands on the earth. Thereby, this condition has formed the mangrove ecosystem. The large area mangrove forest is very important to protect the ecological balance of sea and coastline. Healthy mangrove forests are key to a healthy marine ecology. Yet, these unique coastal tropical forests are among the most threatened habitats in the world.

The mangrove forest in China mainly distributes in the coastline of Hainan, Fujian, Guandong, Taiwan and Guangxi Province. The largest area for mangrove forest is in Hainan Island. And the largest species and the best growing environment is also in Hainan. But, in recent years, some of mangrove forests haven't been protected well, and result in decreasing gradually. Experts point out that they may be disappearing more quickly than inland tropical rainforests, and so far, with little public notice (Alfredo, 2001). Many factors contribute to this situation in this area, including the charcoal and timber industries, and demand for luxury shrimp. How to monitor the dynamic changes of mangrove is a crucial problem for the conservation of mangrove ecosystem. For management department, it is necessary to know that the distribution, the amount and its dynamic changes in different periods of time. However, it is a difficult task for ground surveying because many mangrove forests grow in the beach of granule sediments in the bottom of

sea. And the traditional ground surveying is not so efficient for the decision management and its protection because of the long period and the large expenses. Moreover, it can't provide the historic information by ground surveying. While remote sensing technology can quickly provide the dynamic macro-information for the objects on the surface of the earth, and it can deduce the historic information from the old remote sensing images and the background information also. So, the method based on remote sensing is put forward here, and it is very u a large scale.

In our study, multi-temporal remote sensing images and its background sources was employed to complete the investigation of the dynamic changes for mangrove forest for Hainan Island in three different periods. To do so, a pilot study area was chosen is Dongzai Harbor mangrove conservation zone in Qiongzhan County. Multi-temporal TM images for different three periods were regarded as the basic sources for the investigation, they include the images in December of 1987, in December of 1995 and in December of 1999 were regarded as the basic sources for this surveying. The study completed in the software called "Image Interactive Interpretation System" (IIS), which is funded by the national key project 97-759, and developed by IRSA/CAS using the objected-oriented approach and visual C++ 6.0 language, and runs in windows 95/98/2000 environment. This paper presents the principal method for the investigation of dynamic changes of the mangrove forest based on IIS.

2. MATERIALS AND METHODS

The pilot study area for this study is Dongzai Harbor mangrove conservation zone, locates in Qiongzhan County and it is a state level conservation zone, like figure 1 shows. Multi-temporal

TM images for different three periods were regarded as the basic sources of the investigation, shows in figure 2. They include the images in December of 1987 (fig2. a), in December of 1995 (fig2.b) and in December of 1999 (fig2. c).

In order to extract the information of dynamic changes of mangrove, we use the software called "Image Interactive Interpretation System" (IIS), which was development by our research group in 1999, its interface shows in figure 3. The method includes: (1) interpretation the background information from reference imagery using IIS; (2) overlaying the reference map with the image for the new period and extracting the information for changes; (3) statistic the areas; (4) producing the thematic map by "OVER" operation, its dialog box was listed in figure 4.

The over operation can be defined by the following equation:

$$imgout = img1 \text{ over } img2.$$

This equation can be explained as: if the value of pixel for image1 is the transparency color (white), i.e, the R,G,B value is (255,255,255), then the value of pixel for the output image is regarded as the value of corresponding pixel of image2; otherwise, it is the value of corresponding pixel of image1.

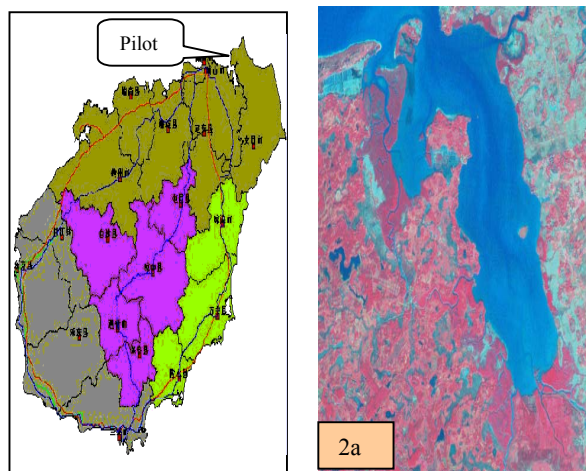


Figure 1. Pilot Area

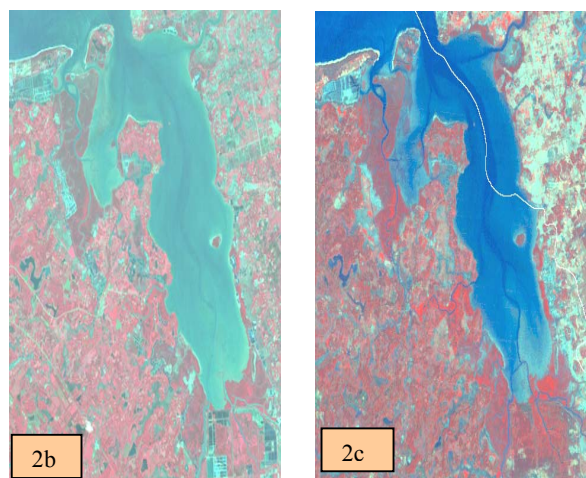


Figure 2. TM Images and its the analysis results of Dynamic changes for Mangrove 2a is TM image in 1987,2b is TM image in 1995,and 2c is TM image in 1999

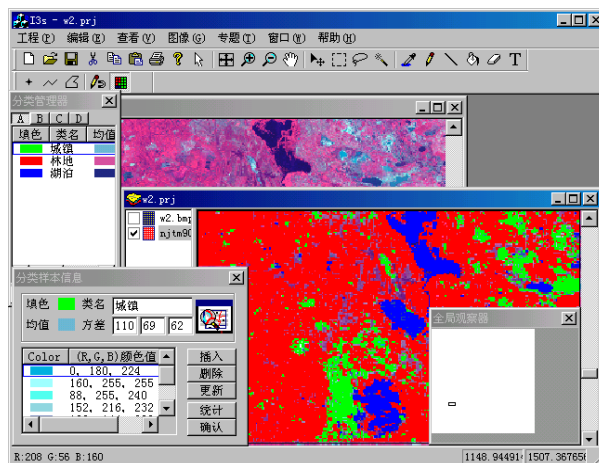


Figure 3. A Main Interface of IIS



Figure 4. The Dialog of Over Operator

3. PROCEDURES

Generally, to accomplish the analysis of dynamic changes needs five procedures. The first step is to prepare the data, its processing includes geometric rectification, geographic location, enhancement and image composite. All TM images were composed of band 4, 3, 2 according to red, green and blue color.

The second step is to extract the reference information by visual interpretation or automatic classification in the system. When do this, it is necessary to create a new raster layer for the storage of the interpretation result, and then to interpret the image according to the feature of mangrove forest.

The third step is to extract the information for changes in the image for another period detected by the system by overlay operation. When overlay the new image with the reference interpretation result, the system can detect the changes for the difference of polygons representing the defined objects. In the study, the defined object refers to the mangrove forest.

The forth step is to acquire the new thematic map by "OVER" operation, which is defined by the system. It is based on the changes in colors, which represent different objects. If the colors in the two-raster layers are different, then the color attribution for the reference layer is regarded as the color of a new layer, otherwise, the color attribution of the new layer is same as the reference. This is easy to get the information for the new changes from the other image.

The final step is to analyze the results from three periods. It includes the total area, the transition matrix and their amount.

By above five primary procedures, the dynamic changes can be extracted easily and the results can be mapped quickly by the system.

4. RESULTS

The results for the analysis lists in table 1, 2 and 3 and figure 5. 5a: Distribution Map of Mangrove in 1987; 5b: Distribution Map of Mangrove in 1995; 5c: Distribution Map in 1999. From figure 5, the statistic shows that:

(1) The total area of mangrove in 1987 is about 2088.18 hectares; in 1995, the total area of mangrove is about 2062.80 hectares, and there is a little change comparing with the area of 1987. The decreasing area for mangrove is only 17.73 hectares, which became into other kind of forest land; and the increasing area is about 25.74 hectare, which became into mangrove from sea beach. (2)In 1999, the total area of mangrove is about 1912.14 hectares, the decreasing area is about 153.18 hectares, which became into farming land for aquatic produces. And in the same time, the increasing area is about 34.11 hectares, they became into mangrove from sea beach.

The study shows: there is a little change for mangrove forest from 1987 to 1995, but from 1995 to 1999, its area decreased greatly. The total area for decreasing is about 153.18 hectares.

By this investigation, it can be concluded that the main the reason for mangrove forest loss in the past 4 years is the corresponding expansion of shrimp farming land because of the consumer’s demand for luxury shrimps. In fact, this result is suitable to the real situation.

Year	Decrease	Increase	Total Area of Mangrove	Total Statistic area
1987			2088.18	2088.18
1995			2045.07	2062.80
1999			1953.00	1912.14
1987-1995	17.73	25.74		
1995-1999	153.18	34.11		
1987-1995	170.91	59.85		

Table 1. Change Statistic for Mangrove in Dongzai Conservation Zone

1995 \ 1987	Mangrove	Farm land for aquatic produces	Sea beach	Forest land
Mangrove	0	0	0	25.74
Sea beach	17.73			

Table 2. Mangrove Change Matrix from 1987 to 1995

1999 \ 1995	Mangrove	Farm land for aquatic produces	Sea beach	Forest land
Mangrove	0	153.18	0	0
Sea beach	34.11		0	0

Table 3. Mangrove Change Matrix from 1995 to 1999*

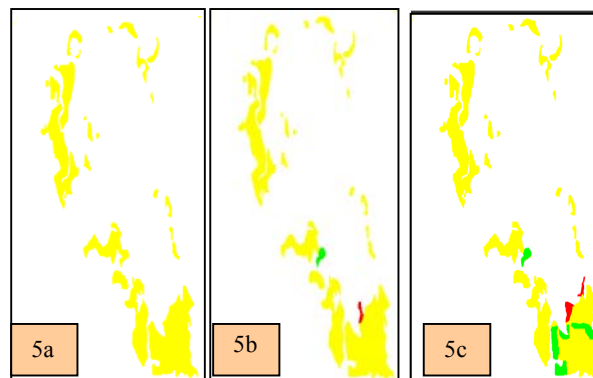


Figure 5. The Analysis Results of Dynamic Changes for Mangrove 5a,5b and 5c is the distribution Map of Mangrove in 1987,1995 and 1999 respectively (Yellow, red and green refers to mangrove, the increasing area and the decreasing area respectively)

5. DISCUSSIONS AND CONCLUSIONS

The mangrove ecosystem is a very dynamic one, where changes are taking place regularly, and within the range of mangrove habitats most major species grow within a given set of conditions. Any major changes in these conditions may start to bring about changes in the growth pattern of different species, a complete elimination of one or more species resulting from changes in the composition of the forests, or in extreme cases a complete disappearance of the forest. Because of this severe sensitivity to change in habitat conditions, mangrove forests are very susceptible to destruction and it is not easy to restore. It is necessary to ensure the sustainable management and conservation of the forest formation. Actually, the local management department is eager to know the information for their decision-making.

Our study has been proved that method based on remote sensing can be employed as the management for mangrove. The study shows that it is a feasible approach using IIRS to extract the dynamic changes and its distribution based on remote sensing images. It can provide the scientific marco-information for the management of mangrove forest timely, and in the meanwhile, can improve the management capabilities. This is very important to the protection the mangrove forest ecosystems and its sustainable management.

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* The unit of area in above three tables is hectare

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