Research on wetland change detection based on Remote Sensing

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Abstract. In recent years, human disturbance and natural factors have led to great changes in the coastal wetland system of the Pearl River Delta, and the research on the changes of coastal wetland landscape pattern has become a hot topic. Based on the remote sensing data in recent 35 years, this paper studies the dynamic changes of coastal wetland landscape in the Pearl River Delta, and analyzes the driving forces of the changes of coastal wetland landscape pattern in the Pearl River Delta.

1. Introduction
As an important part of the global natural ecosystem, wetland system also plays a very important role in flood resistance, hydrological regulation, climate improvement, water purification, pollutant degradation and so on[1]. Coastal wetland is a transitional zone between terrestrial ecosystem and marine ecosystem, which plays an irreplaceable role in water conservation, erosion control, flood storage and drought prevention, pollution degradation, climate regulation and biological habitat protection[2].

With the rapid economic development of coastal wetlands in the Pearl River Estuary, a large number of coastal wetlands have been transformed. In recent years, the Pearl River Estuary has built a large number of canals and port construction land through "reclamation". Reclamation activities not only bring huge economic benefits, but also cause a qualitative damage to coastal wetlands. In this paper, the remote sensing image is used as the main data source, combined with the driving force to study the reasons for the changes, which provides an important basis for the protection and reclamation planning of coastal wetlands in the Pearl River Delta.

2. Overview of the study area
The coastal wet area of Pearl River Delta is located in 112°54′~114°24′E and 21°49′~23°15′N. The Pearl River Delta region includes administrative regions such as Guangzhou, Shenzhen and Zhuhai. The total land area is 41698km², accounting for 23.2% of the total land area in Guangdong Province, and the total registered residence population is 57634 thousand (2015). It is one of the most densely populated areas in China. The annual average temperature in the Pearl River Delta is about 22℃, the rainfall is 1600-2000 mm, and the relative humidity is 79%[4].
Figure 1. The research area and geographical location.

3. Remote sensing data
The time span of this study is 35 years, which is divided into five periods: 1980s, 1990s, 2000s, 2010s and 2015s. LANDSAT MSS / TM / ETM + / oli data is an important data source for dynamic change monitoring of coastal wetlands. The spatial resolution of Landsat TM data is 30m, which can be directly used as the data source and the reference image for geometric correction of LANDSAT MSS image after preprocessing such as geometric correction and orthorectification. Some regions lack landsat TM images from 1970s to 1980s, so we choose good quality LANDSAT MSS images as supplementary data. Because of the large deviation of geometric position and UV difference of the data, we choose the Landsat TM images from early 1990s in the corresponding region TM image is used as the reference image, and geometric correction is carried out. The position deviation between the corrected image and the reference image is within one pixel, which can meet the accuracy requirements of landscape pattern classification.

4. Experimental methods
In this experiment, object-oriented classification method is adopted, and classification rules are made by decision tree method. This method classifies the data according to the rules from top to bottom, and finally creates the path to achieve the goal. Classification is a language framework of ecognition, which is used to express the knowledge base of image objects to be classified. Its hierarchical structure includes subclass inheritance, class description and semantic grouping. Inheritance means that the description of the parent class can be passed on to the subclass. This feature can be used to help distinguish the parent class. For example, when describing an accurate housing construction land type, due to the variety of urban housing, it can be divided into several subclasses with different color roofs and representing the housing construction land type, which can help to reduce the number of class description. Suppose you want to change the description of a subclass, if there is no inheritance, you need to spend time inserting the same description into many classes. But with the inheritance of this kind of description, we can directly find the related parent class in the decision tree to change. Because the change of the parent class will be inherited from all its subclasses to simplify the modification process and change the flexibility of the classification knowledge base.
5. Landscape dynamic change results and analysis

5.1. Results of landscape dynamic changes in the Pearl River Delta

Figure 2 shows the landscape pattern of the Pearl River Delta from 1980 to 2015, table 1 shows the change of land type area in the Pearl River Delta from 1980 to 2015.

According to the table 1, the total area of coastal wetland increased rapidly from 909.04 km² in 1980 to 1580.9 km² in 2000, but gradually decreased to 1438 km² after 2000. In general, the coastal wetland area shows an increasing trend, which is consistent with the change trend studied by Li Jing[3].

The area of aquaculture pond in 1990 is about 4 times of that in 1980; The estuarine water area increased from 530.81 km² in 1980 to 942.18 km² in 2000;

In contrast, the natural wetland has little change. Mangrove area decreased rapidly from 40.64 km² in 1980 to 8.9 km² in 2000. Then, by 2015, the area of mangrove swamp increased to 32.31 km²; the area of saline swamp increased slightly from 1990 to 2000, but decreased sharply from 2000 to 2015, showing a decreasing trend, which is consistent with the change trend of Liang Guozhao[5]. The muddy beach increased from 3.99 km² in 1980 to 40.13 km² in 1990.

![Figure 2. The landscape pattern of the Pearl River Delta from 1980 to 2015.](image)

### Table 1. The area of the main type of the Pearl River Delta from 1980 to 2015.

| area          | 1980  | 1990  | 2000  | 2010  | 2015  |
|---------------|-------|-------|-------|-------|-------|
| Culture pond  | 256.01| 912.64| 857.24| 844.82| 826.97|
| Reservoir pond| 93.97 | 19.13 | 128.37| 115.07| 139.04|
| Estuarine waters| 530.81| 612.98| 942.18| 436.79| 459.88|
| Mangrove swamp| 40.64 | 19.10 | 8.90  | 25.09 | 32.31 |
| Muddy beach   | 3.99  | 40.13 | 38.09 | 17.65 | 14.96 |
| Salt marsh    | 19.32 | 12.60 | 33.03 | 7.92  | 5.51  |
| Urban construction land | 498.78| 1126.06| 1136.29| 1715.92| 1644.58|
| Industrial land| 7.96 | 29.76 | 57.91 | 129.26| 176.82|
| Port construction land | 4.12 | 26.42 | 32.69 | 65.89 | 78.71 |
| Tourism land  | 0.82  | 1.76  | 2.32  | 7.93  | 8.33  |
According to figure 3, the change of natural wetland area and constructed wetland area from 1980 to 2015 are diametrically opposite. In 1990, the total area of estuarine water area and aquaculture pond in constructed wetland accounts for 78% of the total coastal wetland area.

5.2. Analysis of landscape dynamic change in Pearl River Delta

The reason for the increase of the area of aquaculture ponds during 1980-1990 is that before 1990, people in the Pearl River Delta focused on the development of aquaculture industry. However, after 1990, due to the rapid economic development of the Pearl River Estuary, a large number of port construction land or other land was built, which occupied a large number of aquaculture ponds, resulting in the gradual decrease of the area of aquaculture ponds. During 1980-1990, the area of estuarine water increased significantly, because during this period, human beings mainly used traditional agricultural farming, resulting in a large proportion of paddy field area, so a large amount of water diversion irrigation was needed. However, after 2000, the main human beings continued to build ports on both sides of estuarine water, followed by agricultural construction of breeding ponds, resulting in the narrowing of the river channel, and the area gradually decreased, but the overall reduction rate not big.

Mangrove in natural wetland is an important part of coastal ecosystem. Due to the neglect of mangrove protection in the early stage of reform and opening up, the area of mangrove decreased rapidly from 1980 to 2000, which brought a series of ecological problems. In 2000, the Chinese government issued a series of mangrove protection and restoration policies. After the policy of increasing efforts to protect mangrove was issued, the area of mangrove increased after 2000, and the area in 2015 was four times of that in 2000, but the overall trend was decreasing; the main reason for the decrease of salt marsh after 2000 was that salt marsh had been developed into farmland. The decrease of muddy beach area is mainly due to the utilization of the original muddy beach wetland due to human activities. Therefore, the area of muddy beach wetland decreased rapidly to 14.96km² in 2015 after 1990.

The main reason for the decrease of the total area of coastal wetlands is that a large number of artificial activities have disturbed the coastal wetlands in the Pearl River Delta driven by economic demand since 2000. According to table 1, the area of urban construction land, industrial land, port construction land and tourism land increased rapidly from 1980 to 2015, with the total area accounting for 72.3% of the land area in 2015. This data further proves that human activities are increasing year by year.

6. conclusion

By analyzing and comparing the landscape data of coastal wetlands in the Pearl River Delta in different historical periods, it is concluded that the area of constructed wetlands and the total area of natural wetlands decrease. It is concluded that the increase of aquaculture pond area is caused by the transformation of estuarine water area, mangrove swamp and saline swamp; the increase of urban construction land, port construction land and industrial land mostly comes from the transformation of
cultivated land and forest land. In general, the changes of coastal wetlands in the Pearl River Delta are mainly affected by human activities. We should further build and improve various flood control infrastructure, increase vegetation coverage and improve the environmental quality of coastal wetlands.

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