A Study on Dynamic Change Features of Wetlands in Dongying City Based on RS

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Abstract

This paper sets 10 interpretation marks and conducts remote sensing interpretation on wetlands of Dongying City, according to data of TM and SPOT remote sensing image from three time phases in 1996, 2002 and 2006. Major types of wetlands in Dongying City include offshore and coastal wetlands, river wetlands, lake wetlands, swamp and swamping wetlands, etc. Results of interpretation show that, for recent ten years, areas of reed marsh wetlands, perpetual river wetlands and intertidal wetlands show an increasing trend, while areas of shallow sea wetlands, paddy field wetlands and mud flat wetlands have a decreasing trend. This provides scientific basis for protection of wetlands resources.

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Introduction

Wetland is one of the landscapes with the richest biodiversity in the natural world, which not only has tremendous ecological functions but also largely benefits the protection of wildlife and the enhancement of aesthetic value of local landscape. Wetland in Dongying City of Shandong Province is located near the Yellow River Estuary of Bohai Sea and the ancient riverbed of the Yellow River, being the vastest, the most complete and the youngest wetland in the temperate zone of our country. Affected by activities of human society and economy, the evolving trend of geological environment condition is far from being satisfactory in recent years and causes a series of geological environment problems, becoming major factors that restrict the benign development of wetlands ecosystem. For this reason, it is of vital realistic meaning to carry out research on wetlands change rule of Dongying City.
General Situation of Natural Background in Research Area

Meteorology and Hydrology.

The research area belongs to the semihumid continental monsoon climatic province in the warm temperate zone. Rainy days and hot days are in the same season. It makes a clear distinction between the four seasons. The annual mean temperature is 12.4°C, with the maximum of 39.7°C and the minimum of -19.1°C. There are 80 days in the period of freezing soil, with the maximum depth of frozen soil of 54cm. The seasonality of precipitation is so obvious that the summer precipitation is 69% of that in a whole year. The annual average precipitation is 549.36mm (1966-2006). The annual average evaporation capacity is 1885mm. The annual average relative humidity is 67%.

There are altogether 25 rivers and streams in Dongying City. In addition to the Yellow River, there are other relatively long rivers that cross borders such as Branch River, Xiaoqing River, Zihe River, Yanghe River, Chao River and etc. There are 12 drainage channels with control areas of more than 100km² in Dongying City. To the north of the Yellow River, there are Maxin River, Zhanli River, Caoqiao Ditch River, Tiaohe River, the east trunk stream of Caoqiao Ditch River, Chuguan River and Peace River. The first five rivers flow into the sea with only one stream, yet the last two merge into the Chao River; to the south of the Yellow River, there are Island River, Three Ditches River, Yongfeng River, Yihong River and Guangli River, all of which flow into the sea with one stream.

Rivers that have great impact on working area mainly include the Yellow River and rivers with smaller extent, like Zhangzhen River and Island River. Inside the research area, there are the Isolated North Reservoir, the Isolated East Reservoir and the East Land Reservoir.

Landform.

It is a relatively flat terrain in this research area. The highest elevation of the southwest is 28m and the lowest elevation of the northeast is 1m. The natural gradient is 1/8000-1/12000. Due to excessive diversions of the Yellow River, the geomorphologic landscape that highland, slope and depression alternate with each other comes into being. According to its topographic feature, it can be classified into four microtopography types, namely highland, slope, depression and intertidal belt.

Features of Hydrogeologic Condition.

Shallow phreatic water—micro artesian water spreads all over the research area. The aquifer is lithologically composed of silt, silt-like argillaceous sand, arenaceous clay, ooze and others. Because of the complicated and changeable nature of the microtopography and the effect of hydrology and man-made water diversion, the water quality changes greatly in the plane. Generally speaking, the degree of mineralization increases from land to coast. It can be divided into: shallow fresh water—brackish water, shallow brackish water and salt water, shallow saline water. The shallow fresh water—brackish water is mainly distributed in the Yellow River Beach, the top of the crevasse splay and the paleochannel band, occurring in sedimentary stratum of alluvial facies; shallow brackish water and salt water are distributed on the periphery of the shallow fresh water—brackish water, being closely related with its water power and occurring in sedimentary stratum of alluvial facies and littoral facies; the shallow saline water is largely distributed in coast, occurring in sedimentary stratum of littoral facies.

Types of Wetlands and Remote Sensing Interpretation
Research Method.

Within the extent of 2850km² in the working area, perform the wetlands resources interpretation of TM remote sensing image of three time phases, namely 1996, 2002 and 2006, coordinating with SPOT remote sensing image of 2005. The major steps and processes are: collect remote sensing data and all kinds of related information → rectify image processing → chart satellite image → determine objects of remote sensing interpretation → set marks of remote sensing interpretation → preliminary interpretation → interpret compiled map → verify the field inspection of key sections → complement interpretation marks → detailed interpretation → chart the result map of interpretation[2].

Remote Sensing Interpretation Marks of Wetlands.

Remote sensing interpretation marks of offshore and coastal wetlands. The shallow water area on image map is in tones from light blue to dark blue. The color is uneven due to the influence of waves. Refer to Fig 1 and Fig 2.

![Fig 1. Remote sensing image feature 1 of wetlands in shallow water area](image1)

![Fig 2. Remote sensing image feature 2 of wetlands in shallow water area](image2)

The intertidal belt on image map is in the tone of pale violet-red. Because of uneven water erosion, clay is washed away while sand increases. The color of ash grey on the image map increases slightly.

![Fig 3. Remote sensing image feature 1 of intertidal belt wetlands](image3)

![Fig 4. Remote sensing image feature 2 of intertidal belt wetlands](image4)
Mud flat on image map is mainly in grey tone, partially in ash grey. There is an obvious boundary between mud flat and the land.

The estuarine water area on image map is mainly in tones from light blue to dark blue. Because the water quality of river water is different from that of sea water, wave spectrum features of the two are different from each other when the river merges into the sea. So tone on image map are also different. The boundary between the two is clear. See Fig 5 and Fig 6.

The salt pan on image map has the regular block image feature with blue color. Dry ponds with evaporated salt are in tones of grey and ash grey. At present, some parts of salt pan wetlands haven been changed into fish and shrimp pond wetlands.

Remote sensing interpretation marks of river wetlands.

Permanent rivers on remote sensing image generally appear with image features of light blue to dark blue. Generally speaking, the shallows and river banks are largely light blue and pale purple, yet the deeps are mainly dark blue.

Seasonal or intermittent rivers on image map have features of blue to dark blue and light ash grey. Anhydrous places are largely in tones of light grey and ash grey. Image features are displayed obviously.

Remote sensing interpretation marks of water field wetlands.

Dams and cofferdams of reservoirs are mainly in tones from white to ash grey on the image. Most reservoirs are distributed in regular forms of rectangle or polygon, with distinct features of color and texture. Generally, the darker the color of reservoir on the image, the deeper the water body.

Ponds on remote sensing image are displayed in tones from light blue to dark blue. Outlines of distributing forms on the plane are irregular, most of which are naturally bent closed curves.

Paddy wetlands are in the color of relatively deep red, with the texture feature of large rectangle. Channels around paddy fields are in linear shape with the color of blue. Ridges of field are in the shape of fine thread with light color. They are significantly different with each other in terms of color and texture. Uncropped rice of the ripening period is in deep red on the image, representing the wave spectrum features of rice itself. Refer to Fig 7 and Fig 8.
Image features of fish pond and shrimp pond differ from each other considerably. Fish ponds located in mud flat of littoral belt are generally in colors from light blue to dark blue on the image. And the ponds are largely in the shape of long strip and square, among which there are separations of roads in ash grey. The image features are clear. Fish and shrimp ponds on land present colors of different shades on the image.

Remote sensing interpretation marks of swamping wetlands resources.

Herbaceous swamp wetlands of reed are presented with the image feature of dark red spots. The herbaceous swamp wetlands of reed around the ancient riverbed of the Yellow River are naturally formed. The reeds are mixed with a small amount of open forest wetlands. Open forest is distributed sparsely on the image, with unclear texture and unapparent regularity.

**Interpretation Results and Discussion**

**Interpretation Results.** Through interpretation, dynamic change features of wetlands area in Dongying City are as shown in Table 1.

**Table 1. Dynamic change of wetlands area in Dongying City**

<table>
<thead>
<tr>
<th>Types of wetlands</th>
<th>Wetlands area (hm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1996</td>
</tr>
<tr>
<td><strong>I. Offshore and coastal wetlands</strong></td>
<td></td>
</tr>
<tr>
<td>Shallow water wetlands</td>
<td>78729.11</td>
</tr>
<tr>
<td>Intertidal mud flat wetlands</td>
<td>14005.75</td>
</tr>
<tr>
<td>Mud flat wetlands</td>
<td>33468.8</td>
</tr>
<tr>
<td>Salt pan wetlands</td>
<td>5614.13</td>
</tr>
<tr>
<td>Permanent river wetlands</td>
<td>3308.64</td>
</tr>
<tr>
<td><strong>II. River wetlands</strong></td>
<td></td>
</tr>
<tr>
<td>Seasonal or intermittent rivers</td>
<td>9110.18</td>
</tr>
<tr>
<td>wetlands</td>
<td></td>
</tr>
<tr>
<td><strong>III. Lake wetlands</strong></td>
<td></td>
</tr>
<tr>
<td>Reservoir and pond wetlands</td>
<td>12736.91</td>
</tr>
<tr>
<td>Paddy field wetlands</td>
<td>8341.24</td>
</tr>
<tr>
<td>Fish and shrimp pond wetlands</td>
<td>2779.46</td>
</tr>
<tr>
<td><strong>IV. Swamp and swamping wetlands</strong></td>
<td></td>
</tr>
<tr>
<td>Herbaceous swamp wetlands of reed</td>
<td>7061.91</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>175156.1</td>
</tr>
</tbody>
</table>
Analysis on Dynamic Change Features of Wetlands. The amount of water of the Yellow River has been relatively balanced in recent years and it never dried up. The water amounts of all reservoirs and ponds of the Yellow River Diversion project along the way are sufficient. Several experiments of water and sediment regulation wash large amounts of sediment into the Bohai Sea while eroding the channel, so that areas of permanent river wetlands and intertidal wetlands increase significantly. The area of reservoir and pond wetlands has increased by 4533.99hm² from 2002 to 2006. The mud flat is formed because of the sea reclamation, making a decrease of shallow water wetlands area by 1006.63hm² for recent ten years. The area of intertidal wetlands has an average annual increase of 1695.962hm² and the area of permanent Yellow River wetlands increases by 636.26hm².

The rise of aquaculture and the enormous increase of fish and shrimp ponds bring a substantial increase in the area of fish and shrimp pond wetlands. Mud flat wetlands are exploited for fish and shrimp ponds. The area of mud flat wetlands has been decreased annually by 924.341hm² on average in ten years from 1996-2006. Therefore, the area of salt pan wetlands has never increased since 2000.

Due to the reduction of atmospheric precipitation year by year, parts of rivers are dried up. In ten years, the area of river wetlands has been reduced by 1339.57hm², the area of paddy field wetlands has been reduced by 2189.95hm² and that of reed swamp wetlands has been decreased annually by 46.264hm² on average. Driven by economic interest, people accelerate the exploitation and the utilization of ocean mud flat. The area of fish and shrimp pond wetlands has increased annually by 1695.962hm² in ten years. Along with the increase of artificial wetlands, the unscientific development of wetlands is reflected.

Acknowledgement

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References