Analysis on dynamic change of vegetation coverage in coastal wetland of Yellow River delta

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Abstract. How to efficiently use multi-source remote sensing images to extract the coastal wetland vegetation landscape information of the Yellow River Delta, and provide scientific basis for wetland protection, utilization and ecological restoration, is of great significance. In this paper, the vegetation coverage of Landsat TM/OLI remote sensing images from 1984 to 2018 is dynamically monitored, and the remote sensing images are analyzed using NDVI and pixel dichotomous models. The conclusions are as follows: From 1984 to 2018, the coverage of vegetation in the northern part of the Yellow River Delta is relatively low, and the coverage of vegetation in the south due to agricultural development is high; Over the past 30 years, the vegetation coverage area of the Yellow River Delta has shown an overall upward trend, and the area of low vegetation coverage areas has declined significantly, decreasing by 19.64% from 1984 to 2018. For the study of the Yellow River Delta coastal wetland, the methods used include the NDVI and pixel dichotomy model, and the results obtained are consistent with the facts, which can help the local ecological protection or soil and water conservation.

Keywords: Dynamic monitoring; Vegetation index; Vegetation coverage; Yellow River Delta.

1. Introduction

The coastal wetland of the Yellow River delta is one of the international important wetlands in the wetland convention, and the most complete, extensive and youngest coastal wetland in the warm temperate zone of China. Meanwhile, the wetland is accompanied by a variety of aquatic, wet, Mesozoic and salt-tolerant plant communities, making it an ideal place for the study of coastal wetland vegetation. Vegetation is an important part of coastal wetlands. During the 13th five-year plan period, the state oceanic administration promoted the "south red and north liu" major project [1, 2] to improve the coastal wetland ecosystem with coastal wetland plants. Landscape information such as vegetation distribution and structural changes largely reflects the health of coastal wetlands.

From the perspective of plant community, high-density and small-area quadrangles were set up to describe the distribution of vegetation types in conventional vegetation surveys. This method has a long
period, poor aging, and the coastal wetland environment is complex, so most areas are difficult to enter. Remote sensing has the advantages of wide range synchronization, economy and efficiency, and has become an important means of dynamic monitoring and information extraction. At present, with the continuous improvement of spatial resolution and increasingly fine spectral resolution of remote sensing images, remote sensing data present multi-source, which not only brings abundant information but also brings redundancy of data. Therefore, it is of great significance to extract vegetation landscape information from multi-source remote sensing images to provide scientific basis for wetland protection, utilization and ecological restoration.

2. Research area overview
Located in the northeast of Shandong province, between the west coast of Bohai Sea, Bohai Bay and Laizhou Bay, the Yellow River delta is the most explosible delta in China. Its elevation is high in the southwest and low in the northeast, and its natural topographic slope is 1/8000~1/12000. The landform types of the region are slightly inclined flat land, beach land, shallow flat depression, flat land and ancient flat land. The soil types are mainly saline-alkali soil, tidal soil, sandy ginger black soil and cinnamon paddy soil, among which tidal soil covers nearly 50% and saline-alkali soil covers more than 45%. The distribution of vegetation is influenced by the degree of soil salinization, climate, precipitation and geomorphologic types, etc. The composition of vegetation population is simple, and herbaceous plants occupy a greater advantage.

![Figure 1. Geographical location of the study area](image)

3. Data processing

3.1. Data sources
In this paper, Landsat TM / OLI satellite data from the United States is used to invert various indicators actually needed in the study area. The band and row numbers of each image are 121 and 34 respectively. In order to ensure the sharpness of the image, the cloud content of the selected image does not exceed 10%, so the obtained feature information is better and more accurate.

3.2. Data preprocessing
Images from 1983 to 2018 are preprocessed with ENVI, including radiometric calibration, atmospheric correction and cropping. The changes of vegetation cover in the Yellow River delta [3] are analyzed by normalized vegetation index, pixel dichotomy model and dynamic monitoring. Since the selected remote sensing images have been precisely corrected, there is no need to carry out geometric correction again.
Radiometric calibration: radiometric calibration is performed on the image according to the relative radiometric calibration coefficient, and the DN value of each band is converted into the surface radiative brightness;

\[ L_{sat} = DN \times Gain + Offset \],

where \( L_{sat} \) represents the surface irradiance, DN represents the pixel brightness value, \( Gain \) represents the gain value, and \( Offset \) represents the offset value.

Image cropping: Using the Yellow River Delta flooding data to obtain a cropped image of the Yellow River Delta.

FLAASH atmospheric correction: When the sunlight passes through the atmosphere, the remote sensing original image formed by the electromagnetic radiation radiated or reflected by the target object is distorted due to the effects of distance radiation and sky diffusion. In this paper, the FLAASH model is used to correct the atmosphere of the image to remove or weaken the noise information from the total remote sensing signal. Figure 2 shows the comparison between the original image and the FLAASH corrected image.

4. Basic situation of vegetation coverage

4.1. Normalization and extraction of vegetation index

Normalized vegetation index is the most widely used vegetation cover index, which can well reflect the changes of vegetation growth, biomass and ecosystem parameters, and to some extent reflect the comprehensive situation of vegetation and land cover types in the area corresponding to the pixel.

NDVI is the ratio parameter of near-infrared band and red band of remote sensing image. The calculation formula is as follows:

\[ \text{NDVI} = \frac{\text{NIR} - R}{\text{NIR} + R} \]  

(1)

Where \( \text{NIR} \) is near infrared band and \( R \) is red band. According to the spectral reflectance curve of the vegetation, the spectral reflectance of the vegetation is higher in the near-infrared [4, 5] band and lower in the red band, so the formula can intuitively represent the normalized vegetation coverage level. NDVI values range from -1 to 1, and NDVI values are higher in areas with higher vegetation density. Red light in bare soil without vegetation is similar to near-infrared reflectance, NDVI value is close to 0. The red reflectance of water is greater than that of near infrared, and NDVI is negative.
4.2. Pixel Dichotomy

Vegetation coverage refers to the ratio of the total projected area of the plant community or the vertical projection area of the above-ground part to the land area, which reflects the changes in the ecological environment of the study area and has important research value. There are currently many methods for measuring vegetation coverage using remote sensing. It is more practical to approximate the vegetation coverage using the vegetation index. The research model based on the pixel dichotomy is:

\[ f_c = \frac{NDVI_{\text{veg}} - NDVI_{\text{soil}}}{NDVI_{\text{veg}} - NDVI_{\text{soil}}} \]  

Among them, \( NDVI_{\text{veg}} \) represents the \( NDVI \) value of full vegetation coverage, and \( NDVI_{\text{soil}} \) represents the \( NDVI \) value of no vegetation coverage. In order to exclude the influence of extreme values, this paper selects \( NDVI \) value of cumulative pixel 2% as \( NDVI_{\text{soil}} \), and \( NDVI \) value of cumulative pixel 98% as \( NDVI_{\text{veg}} \).

Combined with visual interpretation of true-color remote sensing images, the vegetation coverage of the Yellow River delta region is divided into five grades: seawater area \( 0 < f_c \leq 0.2 \), sediment area \( 0.2 < f_c \leq 0.4 \), low vegetation coverage area \( 0.4 < f_c \leq 0.6 \), middle vegetation coverage area \( 0.6 < f_c \leq 0.8 \) and high vegetation coverage area \( 0.8 < f_c \leq 1 \). Based on the remote sensing data from 1984 to 2018, the medium and high-level vegetation coverage areas were extracted for statistical coloring.

Figure 4. Classification map of vegetation cover levels
As can be seen from figure 4, vegetation coverage [7, 8] in the northern part of the Yellow River delta is low, while vegetation coverage in the southern part is high due to developed agriculture. At the same time, it can be found that over the past 30 years, the overall vegetation coverage area of the Yellow River delta has been on the rise, while the area of low-vegetation coverage area has declined significantly, with a decline of 19.64% from 1984 to 2017.

### Table 1. Proportion of vegetation coverage in the Yellow River Delta

| Year | Coverage | 1984  | 1987  | 1992  | 1998  | 2005  | 2009  | 2013  | 2017  |
|------|----------|-------|-------|-------|-------|-------|-------|-------|-------|
| 0~0.2|          | 12.15%| 16.31%| 12.83%| 16.13%| 12.88%| 13.78%| 22.94%| 24.83%|
| 0.2~0.4|        | 5.74% | 3.30% | 12.07%| 11.78%| 12.81%| 13.13%| 14.60%| 14.87%|
| 0.4~0.6|        | 45.95%| 22.03%| 48.36%| 38.16%| 43.23%| 30.79%| 31.34%| 26.31%|
| 0.6~0.8|        | 24.56%| 43.23%| 13.59%| 14.12%| 16.86%| 25.86%| 15.97%| 17.85%|
| 0.8~1 |         | 7.42% | 11.41%| 8.89% | 15.65%| 10.16%| 12.37%| 11.11%| 12.43%|

Combined with table 1 and figures 5 and 6, it was found that the middle vegetation cover area and the high vegetation cover area showed a general decreasing trend from 1984 to 2018, among which the...
middle vegetation cover area had the largest change rate. Low FVC areas and low FVC areas generally show an increasing trend. The area of low FVC areas has the largest change range, while the overall fluctuation range of very high FVC areas is relatively small. However, according to the change of average FVC, the overall FVC of the Yellow River delta still shows an increasing trend.

5. Conclusion

In this paper, the vegetation coverage of Landsat TM / OLI remote sensing images from 1984 to 2018 is dynamically monitored, and the remote sensing images are analyzed using NDVI and pixel dichotomy models. The conclusion is that the vegetation coverage in the Yellow River Delta has changed significantly in the past 30 years.

1. The vegetation coverage of the Yellow River delta shows an increasing trend from 1992 to 2018, indicating that the vegetation in the Yellow River delta can maintain a sustainable growth trend after the large-scale development in 1987, indicating that the local ecological environment is well protected and the planting and environmental protection measures are relatively perfect.

2. From 1984 to 2018, vegetation coverage in the northern part of the Yellow River delta is relatively low, while vegetation coverage in the southern part is relatively high due to developed agriculture. Over the past 30 years, the overall vegetation coverage area of the Yellow River delta has been on the rise, while the area of low-vegetation coverage area has declined significantly, with a decline of 19.64% from 1984 to 2018.

3. The results obtain by the methods adopted in the study, such as NDVI and pixel dichotomy model, are relatively real and helpful to local ecological protection or soil and water conservation.

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