

Analysis of the Characteristics of Landscape Pattern Changes in the Estuary of the Yellow River

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Abstract. To improve the increasingly degenerating environment of the wetland in the estuarine delta of Diaokou River, the Yellow River Conservancy Commission conducted ecological water supplement to the wetland during the water and sediment regulation period in 2010. In this study, we analyzed the landscape patterns before and after the event. HJ-1B CCD data were adopted to monitor the dynamic changes of Diaokou River in national reserve of Yellow River Delta, and the ArcGIS and FRAGSTATS softwares were used to analyze the landscape patterns. The result shows that the ecological efficiency from the ecological water supplement to Diaokou River is remarkable. The landscape contagion index and landscape shape index decreased, while the edge density and mean patch area increased from 2009 to 2012 which led to a decrease in landscape heterogeneity. The Shannon diversity index increased, and the landscape contagion index decreased in the meantime, which resulted in decreased landscape connectivity. Shape of vegetation patches became more regular. The results showed the dynamic characteristics of landscape pattern in Diaokou River before and after the ecological water supplements, which provided the scientific basis for ecological regulation and wetland restoration.

Introduction

The patterns of landscape development in time and space result from the complex interactions among physical, biological and social forcings [1]. Landscape ecology can help realizing that maintenance of ecological resources requires management at several spatio-temporal scales [2]. Understanding the dynamics of past vegetation and landscape-scale patterns of vegetation change allows resource managers to develop realistic goals for productivity, conservation, long-term site stability, and restoration [3]. An ecological approach to landscape analysis is helpful for analyzing the Characteristics changes by human activities [4]. Geographical information systems (GIS) and remote sensing (RS) of varying complexity have emerged as useful tools in addressing landscape-level research questions. Many current ecological problems can be addressed more easily by using some type of GIS and RS.

Diaokou River is one of the old courses of the Yellow River access to the sea before 1976 and its estuarine delta is an important part of National Nature Reserve. To recover the increasingly degenerating environment of the wetland in the estuarine delta of Diaokou River, the Yellow River Conservancy Commission decided to supply ecological water to the wetland during the water and sediment regulation period in 2010 [5]. The primary objectives of this study is to analyze the change of landscape patterns before and after the ecological water supplement based on GIS and RS .

Study area

The study area is located at the estuary of the Yellow River in the northeastern part of Dongying City, Shandong Province, China. The region lies within latitudes 37°44' 24" and 38°15' 48" N and within longitudes 118° 33' 24" and 118° 53' 18" E, covering an area of 424km². The wetland protection zone of Yiqianer and Diaokou River are main part of the study area (Fig. 1). Diaokou River is one of the old courses before 1976. As the river had been dry for nearly 34 years, wetlands had experienced severe ecological deterioration and biodiversity damages. To recover the increasingly degenerated environment of the wetland in the estuarine delta of Diaokou River, the Yellow River Conservancy Commission decided to transferring water to the wetland during the water and sediment regulation period in June 2010. The climate in this region is warm temperate semi-humid continental monsoon climate with an average annual precipitation of 530-630 mm. Most of rainfall occurs in the summer. The annual sunlight hours amount to around 2590-2830h. The annual average temperature is 11.7-12.6°C, and reaches its peak in July and August. Annual water surface evaporation in this region is 1900 to 2400mm; annual average wind speed is 3.1 to 4.6 m/s.

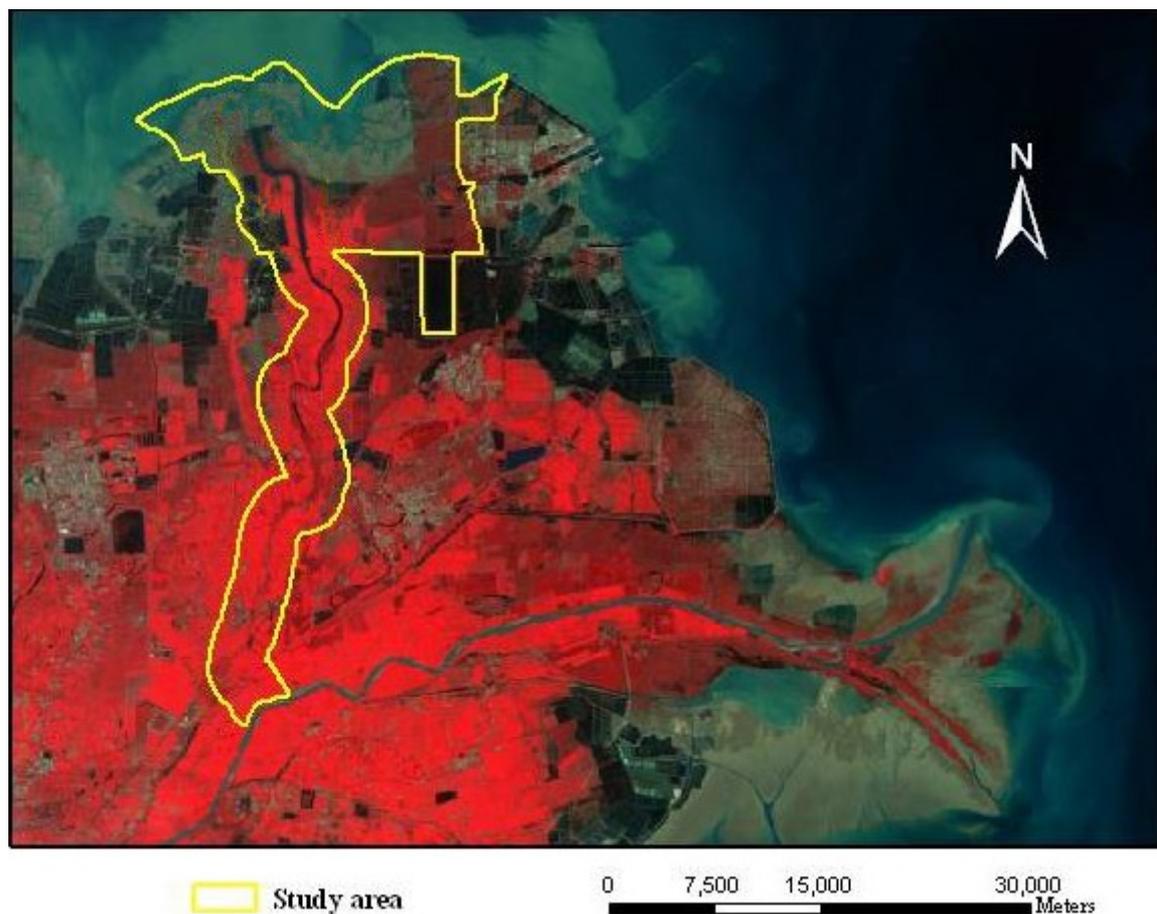


Fig.1. Location of study area at the estuary of the Yellow River

Materials

HJ-1B CCD cameras were carried by the HJ-1B small satellite, with sun synchronous recurrent frozen orbit, a 96 h re-visiting cycle, 30 m spatial resolution, and working bands covering a spectral range of 0.43-0.9 μ m. HJ-1B/CCD imaging spectrometer has improved spectral resolution for better ground feature identification and information extraction, which had been used to monitor vegetation changes, and dynamic land use and land cover changes. The CCD image data (path 455, row 68) covering the entire study area in Dongying City were acquired for Sep. 9, 2009, and on Aug. 6, 2012 (<http://www.cresda.com>).

Methods

RS data process and analysis were performed using ArcGIS 9.3 and ENVI 4.4 image processing software. The original HJ-1B images were georeferenced to the Universal Transverse Mercator (UTM) projection system by the nearest-neighbor resampling method. To normalize the coordinate system, a geometric correction was carried out for the HJ-1B image on the basis of the 1:50,000 digitized map.

Landscape fragmentation was investigated. Information on the structure, composition and configuration of patches and spatial pattern of varied landscapes has been widely assessed using software FRAGSTATS, a spatial pattern analysis software program for computing a wide variety of landscape metrics for categorical map patterns [6]. Landscape indices computed by FRAGSTATS 3.3 characterize each patch in the mosaic, each patch class in the mosaic, and the landscape mosaic as a whole.

Results

Landscape metrics in class level and land level in 2009 and 2012 was shown in Table 1 and Table 2. On class level, percentages of landscape of all the land type increased, except for unutilized land and shallows. Number of patches of built-up land increased significantly, while number of patches of Shrub-grassland declined sharply. A significant decrease in largest patch index of shrub-grassland, unutilized land and shallows occurred from 2009 to 2012. On land level, the landscape contagion index and landscape shape index decreased, while the edge density and mean patch area increased from 2009 to 2012 which led to a decrease in landscape heterogeneity. The Shannon diversity index increased, and the landscape contagion index decreased in the meantime, which resulted in decreased landscape connectivity. Shape of vegetation patches became more regular.

Table1. Landscape metrics in class level in 2009 and 2012

Type	Year	PLAND	NP	PD	LPI	ED	LSI	AI
Cropland	2009	30.34	49	0.11	7.90	8.18	9.47	97.76
	2012	30.96	48	0.11	7.89	8.32	9.38	97.81
Forest	2009	11.84	28	0.07	4.32	7.69	12.24	95.24
	2012	11.95	27	0.06	4.32	7.74	12.05	95.33
Shrub-grass	2009	21.24	40	0.09	10.39	8.86	11.28	96.75
	2012	23.35	31	0.07	8.88	8.37	10.10	97.26
Water body	2009	6.02	35	0.08	2.90	4.52	10.63	94.26
	2012	7.51	39	0.09	2.90	5.18	10.44	94.97
Built-up land	2009	2.94	44	0.10	1.77	2.30	7.35	94.57
	2012	3.31	51	0.12	1.85	2.44	7.69	94.60
Unutilized land	2009	4.12	12	0.03	1.72	1.94	5.63	96.66
	2012	2.97	9	0.02	1.44	1.61	5.49	96.17
Shallows	2009	23.50	6	0.01	23.16	2.68	4.04	99.09
	2012	19.95	6	0.01	19.74	2.89	4.50	98.86

PLAND is percent of landscape, NP is number of patches, PD is patch density, LPI is largest patch index, ED is edge density, LSI is landscape shape index, AI is aggregation index.

Table 2. Landscape metrics in land level in 2009 and 2012

Year	TA	PD	LPI	ED	LSI	MPS	CONTAG	SHDI	AI
2009	42415.2	0.50	23.16	18.08	12.27	198.20	52.61	1.688	97.21
2012	42415.2	0.49	19.74	18.28	12.06	201.02	52.50	1.690	97.22

TA is total area, PD is patch density, LPI is largest patch index, ED is edge density, LSI is landscape shape index, MPS is mean patch space, CONTAG is contagion index, SHDI is Shannon diversity index, AI is aggregation index.

Conclusions

The result shows that the ecological efficiency from the ecological water supplement to Diaokou River is remarkable. On class level, percentage of landscape of all the land type increased, except for unutilized land and shallows. Number of patches of built-up land increased significantly, while number of patches of Shrub-grassland declined sharply. A significant decrease in largest patch index of shrub-grassland, unutilized land and shallows occurred. On land level, the landscape contagion index and landscape shape index decreased, while the edge density and mean patch area increased from 2009 to 2012 which led to a decrease in landscape heterogeneity. The Shannon diversity index increased, and the landscape contagion index decreased in the meantime, which resulted in decreased landscape connectivity. Shape of vegetation patches became more regular. The results showed the dynamic characteristics of landscape pattern in Diaokou River before and after the ecological water supplements, which provided the scientific basis for ecological regulation and wetland restoration.

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