

The Establish of Liaohe Estuarine Wetland Ecological Compensation Standard Based on Muti-Source Remote Sensing Data

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Abstract. This article choosed LiaoHe Estuarine Wetlands National Nature Reserve as the research object. On the basis of analyzing the present situation of wetland ecological compensation, combining wetland nature reserve, economic development demand and land use requirements of the surrounding area. Combined with the 3S technology, cooperated with field reconnaissance and survey, conducted wetland ecological compensation standard analysis from space and global perspective, gave full consideration to ecological service function value of different Market value. This paper established ecological compensation standard to provide a scientific basis to establish the standard of Liaoning province.

1. Introduction

Liaohe estuarine wetland is located in southern coast of Linghai city, Liaoning Province, northeast China. Compositied of large areas of reed marshes, tidal flats, wet meadows, sea water area and small rivers, the wetland has great value for scientific research and economy development. While in recent years, due to excessive reclamation and human activities, reed marshland area had experienced substantial contraction, retreat sea shoals area kept growing and the wetland environment became increasingly fragile, which seriously destroyed local ecological environment and caused enormous economic losses and resource waste [1]- [2].In this situation, how to establish a long-term mechanism of rational ecological compensation is important .This paper established ecological compensation standard to provide a scientific basis to establish the standard of Liaoning province.

2. Data Source

2.1. Overview of Study Area

Liaohe estuarine wetland national nature reserve is located at Panjin city, northern Liaodong Bay of Liaoning province, northeast China. The geographical coordinates is longitude $121^{\circ}30' \sim 122^{\circ}00'$, latitude $40^{\circ}45' \sim 41^{\circ}10'$. With the boundary of 60 km in north to south direction and 35 km in east to west direction, the wetland has a total area of $12.8 \times 10^4 \text{hm}^2$. This area belongs to the semi-humid warm temperate continental monsoon climate, the annual average temperature is 8.4°C , annual average rainfall is 623.2mm, annual average evaporation is 1669.6mm. There are various vegetations and rich habitations of large number of animal species. Location of Liaohe estuarine wetland national nature reserve is shown in Figure 1.



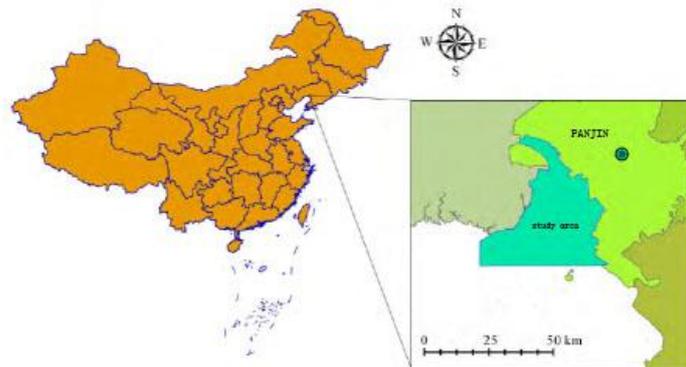


Figure 1. Location of Liaohe estuarine wetland National Nature Reserve

2.2. Data Source

Based on the wetland’s landscape data in TM RS image of 1988 and 2015 and combination on text and graphic materials such as land use maps and functional zone maps in 2000, vegetation maps and field survey data, an information database of the study area was established. Image interpretation was conducted in ArcGIS platform with combination interpretation method of direct interpretation and comprehensive analysis [3]-[4]. A classification system of Liaohe estuarine wetland estuary wetland was established with consideration of image spectral characteristics and spatial features. To validate the accuracy of interpretation achievements, we conducted field GPS validation and projection conversion to ensure the data consistent with its corresponding RS image coordination. According to "Liaoning Province land use classification code" standard to establish wetland property classification code, as shown in Table 1. Changes of wetland types in Liaohe estuarine Nature Reserve from 1988 to 2015 are shown in Figure 2.

Table 1. Category interpretation of Liaohe estuarine wetland

Items	ID	1988 Area(km ²)	2015 Area(km ²)	Items	ID	1988 Area(km ²)	2015 Area(km ²)
Paddy Field	11	112.67	110.66	Reservoir	53	29.80	35.08
Dry Land	12	10.37	13.16	Tidal flat	61	99.08	74.63
Residential Area	42	74.70	102.24	Reed	63	484.73	491.69
River	52	469.68	453.58				

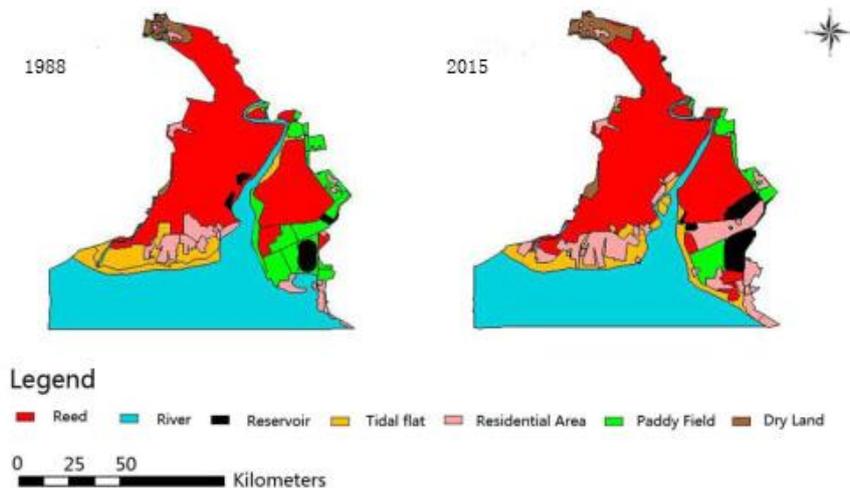


Figure 2. Changes of wetland types in Liaohe estuarine Nature Reserve (1988-2015)

3. Ecological Compensation Calculation

3.1. Ecological Compensation Based on the Value of Ecological Functions

3.1.1. Ecological service function value calculation. There were complete ecological functions and huge economic, ecological and social benefits in the Liaohe Estuarine Wetland Reserve. There were different types of wetlands and different environments in this area. The leading service functions include material production, climate regulation, water purification, bank protection, biodiversity conservation, tourism and leisure functions, education and scientific research, and historical and cultural functions[4]-[5]. Based on the data interpreted in 2015, we could estimate the total value of material production functions is 23.32×10^8 yuan, the total value of climate regulation function is 0.28×10^8 yuan, the value of purifying water quality function is 0.09×10^8 yuan, the ecosystem protection value is 2.63×10^8 yuan, the value of maintaining biodiversity is 0.48×10^8 , the value of scientific research service is 4.65×10^8 yuan, the value of historical and cultural functions is 49.35×10^8 yuan, and the total value of ecological service of Liaohe estuarine Wetland Reserve is 81.09×10^8 yuan which based on the market value method, carbon tax law, substitution method, expert evaluation method, ecological value method, cost-expenditure method and so on [6]-[7].

3.1.2. Result verification. The value of ecological services per unit area of wetlands in the world was 55,420 yuan / hm^2 , and the ecological service value per unit area of wetlands in China was 55,489 yuan / hm^2 . The area of Liaohe estuarine wetland was 128000 hm^2 , the total value of ecological service was 81.09×10^8 yuan, unit ecological service value of 63328 yuan / hm^2 . We could see the value of ecological service function per unit area of wetland is close to the average level of the whole country and the whole country.

3.1.3. Ecological compensation standards. The total value of ecological functions of Liaohe estuarine wetland was 81.09×10^8 yuan based on the calculation results and the unit ecological service function value was 63328 yuan / hm^2 . Compared with 1988, it could be seen that the loss of ecological function value (total compensation fund) was 1,920,0496 yuan, in which the ecological compensation fund was 1548369.6 yuan of Tidal flat, the ecological compensation fund was 1019580.8 yuan of river, the ecological compensation fund was 127,289.28 yuan of Paddy Field.

3.2. The Calculation of Ecological Compensation Based on Market Value Loss

3.2.1. Calculation of market value loss. We could calculate the loss of market value of wetlands in terms of both ecological damage and environmental pollution losses.

$$EC = EC_1 + EC_2 \quad (1)$$

EC: market value loss;

EC_1 : ecological damage loss;

EC_2 : environmental pollution loss.

3.2.2. Market value loss caused by ecological damage. According to the research results paddy fields, Tidal flat, rivers had reduced to varying degrees. Tidal flat reduced mostly. The formula for calculating the value of ecological damage to the market value was as follows:

$$EC_1 = \sum_{i=1}^n E_i L_i + EC_r = E_1 L_1 + E_2 L_2 + E_3 L_3 + EC_r \quad (2)$$

EC_1 : Market value loss ;

EC_r : Indirect loss;

E_1L_1 :Tidal flat loss;

E_2L_2 :River loss;

E_3L_3 :Paddy Field loss

In a few years, the loss of paddy field area was 201hm², we could Specify average yield is 650kg per month.The price rice was 4660 yuan / t in 2015, so the market value loss of paddy field was 0.09×10^8 yuan.An alternative approach was used to assess the value of canal losses, which was replaced by the investment in man-made rivers of the same construction scale. According to statistics, the cost of excavation of artificial river with a depth of 3 meters and an area of 1hm² was about 150,000 yuan.So we could caculate the loss of river is 1610hm² and the value loss of Tidal flat is 2445hm²,so the value loss of river is 2.41×10^8 yuan and the value loss of Tidal flat is 0.7×10^8 yuan by the analysis of the interpretation result.

Access to relevant literature,the total wetland ecological benefits compensation and returning farmland was 0.35×10^8 yuan.the formula of the loss of market value of wetland ecological damage as follows:

$$EC_1 = \sum_{i=1}^n E_i L_i + EC_r \quad (3)$$

The loss of market value of wetland ecological damage was 3.55×10^8 yuan.

3.2.3. The market value loss caused by wetland environmental pollution. The pollution types of the Liaohe estuarine wetland environment mainly included air pollution, water pollution, noise pollution and solid waste pollution, and the losses caused by them were usually measured by the cost of the project. Therefore, the loss of the total value of the wetland market was 4.36×10^8 yuan.

3.2.4. Wetland ecological compensation standard based on market value loss. The total area of wetlands decreased by 3032 hm² and the compensation standard of market value loss was 6,536 yuan / hm².a. during the period from 1988 to 2015.

4. Conclusions

The ecological compensation value per unit area was 63328 yuan / hm².a. according to the calculation method of ecological compensation value of ecological function value.The compensation standard per unit area was 6,536 yuan / hm².a. according to the calculation method of ecological compensation for the loss of market value.Therefore, the ecological compensation standard based on the loss of market value was easier to operate which was more intuitive and easier to be accepted by the masses and more in line with the local economic development level.According to this standard for ecological compensation,the compensation of river was 105,229.6 yuan, the compensation of Tidal flat was 159,805.2 yuan, and compensation of the paddy field was 13,137.36 yuan.

5. References

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