

Research on Land Use Changes in Panjin City Basing on Remote Sensing Data

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Abstract. Taking Landsat remote sensing image as the main data source, the research on land use changes in Panjin City in 2005 to 2015 is made with the support of remote sensing platform and GIS platform in this paper; the range of land use changes and change rate are analyzed through the classification of remote sensing image; the dynamic analysis on land changes is made with the help of transfer matrix of land use type; the quantitative calculation on all kinds of dynamic change features of land changes is made by utilizing mathematical model; and the analysis on driving factors of land changes of image is made at last. The research results show that, in recent ten years, the area of cultivated land in Panjin City decreased, the area of vegetation increased, and meanwhile the area of road increased drastically, the settlement place decreased than ever, and water area changed slightly.

1 Introduction

Land Use/Land Cover Change (LUCC) is the most direct pattern of manifestation of interaction of human activity and natural environment, which is also the core content and hotspot field of global environmental change and sustainable development at present. Panjin is located on the shore of Bohai Sea, heartland of Liaohe River Delta, which is a newly-developing coastal city of petrochemical industry in the west of Liaoning Province, and it is also one of coastal open city in our country. Panjin wetland is one of the most beautiful six wetlands in our country, with the largest reed marshland that has perfect vegetation form protection in the world, and meanwhile it is also an important place for inhabitation and propagation of many kinds of rare wild animals. In addition to this, Liaohe Oilfield in Panjin City is the largest production base of thick oil and high-fat oil and important petrochemical industrial base in the whole nation with annual output of crude oil of 12 million tons and natural gas of 0.9 billion m³. In recent ten years, with the help of rich resources, the economy of Panjin City had a rapid development. The development of economy brought about rapid expansion of the city, but led to some problems like environmental deterioration, continuous decrease of land quality and so on. The analysis on land use changes in research area is made by utilizing two kinds of remote sensing data of time and relevant reasons are summarized in this paper, so as to provide important practical significance for use and protection of land resources in Panjin City and even the whole Liaohe River Delta as well as theoretical basis for reasonable use of land resources and promotion of good ecological environment and harmonious economic development in this area in the future.

2 General situation of research area



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Panjin is located in the southwest of Liaoning Province, heartland of Liaohe River Delta, closing to Anshan in the northeast, facing Yingkou across Liaohe River, and closing to Jinzhou in the northwest and Liaodong Bay of Bohai Sea in the south. The geographic coordinate lies between 40°39' and 41°27' north latitude, and 121°25' and 122°31' east longitude. The total area is 4,071 km², accounting for 2.75% of total area of Liaoning Province. Panjin belongs to a sub-humid warm temperate continental monsoon climate, the average annual temperature is 8.6°C, the mean annual precipitation is 631mm, and the annual sunshine duration is over 2700h.

3 Data sources and pre-processing

The data of one view (Landsat7 satellite) of ETM+ sensor on August 2005 is adopted in this paper. This sensor has data of 8 wave bands, covering different wavelength ranges from infrared to visible light. However, the data of one view (Landsat8 satellite) of OLI sensor on August 2015 has 9 wave bands. The resolution ratio of multi-spectral data in these two kinds of sensor data is 30M, and panchromatic resolution ratio is 15M. To improve the classification accuracy, it is necessary to perform image fusion processing.

Data pre-processing shall include radiometric calibration, atmospheric correction, image fusion and image cutting. After radiometric calibration and atmospheric correction, it is necessary to perform image fusion to fuse multi-spectral image and panchromatic image to obtain data for experiment, so the data shall be with features of multi-spectral image and merits of panchromatic image like higher resolution ratio. With the help of rich information content, the data after fusion can meet the requirement of research on land use changes. After image fusion, it is necessary to cut interested area (Panjin City) to finish the pre-processing of image.

4 Analysis on land use changes in research area

4.1. Analysis on land use area changes

The remote sensing images of Panjin area in 2005 and 2015 are classified by adopting the neural network method in supervised classification. Artificial neural network is a kind of artificial neural network system with some low intelligence, which is constructed basing on the distributed storage, parallel processing and adaptive learning of biological neural system for these phenomena. The classification is performed by adopting error back propagation of neural network in this paper, that is, so-called BP network method, and it is also a kind of neural network that is mostly used in pattern classification. Before performing the classification by adopting the remote sensing image of BP neural network, it is necessary to select the training sample data. The interpretation signs of five categories like settlement place, cultivated land, water area, vegetation and road are defined in this paper, spectral features and other features of all kinds of land categories are extracted by adopting four groups of training samples, and the analysis on the separability of data is made; and then the design on the structure of BP neural network is performed. Firstly, the node number of input layer, hide layer and output layer is respectively determined as 3, 8, 5; during the learning of training sample in ENVI, the setup of important parameters is that, initial weight $a=0.1$, learning rate factor is set as 0.85, factor of momentum is also set as 0.01, and global error of network is set as 0.01. Better classification results are obtained by about 600 times of learning, and the classification situation is obtained at last, see Fig. 1.

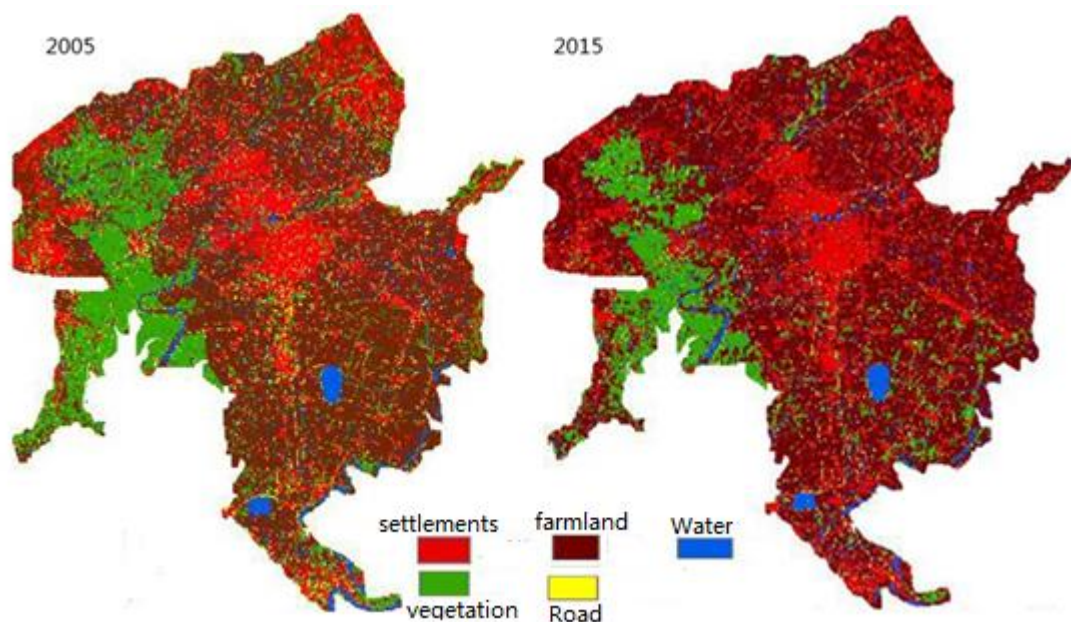


Figure 1 Land classification chart in Panjin City in 2005-2015

With the support of ArcGIS software, the summary on results of classification chart is made by utilizing the remote sensing interpretation on land, and data like area, change area, change range, annual change rate and so on of different land use types in 2005 and 2015 are obtained, see Table 1:

Table 1 Comparative table of land use in 2005-2015 (Unit: ha.)

	Cultivated land	Vegetation	Water area	Settlement place	Road
Area in 2005	1860.896	392.318	161.713	695.514	125.078
Area in 2015	1623.866	585.893	186.983	649.009	191.408
Change area in 2005-2015	237.03	-193.575	-25.27	46.505	-66.33
Change range in 2005-2015	0.2173	-0.4934	-0.1562	0.0668	-0.5303
Change rate in 2005-2015	1.273%	4.934%	1.562%	0.668%	5.303%

We can see from the analysis in the table that, the cultivated land and settlement place in 2005-2015 decreased to a certain extent, of which the area of cultivated land decreased 237.03Km², that of settlement place decreased 46.505Km², but vegetation, water area and road had large growth trend, of which the area of vegetation increased 193.575Km², that of water area increased 25.27Km², and that of road increased 66.33Km². We can see from the change range that, the increasing range of forest land in Panjin City in 2005-2015 was the largest, namely 0.5303. The change range of cultivated land and water area was roughly the same. The change range of settlement place was the smallest. We can see from the annual change rate that, road in Panjin City in 2005-2015 had the most rapid rate of change, with annual increase of 5.303%. The annual change rate of cultivated land and water area was roughly the same, and that of settlement place was the smallest.

4.2. Analysis on dynamic model for land changes

(1) Transfer matrix model

To analyze the sources and whereabouts of land use changes in Panjin City, it is not only necessary to make the analysis on all kinds of land use changes, but also to make further analysis on land type conversion changes and internal structure in this paper. The transfer matrix can not only be quantitative to illustrate the mutual transformation status between land use types, but also to reveal the transfer probability between different land use types and better analyze the spatial and temporal

changes of spatial pattern of land use. The analysis on internal structure transformation of five kinds of land categories in 2005-2015 is made by utilizing Change Detection Statistics model in ENVI software, so as to generate the land use transfer matrix in Panjin City, see Table 2:

Table 2 Land use transfer matrix in Panjin City in 2005-2015 (Unit of area: ha.)

2005-2015	Settlement place	Cultivated land	Water area	Vegetation	Road	Proportion
Settlement place	486.459	137.884	6.798	31.104	14.618	20.017%
Cultivated land	75.524	1345.084	54.117	117.373	30.513	50.084%
Water area	13.376	87.522	65.890	7.087	12.993	5.767%
Vegetation	29.045	254.851	25.147	258.188	17.662	18.070%
Road	90.045	34.412	9.712	6.053	49.268	5.903%
Proportion	21.451%	57.394%	4.988%	12.099%	3.858%	

We can obtain the following results through the analysis on the data in the table: the area of cultivated land totally decreased 237.03Km² in 2005-2015, mainly flowing to settlement place and vegetation, and part of vegetation and road changed to cultivated land during this period; during 2005-2015, there existed a situation of transferring rural population into cities; the water area mainly presented an increasing situation in 2005-2015, and part of cultivated land changed to fishpond; the category of vegetation in this paper mainly referred to wetland plant, during 2005-2015, the area of wetland increased substantially, and main source and flow direction were cultivated land; road presented an increasing trend during 2005-2015, mainly from cultivated land, which accorded with the rule of urban development.

(2) Dynamic change model

① Dynamic degree of comprehensive land use

The expression formula of dynamic degree of comprehensive land use in a research area is:

$$LC = \left\{ \frac{\sum_{i=1}^n \Delta LU_{i-j}}{2 \sum_{i=1}^n LU_i} \right\} * \frac{1}{T} * 100\% \quad (1)$$

In the formula, LU_i is the area of land use type of category i during the starting time of monitoring; ΔLU_{i-j} is the sum of area of land use type of category i during the time frame of monitoring to that of land use type of non-category i and area of land use type of non-category i to that of land use type of category i ; T is the length of research time frame, when the length of T is set as year, LC value is the comprehensive annual change rate of land use in this research area. The dynamic degree of land use comprehensively considers the transfer between land use types within the research time frame, and focuses on the change procedure but not change result, so as to describe the vigorous exercise of land use changes in this area. The calculation results in this paper show that, the dynamic degree of comprehensive land use in 2005-2015 was 1.359%, illustrating that land use type of 1.359 mu in 100 mu changed during this period.

② Analysis on land use degree

The change of land use degree within specific range is the result of change of many kinds of land use types, and land use degree and its change rate can quantificationally describe the comprehensive level and change trend of land use in this area. According to Ji-Yuan Liu and other person, the grading index of land use degree is put forward, see Table 3.

Table 3 Land grading index

Grading type	Unused land grading	Extensive use land grading	Intensive use land grading	Land grading of cities and towns settlement
Land use	Unused land, wetland	Forest land, water	Cultivated	Settlement place

type Grading index	1	area 2	land 4	4
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Meanwhile the quantitative expression formula of change number of land use degree is given:

$$D = 100 \sum_{i=1}^n A_i \times \frac{CC_i}{HJ}, D \in [100, 400] \quad (2)$$

In the formula, D refers to comprehensive index of land use degree; A_i refers to grading index of land use degree at level i ; CC_i refers to land use area at level i ; HJ refers to total area of land within land use evaluation area; n refers to grading index of land use degree. We can know from the formula that, comprehensive quantitative index system for land use is a continuous change index between 100 and 400, and comprehensive index can reflect the land use degree. We can obtain the comprehensive index of land use degree in Panjin City in 2005 to 2015 through the calculation, see Table 4:

Table 4 Table of analysis on land use degree

Comprehensive index of land use degree		Change quantity of land use degree	Change rate of land use degree
2005	2015	2005-2015	2005-2015
283.536	295.493	11.957	4.21

We can see from the data in the table that, the comprehensive index of land use degree in Panjin City in 2005 and 2015 was respectively 283.536 and 295.493, and the change quantity and change rate of land use degree in this area were all more than zero. Land use is at the stage of development, showing that the land use degree increases continuously. The comprehensive index range value of land use degree is between 100 and 400. When reaching 400, it is the limit value of land use degree. The annual change rate of land use degree has reached 4.21%, the development speed is higher, so it is necessary to fully and reasonably utilize limited resources in the land use in the future and protect the land resources, so as to realize the sustainable utilization of resources.

4.3. Analysis on driving factors of land use changes

Seeing from long time scope, natural and human factors drive the land use and land cover change, but during the procedure of urban change in short time scope, human activity undoubtedly is a main driving factor. Therefore, it is necessary to build a human caused influence index, so as to reveal the influence intensity of human activity on land use and land cover change in this area on the whole. The calculation formula is:

$$HAI = \sum_{i=1}^n A_i P_i / T_A \quad (3)$$

In the formula, HAI is human caused influence index, N is number of landscape component type, A_i is area of landscape component of category i , P_i is human caused intensity parameter that is reflected by landscape type of category i , T_A is total area of landscape. The human caused influence intensity parameter can reflect the intensity and attributive character of human participation, management, and reconstruction of different landscape components. HAI value changes between 0 to 1, the larger HAI value is, the larger the composition of landscape component that is dominant in human activity is, the larger the influence intensity of human activity is; the smaller HAI value is, the smaller the human caused reconstruction activity intensity of landscape is. Human caused intensity indexes of all kinds of land categories are shown in Table 5.

According to the calculation of human caused influence intensity indexes, we can obtain that the human caused influence index in Panjin City in 2005 was 49.620%, and that in 2015 was 51.867%. From this we can see that the influences of human on the whole area become increasingly strong, of which, influences of human factors include: influence on population growth, influence on policy factor and dynamic factor of economic development. Therefore, they are not introduced one by one.

Table 5 Human caused intensity indexes of all kinds of land categories

Cultivated land	Water area	Settlement place and road	Vegetation
0.46	0.12	0.94	0.08

5 Conclusion

(1) We can discover that through the research in this paper, the total tendency and basic features of land use and land cover change in Panjin City are: the area of cultivated land decreases, the area of vegetation increases rapidly, meanwhile the area of road also increases drastically, the settlement place presents a decreasing tendency, and water area changes a little. The ecological environment in the research area is with certain improvement, and land use type is developing toward reasonable and sustainable direction.

(2) The condition of land use changes in the research area can be reflected from various points of view by utilizing three models like “transfer matrix”, “dynamic degree of comprehensive land use” and “change indexes of land use degree”, so as to reveal the condition of land use in the research area.

(3) We can obtain that the influences of human activity in Panjin City on the whole area is daily on the increase by adopting the model of human caused influence indexes, increasing from 49.620% in 2005 to 51.867% in 2015.

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