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# Land Use Dynamic Change and Ecological Effects Analysis Based on GIS - A Case Study at Hailun City

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## Abstract

The typical natural landscapes and temporal- spatial regulation of Land use change and their ecological effects at Hailun County were conducted and analyzed, based on the translated data from remote sensing images in 1986, 1996 and 2000 using GIS and landscape ecological theory. The results indicated the area of arable land, paddy field and city land increased 7,786.39 $hm^2$, 3391.18 $hm^2$ and 120.84 $hm^2$ while the area of forestry, grassland and marsh decreased 3,184.88 $hm^2$, 1,625.8 $hm^2$ and 3,994.85 $hm^2$ respectively during 14 years. Dry land is a main landscape in this area. These changes made the environmental quality worse gradually, such as land degradation, soil erosion and water and soil losses, and temperature getting warmer. This study is very important for the local ecological environment protect and agricultural sustainability and land resources sustainable using.

**Key Words:** land use, ecological effects, landscape

## Introduction

Nowadays, with the population increase and economic development, the land resource faces greatly pressure. The change of land use, human life and ecologic environment caused by human being has attracted wide attention (Zhang et al. 1997; Chen 1999; Gao et al. 1999; Shi et al. 1999; Wang 1999). In a certain sense, the development of human society is the history of the change of land use. Land cover change caused by Land use has an important effect on the earth system of climate, hydrology, and biological diversity and so on. Meanwhile, land cover change also is the landscape of the earth surface physical, chemical, and biological interaction process (Li 1996). For example, Songnen plain black soil region is China's important grain production base. Farming intensity is often overloaded. Therefore, it triggered the worsening drought, loss of water and soil and gully erosion. For Songnen plain, Hailun's hills and hillock were covered by large forest two hundred years ago. But over the last one hundred years, it has become an important agricultural production area due to immigration, establishment of villages, and increase of cultivated area and deforestation of primeval forest. It brought some negative effects on ecological environment and agricultural production. Good weather for harvest has been replaced by drought, fierce spring breeze and frequent disasters (CAS' research team, 1978). Taking Hailun as an example, this article uses GIS technology, landscape ecology and agricultural ecology method to analyze the change of land use and its ecological effect in 14 years. It aims to provide scientific evidence for

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ecological environment and agricultural sustainable development.

### *Study on regional geographic position and social economic attribute*

Hailun is situated at 47°26' north latitude and 126°38' east longitude, altitude of 240 meters, the black soil area of central Heilongjiang Province. There are four main rivers running through its territory. The county from northeast to southwest is the longest, north and south is shorter. According to the vegetation regionalization, Helen belongs to the changbai mountain forest plant area xiaoxinganling plant subregion. Since it developed in 1897, the ecological environment has changed greatly in about 100 years. Hailun was widely covered by forest in history, due to the human's society and production activities, deforestation and fire, the vast forests have disappeared.

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According to the Chinese academy of sciences Hailun natural resources comprehensive research team's report in 1978, Hailun has a total land area of 455,000 hectares (higher than statistical data). The majority of soil is black soil, followed by meadow soil and carbonate meadow soil. Hailun has a total population of 786,000 in 1978, including agricultural population of 686,000. In 2000, the statistical total population of 798,570, the agriculture population for 638447, the agricultural GDP for 958.85 million yuan, industrial output value is 513.88 million yuan. Hailun is one of important agricultural production cities in Heilongjiang Province.

## Materials and Methods

### *Data source*

These data come from the 1:100,000 Landsat TM's remote sensing data in 1986, 1996 and 2000 interpreted by the National Scientific Data Center for Resources and Environment. It used two methods to test the accuracy of interpretive data. Firstly, we compare the land use map (small scale 1:50,000) with interpretive map. Secondly, we use punctum and field study to test the accuracy of interpretive data's patches attribute and space distribution. It has approved that the accuracy is above 80%. According to the 'Survey technical regulation of Land use', usage, Utilization pattern, cover characteristics and ecological types, the land use can be divided into six first-level types, including farmland, forest land, grassland, water area, urban residential and industrial area and unused land. First-level type can be divided into 25 second-level types, mainly based on the cultivated land geomorphic types. Data format is ARC/INFO of COVERAGE. This article will focus on the mainly vegetation types in second-level classification.

### *Research method*

Based on the 1:100,000 Landsat TM's interpretation data in 1986, 1996 and 2000, these data will have a coordinate projection transformation according to Albert double standard conic projection mode. Using SUPERMAP's GIS environment to analyze and calculated these three period data separately, to establish Markov model to analyze the change process of Hailun's land cover. Meanwhile, it also established related landscape model and evaluation index and analyze the landscape structure change. On this basis, it studies the agricultural ecological effet.

### *The speed of land use change*

Dynamic index of single land use type (Wang and Bao 1999) is used to quantitatively describe the change rate of land use type and certain time interval in research area. Following is the computational formula:

$$K = \frac{U_2 - U_1}{U_1} \times \frac{1}{T} \times 100\% \qquad \text{Formula (1)}$$

There, K is the dynamic index of land use type in the re-

search period. $U_1$ is the number of land type in beginning time and $U_2$ is the number of land type in the final time. $T$ is research period, year is its basic unit. $K$ is annual change rate. This model can use to analyze and compare the change rate of different land use type in research area.

### *Conversion matrix of land use change (Markov model)*

Markov model is a useful stochastic model in ecology study. In this model, the basic form is a transition probability matrix from one space to another space in certain time interval.

System of future time is only related to present situation and no direct relation with past history, it is Markov model's nature. The theorem: for one Markov Chain $\{\xi n, n=1,2\cdots\}$, the matrix $P(m)=(P_{ij}(m))$ with $m$ step transition probability as its element is Markov's $m$ step transition matrix. When $m=1$, $P(1)=P$ is called as the one step transition matrix of Markov Chain, or referred as transfer matrix.

It has following basic nature: For all, $i, j \in E, 0 \le P_{ij}(m) \le 1$; for each one $i \in E, \sum_{j \in E} P_{ij}(m) = 1$

Markov model can be used to analyze the change and transform in different land use type (Xu 1993; Liu 1995; Wang et al. 2002; Li et al. 2003; Yu et al. 2003). It will get land use type transformation table for 14 years (Table 1) by using SUPERMAP software's GIS spatial analysis function to calculate land use maps in these two periods. Based on the

formula $P_{ij} = n_{ij} / \sum_{k=1}^{m} n_{ik}$ in Table 1, it can get the land use transition probability matrix.

## Results and Discussion

### *Change of land use structure in Hailun*

The land use structure of Hailun changed greatly from1986 to 2000. Dry land, paddy land, town land and residential area have increased. The dry farmland increased 7,786.39 $hm^2$ from 1986 to 2000. The change rate is 2.5%. The most important aspect is that the increase of dry land mainly comes from shrubbery and open forest land in hill area. Table 2 shows that hill dry land increased from 215.85 to 686.41 $hm^2$. The increase rate is 218%. Farmers are used to cultivate plant along the slope; this is also the main reason of water and soil loss. Paddy field also increased 3,391.18 $hm^2$ from 1986 to 2000; the increase rate is 12.9%. Town land increased greatly from 1,024.68 to 1,145.51 $hm^2$; the increase rate is 11.8%. The residential area also increased.

At the same time, forest land, other forest land (including shrubbery, open forest land and others), grassland and wetland decreased rapidly. Forest land, other forest land, grassland and wetland decreased 3,184.88 $hm^2$, 2,507.51 $hm^2$, 3,994.85 $hm^2$, 1,625.8 $hm^2$ respectively. Rate of decrease are 7.11%, 44.03 %, 44.9% and 3.58%. Water area basically unchanged, including lake, reservoir and bottomland.

Table 2 shows that dry farmland, town land, rural residential area and wetland increased from 1986 to 1996, but decreased from 1996 to 2000. On the contrary, paddy field, forest land and grassland decreased from 1986 to 1996, but increased from 1996 to 2000. The change rule is closely linked to the change of Hailun's relevant policies.

### *Analysis on land use dynamic index*

Formula 1 analyzed the land use dynamic index of Hailun City. This article only consider single land use dynamic index. The Table 1 shows that hill dry land and paddy field increased very fast; its dynamic index are +15.57% and +0.9% respectively. Town land's dynamic index is 0.8%. Grassland, shrubbery, forest land and wetland decreased in this period. The dynamic index is -3.2%, -3.1%, -0.5% and -0.26% respectively.

### *Transition matrix analysis of land use type (Markov model)*

By using GIS spatial analysis function and statistical analysis on land use table in these two period, it can get the land use type transition matrix table.

Note: The number in Table 1 is acreage number.

Analysis the transition of land use type from the result, it shows:

1. The increase of dry land mainly comes from forest, other forest land, grassland and wetland; they are 3,041.03, 2,600.55, 2,293.66 and 407.7 hectares respectively. Some of dry land has change into paddy field, town land, residential area and wetland; the change rates are 0.15%, 0.013%, 0.004% and 0.008%.

**Table 1.** Transition matrix of land use type in Harlun from 1986-2000 ($hm^2$/%)

| Land use | Dry land | Paddy land | Forest land | Other forest land | Town land | Rural residential area | Water area | Grass land | Wet land |
|---|---|---|---|---|---|---|---|---|---|
| Dry land | 310,153.09 | 479.08 | 0 | 0 | 39.98 | 13.49 | 0 | 0 | 24.06 |
| | 99.82 | 0.154 | | | 0.013 | 0.004 | | | 0.008 |
| Paddy land | 0 | 26,237.47 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 100 | | | | | | | |
| Forest land | 3,041.03 | 0 | 41,600.54 | 142.67 | 0 | 1.18 | 0 | 0 | 0 |
| | 6.79 | | 92.88 | 0.319 | | 0.003 | | | |
| Other forest land | 2,600.55 | 49.65 | 0 | 3,045.02 | 0 | 0 | 0 | 0 | 0 |
| | 45.66 | 0.87 | | 53.466 | | | | | |
| Town land | 0 | 0 | 0 | 0 | 1,024.68 | 0 | 0 | 0 | 0 |
| | | | | | 100 | | | | |
| Rural residential area | 0 | 0 | 0 | 0 | 0 | 21,228.86 | 0 | 0 | 0 |
| | | | | | | 100 | | | |
| Water area | 0 | 0 | 0 | 0 | 0 | 0 | 5,703.79 | 0 | 0 |
| | | | | | | | 100 | | |
| Grass land | 2,293.66 | 1,620.33 | 0 | 0 | 80.85 | 0 | 0 | 4,900.73 | 0 |
| | 25.78 | 18.215 | | | 0.909 | | | 55.092 | |
| Wet land | 407.73 | 1,242.13 | 0 | 0 | 0 | 0 | 0 | 0 | 43,761.49 |
| | 0.89 | 2.735 | | | | | | | 96.367 |
| Total | 318,496.06 | 29,628.65 | 41,600.54 | 3,187.70 | 1,145.51 | 21,243.53 | 5,703.79 | 4,900.73 | 43,785.55 |

**Table 2.** Change of land use structure in Hailun ($hm^2$)

| Land use type | 1986 | 1996 | 2000 | 1986-2000 variable quantity | 1986-2000 percent change (%) | 1986-2000 dynamic index K+ |
|---|---|---|---|---|---|---|
| Hill dry farmland | 215.847 | 891.283 | 686.415 | 470.568 | 218.010 | 15.572 |
| Plain dry farmland | 310,493.848 | 322,010.311 | 317,809.667 | 7,315.819 | 2.356 | 0.168 |
| Paddy field | 26,237.468 | 18,768.446 | 29,628.651 | 3,391.183 | 12.925 | 0.923 |
| Forest land | 44,785.421 | 41,032.321 | 41,600.538 | -3,184.883 | -7.111 | -0.508 |
| Other forest land | 5,695.224 | 3,861.540 | 3,187.710 | -2,507.512 | -44.028 | -3.145 |
| Town land | 1,024.676 | 1,229.659 | 1,145.514 | 120.838 | 11.793 | 0.842 |
| Water area | 5,703.790 | 5,684.82 | 5,703.790 | 0.000 | 0.000 | 0.000 |
| Grassland | 8,895.580 | 4,614.790 | 4,900.734 | -3,994.846 | -44.908 | -3.208 |
| Rural residential area | 21,228.863 | 21,247.230 | 21,243.533 | 14.6704 | 0.069 | 0.005 |
| Unused land | 77.409 | 77.410 | 77.409 | 0.0000 | 0.000 | 0.000 |
| Wetland | 45,411.373 | 50,351.507 | 43,785.574 | -1,625.7983 | -3.580 | -0.256 |

2. The increase of paddy field mainly comes from farmland, shrubbery and other forest land, grassland and wet land. 479 hectares farmland, 49.6 hectares shrubbery and other forest land, 1,620.3 hectares grassland and 1,242.1 hectares wetland have changed into paddy field. The largest is grassland, accounts for 18.2%; secondary is wetland accounts for 2.7%.

3. The decreased forest land mainly changed into dry land, shrubbery and residential area, account for 6.8%, 0.3% and 0.003%.

4. Majority of decreased grassland changed into dry land, paddy field and town land, account for 25.8%, 18.2% and 0.9% of grassland.

5. Decreased wetland mainly changed into dry land and paddy field. 407.7 hectares and 1,242.13 hectares have changed into dry land and paddy field respectively, account for 0.9% and 2.7%.

## *Landscape structure change of land use*

### Analysis on dynamic change of landscape element patches

This article will analyze the statistical data of 15 landscape elements of Hailun City. The statistical data include number of patches, acreage, perimeter and total acreage of landscape elements.

Table 3 shows that the plain dry land landscape is the dominant landscape types in Hailun. Except plain dry land, wetland and forest land rank second and third landscape types, account for 10% respectively. Plain dry land, wetland and forest land are three main landscape types in Hailun, account for 80% of the total. Plain dry land's average patches area is largest; followed by wetland, town land and forest land; bare soil is the smallest. Bigger average patches area has better landscape connectivity, and vice versa. Three periods remote sensing interpretation of land use shows that most of plain dry land is stretches of distribution, it also confirmed plain dry land has best connectivity. In addition, wetland's patches area is larger; it means wetland also has better connectivity. But bare soil's patches area is small, so it has worse connectivity.

Nearly circular index is main index of landscape elements plaque shape and circular difference degree. It shows that plain dry land and wetland's patches shape is the most complex by studying on nearly circular index of various landscape elements; it is consistent with current situation. Especially the plain dry land, effected by landform and vegetation distribution limit, presents a complicated situation and very different with circle. Secondly, wetland's patch complexity is only second to plain dry land. Three periods remote sensing interpretation of land use shows that wetland in Hailun City is elongated distribution, bordering with paddy field and plain dry land. In order to increase farmland, people often dig up wetland without organization. It makes the wetland's patches shape become complicated. Patch shape of open forest land, rural residential area, lakes and bare soil is simple. The rural residential area belongs to typical artificial landscape; its patch shape is simple and shows regularization under the human disturbance.

**Table 3.** Dynamic analysis table of HaiLun's landscape elements characteristics

| Type of land | Year | Acreage | Patches average area | Patches nearly circular index | Patches density | Broken chage degree | Number of patches |
|---|---|---|---|---|---|---|---|
| Paddy field | 1986 | 26,237.468 | 230.153 | 0.1159 | 0.4345 | 0.00267 | 114 |
| | 1996 | 18,768.446 | 172.188 | 0.147 | 0.5808 | 0.00206 | 109 |
| | 2000 | 29,628.651 | 238.941 | 0.1246 | 0.4185 | 0.00258 | 124 |
| Hill dry farmland | 1986 | 215.847 | 43.169 | 0.2588 | 2.3165 | 0.30353 | 5 |
| | 1996 | 891.283 | 68.560 | 0.3451 | 1.4586 | 0.17703 | 13 |
| | 2000 | 686.415 | 85.802 | 0.2545 | 1.1655 | 0.30847 | 8 |
| Plain dry farmland | 1986 | 310,493.848 | 5,007.965 | 0.0107 | 0.0200 | 0.00010 | 62 |
| | 1996 | 322,010.311 | 5,457.802 | 0.0065 | 0.0183 | 0.00001 | 59 |
| | 2000 | 317,809.667 | 5,778.358 | 0.0078 | 0.0173 | 0.00009 | 55 |
| Forest land | 1986 | 44,785.421 | 622.02 | 0.0441 | 0.1608 | 0.00244 | 72 |
| | 1996 | 41,032.321 | 672.661 | 0.0422 | 0.1487 | 0.00035 | 61 |
| | 2000 | 41,600.538 | 670.976 | 0.0439 | 0.1490 | 0.00225 | 62 |
| Shrub land | 1986 | 5,634.388 | 61.916 | 0.1769 | 1.6151 | 0.04380 | 91 |
| | 1996 | 3,665.194 | 60.085 | 0.1875 | 1.6643 | 0.04489 | 61 |
| | 2000 | 2,991.364 | 52.480 | 0.1748 | 1.9055 | 0.05133 | 57 |
| Scatter woodland | 1986 | 54.092 | 54.092 | 0.3885 | 1.8487 | 0.00000 | 1 |
| | 1996 | 189.604 | 94.802 | 0.4574 | 1.0548 | 0.24759 | 2 |
| | 2000 | 189.603 | 94.802 | 0.4574 | 1.0548 | 0.24759 | 2 |
| High-overlay grassland | 1986 | 8,315.898 | 71.076 | 0.1957 | 1.4069 | 0.04686 | 117 |
| | 1996 | 4,035.099 | 41.599 | 0.2609 | 2.4039 | 0.10744 | 97 |
| | 2000 | 4,321.053 | 46.463 | 0.2587 | 2.1523 | 0.09615 | 93 |
| Medium-overlay grassland | 1986 | 579.682 | 72.460 | 0.2543 | 1.3801 | 0.20818 | 8 |
| | 1996 | 579.691 | 72.461 | 0.2543 | 1.3800 | 0.20818 | 8 |
| | 2000 | 579.682 | 72.460 | 0.2543 | 1.3801 | 0.20818 | 8 |
| Lakes | 1986 | 94.105 | 23.526 | 0.5399 | 4.2506 | 0.30866 | 4 |
| | 1996 | 77.719 | 25.906 | 0.4864 | 3.8601 | 0.24915 | 3 |
| | 2000 | 94.105 | 23.536 | 0.5399 | 4.2506 | 0.30866 | 4 |
| Reservoir pond | 1986 | 5,148.592 | 245.171 | 0.2792 | 0.4079 | 0.00794 | 21 |
| | 1996 | 5,150.056 | 245.241 | 0.2793 | 0.4078 | 0.00794 | 21 |
| | 2000 | 5,148.592 | 245.171 | 0.2792 | 0.4079 | 0.00794 | 21 |
| Bottom land | 1986 | 461.090 | 76.848 | 0.1447 | 1.3013 | 0.24169 | 6 |
| | 1996 | 457.049 | 76.175 | 0.1450 | 1.3128 | 0.24383 | 6 |
| | 2000 | 461.090 | 76.848 | 0.1447 | 1.3013 | 0.24169 | 6 |
| Town land | 1986 | 1,024.676 | 1,024.676 | 0.1231 | 0.0976 | 0.00000 | 1 |
| | 1996 | 1,229.659 | 1,229.659 | 0.076 | 0.0813 | 0.00000 | 1 |
| | 2000 | 1,145.514 | 1,145.514 | 0.1034 | 0.0873 | 0.00000 | 1 |
| Rural residential area | 1986 | 21,228.863 | 19.656 | 0.5188 | 5.0874 | 0.13723 | 1,080 |
| | 1996 | 21,247.230 | 19.673 | 0.5191 | 5.0830 | 0.13711 | 1,080 |
| | 2000 | 21,243.533 | 19.67 | 0.5181 | 5.0839 | 0.13714 | 1,080 |
| Wetland | 1986 | 45,411.373 | 1,297.438 | 0.0357 | 0.0771 | 0.00059 | 35 |
| | 1996 | 50,351.507 | 1,144.352 | 0.0377 | 0.0874 | 0.00004 | 44 |
| | 2000 | 43,785.574 | 1,152.252 | 0.0354 | 0.0868 | 0.00066 | 38 |
| Bare land | 1986 | 77.409 | 15.482 | 0.7207 | 6.4592 | 0.54955 | 5 |
| | 1996 | 77.410 | 15.482 | 0.7208 | 6.4591 | 0.54954 | 5 |
| | 2000 | 77.409 | 15.482 | 0.7207 | 6.4592 | 0.54955 | 5 |

**Analysis on dynamic change of spatial landscape pattern**

In this article, patches size, average area, density and broken degree were used to test landscape broken change degree in Hailun City. Except water area and residential area, patches changed in other five landscape types. The number of peaches increased is 47 from 1986 to 2000. The number of patches increased in paddy field and wetland, it showed that man-made interference could seriously influence the landscape broken change degree. Patches decreased in dry land, forest land and grassland. Among them, forest land and grassland's patches and area decreased mostly. It demonstrated that forest land and grassland damaged seriously in the past 14 years. From the transition matrix of land use of Hailun from 1986 to 2000, it can be seen that 98% disappeared forest land and grassland have transformed into farmland, which showed human destructive activities are the main reason for forest land and grassland reduction. In 1950s, in order to enlarge the farmland, some forest land and grassland have been damaged. More and more forest land and grassland changed into farmland and plant their crops up and down the slope lead to soil and water loss. Then under the wrong guideline of taking grain as the key link, the hill dry land also seriously damaged from 1972. In 1980s and 1990s, some forestry workers and miners stated to plant crops at the land suitable for forest due to coal mine enterprises recession and reduce of forest harvesting capacity. But it increased soil and water loss in the black soil zone. According to the results of patches average area, patches density and broken change degree, all landscape types' broken change degree size sequence are town land, grassland, water area, paddy field, forest land, unused land and dry land. As an agricultural county, Hailun should improve agricultural environment and productivity through increasing vegetation area of forest land and grassland, improving agricultural cultivation measures, rationally using water resources, enhancing ability of disaster prevention and mitigation and optimizing agricultural production and management technology. Predatory agricultural operations, such as deforestation, only can gain economical benefit in short time. But in the long run, it only can damage the ecological environment and increase soil and water loss. It also reduces the productivity.

Only in 1996, some individual index of broken change degree changed in water area, forest and paddy field. It is clear that the typical man made landscape, urban and rural residential land is always the highest landscape broken change degree type; man-made interference aggravated landscape broken change degree.

**Table 4.** Diversity, dominance, evenness and fragmentation index of Hailun 1986-2000

| Year | Diversity index H | Dominance index D | Evenness index E | Fragmentation Degree index FN |
|---|---|---|---|---|
| 1986 | 0.5146 | 0.3305 | 0.6089 | 0.00176 |
| 1996 | 0.4989 | 0.3462 | 0.5903 | 0.00012 |
| 2000 | 0.4938 | 0.3513 | 0.5843 | 0.00169 |

In this article, diversity index, evenness index, fragmentation and dominance index were used to test the general landscape pattern changes. Table 4 shows that diversity index and evenness index have decreased in Hailun City, dominance index increased from 1986 to 2000. It indicated that diversity index continued to decrease in recent 14 years; one of some types dominated the general landscape pattern. Fragmentation index decreased generally, but the range is small. Fragmentation index decreased rapidly in the first 10 years, increased in the last 4 years, and recovered to the original level in 2000.

Above comprehensive analysis (Table 4) shows that the general landscape pattern of Hailun City has changed from 1986 to 2000. In the eighties, the broken degree of landscape is small; the landscapes keep well in Hailun. The landscape type is rich and the proportion of various land use type is well- distribute with higher landscape broken degree. n the nineties, with the development of agriculture, forestry, animal husbandry, sideline occupations and fishery and serious environmental damage, water and soil loss and man made destruction, the landscape structure of Hailun changed greatly. People often change the land use type according to market demand. Therefore, patches trends award concentrated distribution; the land use type also concentrated in a few types such as residential area, grassland and farmland. The landscape distribution is uneven. In 2000, the relevant departments have recognized the landscapes structure change and some environmental problems such as soil and water loss and began to adjust the landscape

spatial pattern. The man-made adjustment has eased he change of index; and landscapes have been recovered and protected in a certain extent.

**Analysis on main driving factors of land use**

Land is a nature and human complex. The change of land use structure is influenced by natural factors, society, economy and history and other culture factors; it has a strong comprehensive and regionality. However the human social economic activities directly led to the evolution of change of land use type and land use structure. In essence, it is process of the human constantly adjust and distribute the various land use to meet the demand of social and economic development (Zheng et al. 2008). It is mainly affected by the social and economic factors. These determinative factors, including population factor and social economic development, are real driving force for change of land use structure.

Hailun's total population increasing with the rapid growth of food, fuel and animal product demand has increased great pressure on resource and environment day by day. Therefore, reflected in the change of land use, the farmland increased constantly from 336,900 $hm^2$ in 1986 to 348,100 $hm^2$ in 2000. Secondly, the increase of population will inevitably lead to the increase of residence area; land reclamation and residential land increase will occupy forest land, grassland and unused land. In addition, the increase of population enlarged the demand for water resource and surface water resources over-exploitation. The effect on the evolution of land use landscape pattern is embodied in density of water patches increased and distribution of water became more broken. It is clear that population increase is the basic reason of land use change in this area.

Hailun is located in the central zone of typical black soil; agriculture is its core industry. The rapid development of agricultural economy not only contributes to the social development but also occupy a large amount of land resources. Therefore, economic development is the main driving force of land use change in Hailun. The effect of agricultural development on land use change mainly embodies in increase of farmland and decrease of forest land, grassland and unused land, and increase of patches landscape dominance index.

## Conclusion

In conclusion, analysis on Hailun's land use change from 1986 to 2000 will have a quantitative understanding for Hailun's ecological environment construction and agricultural development. It will provide scientific evidence to Hailun's ecological environment construction and adjustment of land use type, so as to realize the purpose of agriculture sustainable development and environment sustainable utilization.

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