

## The Research on Landcover Change in Beijing-Tianjin-Hebei region in China over the past 25 years

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**Abstract:** *LUCC is key research issue in global change in many international projects. It is the result of multiple driving factors interaction, in which the mechanism and process are complex. Since the 21st century, the landcover in China has changed greatly, especially in Beijing-Tianjin-Hebei (BTH) region, Yangtze River Delta and the Pearl River Delta with rapid economic development. The BTH region is an important economic growth pole in China. Therefore, it is of great significance to carry out the study on land cover change in BTH region. Based on the 30m remote sensing images, object-oriented classification method is used to extract landcover information of the BTH region over the past 25 (1990-2015). Over the past 25 years, great land cover changes have taken place in Beijing-Hebei-Tianjin region with the rapid economic growth. Construction land and transportation land increased rapidly, cropland decrease continuously. The growth rate is greater in Beijing and Tianjin than in Hebei.*

**Keywords:** *LUCC, land cover, remote sensing, object-oriented, Landsat*

### 1. Introduction

Accurate classification of land use and land cover (LULC) is key for numerous applications, including environmental management, climate studies, hydrological modeling, biodiversity conservation, sustainable development, and agricultural planning (Dibaba et al., 2020; Hu et al., 2021; Millard et al., 2021; Shafizadeh Moghadam et al., 2019; Atefe Arfa et al. 2024). Landcover maps are mainly produced from remote sensing imagery, and most of the image classification methods are based on spectral information, which neglect the object information. Object-oriented image classification method can not only use image spectral information, but also use the object information, it can improve the accuracy of image classification.

Since the 21st century, the landcover in China has changed greatly. The BTH region, Yangtze River Delta, Pearl River Delta have rapid economic development. Beijing-Tianjin-Hebei region is an important economic growth pole, and the coordinate development between Beijing, Tianjin and Hebei is a key national strategy in China. Therefore, it is of great significance to carry out the study on land cover change in Beijing-Tianjin-Hebei region.

## 2. Methodology

### 2.1 Study area

The BTH region locates in the north of China at 113°27'E~119° 50'E, 36°05'N~42°40'N, with a total area of  $21.6 \times 10^4 \text{ km}^2$ . It is 'Capital Economic Circle of China', which includes the municipalities of Beijing and Tianjin and 11 prefecture-level cities in Hebei Province, namely Shijiazhuang, Tangshan, Qinhuangdao, Handan, Xingtai, Baoding, Zhangjiakou, Chengde, Cangzhou, Langfang and Hengshui.

### 2.2 Data sources and processes

The land cover data in 1990, 2000, 2010 and 2015 is collected from ChinaCover Dataset which is produced using object-oriented method based on 30m remote sensing images, which can meet the needs of ecological assessment and carbon budget estimation in China (Wu et al., 2020). All of data were spatially transformed to the WGS-84 geographical coordinate system, and the second level land cover types were merged into first level land cover types.

### 2.3 LULC analysis method

#### 2.3.1 Rate of land cover change

The land cover gross change (LCGC) and land cover class change (LCCC) were used to quantify the speed of the LCLUC (Liu et al., 2014; Liu et al., 2010). LCGC refers to the transformation speed among all land cover types in a specific region, reflecting the regional differences in land cover changes. LCCC was used to describe the change speed of a specific land cover type, indicating its speed of increase or decrease (Wu, Bingfang et al., 2024). The LCGC and LCCC were calculated as follows:

$$LCGC = \left\{ \frac{\sum_{i,j \neq i}^n \Delta S_{i-j}}{\sum_i^n S_i} \right\} \times (1/t) \times 100\% \quad (1)$$

$$LCCC_i = \frac{(S'_i - S_i)}{S_i} \times (1/t) \times 100\% \quad (2)$$

where  $S_i$  and  $S'_i$  are the total areas of class  $i$  at the start and end of the monitoring, respectively.  $\Delta S_{i-j}$  is the total area transferred from class  $i$  to class  $j$ , and  $t$  is the time interval.

### 2.3.2 LULC transfer matrix

The LULC transfer matrix is a commonly applied quantitative method for studying the number and directions of different conversions of LULC types (Zhang et al., 2024). Formula (1) reflects the structure of LULC types and reveals the transfer changes for each LULC type in the study period.

$$P = \begin{bmatrix} P_{11} & P_{12} & \dots & P_{1i} & \dots & P_{1j} & \dots & P_{1n} \\ P_{21} & P_{22} & \dots & P_{2i} & \dots & P_{2j} & \dots & P_{2n} \\ \dots & \dots & \dots & \dots & \dots & \dots & \dots & \dots \\ P_{i1} & P_{i2} & \dots & P_{ii} & \dots & P_{ij} & \dots & P_{in} \\ \dots & \dots & \dots & \dots & \dots & \dots & \dots & \dots \\ P_{j1} & P_{j2} & \dots & P_{ji} & \dots & P_{jj} & \dots & P_{jn} \\ \dots & \dots & \dots & \dots & \dots & \dots & \dots & \dots \\ P_{n1} & P_{n2} & \dots & P_{ni} & \dots & P_{nj} & \dots & P_{nn} \end{bmatrix} \quad (1)$$

where  $p$  stands for area,  $n$  denotes the number of LULC types,  $i$  indicates the LULC type at the start year,  $j$  stands for the LULC type at the end year, and  $p_{ij}$  indicates the area of  $i$  converted to  $j$  during the research period.

### 3. Results and Discussion

Cropland, Woodland, grassland and built-up land are the main land cover types. The area and percentage of the main land cover types in 2015 are as follows:

(1) Woodland: The area of Woodland in 2015 is 69,515 km<sup>2</sup>, with 33.02% of the total area of BTH region; (2) The area of grassland in 2015 is 19,996 km<sup>2</sup>, with 9.38% of the total area of BTH region; (3) The area of cropland in 2015 is 103,968 km<sup>2</sup>, with 43.54 % of the total area of BTH region; (4) The area of built-up land in 2015 is 14,592 km<sup>2</sup>, with 10.75 % of the total area of BTH region.

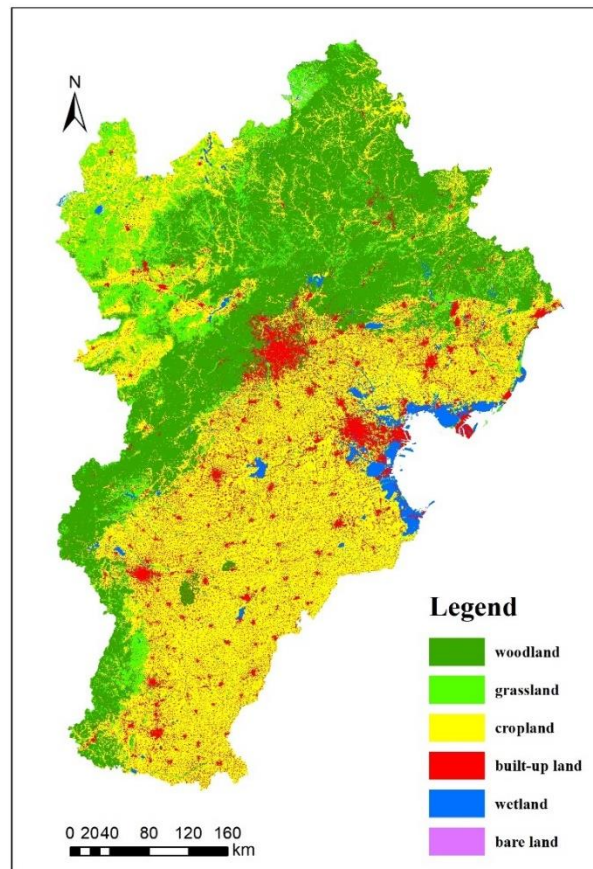


Figure 1: Landcover of BTH region in 2015

The area of land cover change is about 9 per cent of the total area of the BTH region, the conversion of cropland to built-up land was the most important type of LULC change. The spatial pattern of land cover change shows that the BTH region in eastern and southern parts has changed significantly, while the western and northern mountainous areas have not changed much due to the low level of disturbance caused by human activities. Beijing city, Tianjin city and Hebei province have different landcover change pattern and ratio. Overall changes in Beijing and Tianjin were more significant than in Hebei, but Hebei had the largest total area of land cover change due to the large area of the region.

#### 4. Conclusion and Recommendation

This paper carried out the long-time series of LULC analysis in the BTH region from 1990 to 2015 based on ChinaCover land cover data sets. The following are the main findings: (1) The conversion of cropland to built-up land was the most important type of LULC change. This conclusion is consistent with Zeng et al. (2025), Li et al. (2018), Li et al. (2021), and

Chen et al. (2022). (2) The spatial pattern of land cover change shows that the BTH region in eastern and southern parts has changed significantly, while the western and northern mountainous areas have not changed much due to the low level of disturbance caused by human activities. (3) Overall changes in Beijing and Tianjin were more significant than in Hebei, but Hebei had the largest total area of land cover change due to the large area of the region. (4) The terrestrial area increased because of continuous reclamation along the seaside region in Tianjin and Hebei. The new increased land is mainly developed into built-up land.

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