Jinan City Land Use Monitoring Based on Landsat data from 2009 to 2014

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Abstract. In this paper, the land use changes of Jinan City based on Landsat 5 in 2009 and Landsat 8 images in 2014 were described. The images were reprocessed by radiometric calibration, geometric correction, image enhancement, and then the land use changes information were extracted by supervised classification, which was classified by six samples, including cultivated land, forest land, construction land, water system and unused land, then transfer matrix was showed. The results indicate that from 2009 to 2014, the area of construction land, the grass land and water system has been decreasing with the area of cultivated land, forest land and unused land increasing. The cultivated land has suffered the most, and construction land has increased the most.

1. Introduction
Land is the foundation of urban existence and development, so the land use change can reflect the need of the social[1-2]. Satellite remote sensing earth observation technology has the ability of large-scale, long-term and periodic monitoring, so on, which can better obtain the dramatic information of land use changes[3] . This paper used Landsat satellite images to analyze the past 10 years’ land use changes of Jinan city. Based on the supervised classification methods, the land use change maps and transfer matrix were shown during 2009 to 2019 and then suggestion of the city development were provided.

2. Data and methods

2.1. Area analysis
Jinan City(36°40′N, 117°00′E) is located in the Midwest of Shandong Province of an overall area of about 10244 km$^2$. Mount Tai and the Yellow River are respectively bordering in the South and crossing in the North. Jinan terrain can be divided into three zones: yellow belt in the north, piedmont plain in the middle, and hilly area in the south. The northern part is near the Yellow River, most of which are plain areas. The central area of Jinan is constructed in the central piedmont plain part, the south part is hills and mountains. Most of the mountains are covered by forest.
land, with a small amount of grassland in the middle. The flat area around the mountains is cultivated land.

2.2. Data used and pre-processing
Landsat5 satellite was launched in 1984 and ended its long time observation in 2013, the Landsat8 continued the task from February 2013 till now[4-5]. We choose the TM images of Landsat5 in 2009, and the OLI images data of Landsat8 in 2014 for the long time analysis.

The downloaded remote sensing image data meet the requirements that the coverage rate of the centralized cloud layer is less than 5%, the total coverage area of the scattered cloud layer is less than 10%, and there is no cloud coverage in the main research area. According to the latitude and longitude area of Jinan City, we chose strip numbers of 122034 and 122035 of the Landsat5 and Landsat8 image of Jinan.

Radiometric calibration and atmospheric correction was applied for Landsat5 and Landsat8 images data to obtain absolute radiometric values and eliminate the influence of atmosphere and light on the reflection of ground objects[6-7].

2.3. Supervised classification
The sample selection are very important in the supervise classification[8-9]. In this paper, six types of land use was divided: construction land, cultivated land, forest land, water system, grassland and unused land. According to the known samples, construction land sample was the central area of Jinan and the surrounding towns and villages, cultivated land sample was the cultivated land along the northern river, the cultivated land in the flat area around the Southern Hills and mountains and the cultivated land in the eastern plain, forest land sample was the densely forested area in the Southern hills and mountains, grassland was distributed in the mountainous area in the study area, in the hilly and mountainous areas without forest and large-area parks in the urban area, the rest of the land was water system and unused land.

On the basis of pattern recognition, ENVI can be divided into traditional statistical analysis based on neural network, parallelepiped, minimum distance, and maximum likelihood method etc. We used maximum likelihood method for the study area classification. The result of supervised classification is the result of preliminary classification, which can not achieve the final application purpose. Therefore, it is necessary to deal with the supervised classification results. In this study, the clustering method was used for the post-processing of classification. In principle, the algorithm is used to cluster the adjacent areas with similar shape, and then merge them together.

3. Results
3.1. Land use analysis
Based on the results of remote sensing image classification, the area and proportion of Jinan city land were calculated during 2009 to 2014 as shown in Table1, in the meanwhile, we plot the area and the proportion for details using figures (as shown in Figure1).

We can see that, from the time span analyzed, the area and the proportion of three types of land use are decreasing, the details are as followings: the cultivated land showed 3% reduction and 298km², the grass land decrease 50.75km² with 0.489% reduction, and the unused land has the area of 25.21km² reduction, which has 0.24%. In the meanwhile, the construction land, the forest land and the water system show a trend of increasing. The construction land as a whole increased by 273.39km² by 2.68%, while the forest land land show an small increasing trend of 0.2% withe 20.26km². So in general, the amount of construction land, the unused and and the water system are increasing, and the cultivated land, the grass land and the unused land are decreasing.

| Table1. area and proportion of Jinan land use |
|---------------------------------------------|
| year | cultivated land | forest land | grassland | construction land | water system | unused land |
| Area | Proportio | Area | Proportio | Area | Proportio | Area | Proportio | Area | Proportio | Area | Proportio |

2
The area and proportion showed by figure(a) area distribution (b)proportion distribution

### 3.2. Jinan city land use transfer change analysis

For deeply mining the temporal and spatial land use process, we use the transfer matrix for analysis. The transfer matrix can describe land use type quantitatively and also can provide the transition probability[10]. From table 2, the turn in area of cultivated land in the past 5 years is 34.41 while the area of turning out is 333.05, so the cultivated land is decreasing. The same situation occurs on the grass land and water system. For the grass land, there are 66.48 km$^2$ which transforms into other kind land with transforming of 15.69 km$^2$. And the water system transforms out 90.31 km$^2$ with the inside with 7.32 km$^2$. In the meanwhile, the area of forest land is increasing during the analysis period with 93.96 km$^2$ turning in and 75.82 km$^2$ turning out. Also, the construction land and water system are increasing. The area of construction land, forest land, construction land and unused data are increasing with the cultivated land, grass land, water system decreasing. Overall, cultivated land has suffered the most, and construction land has increased the most. This is because with the maritime economy continues to develop, and urbanization continues to accelerate. It is assumed that the demand for land will increase and the change in land use will be more obvious.

### Table 2. The transfer matrix of Jinan land use

|          | cultivated land | forest land | grass land | construction land | water system | unused land | total |
|----------|-----------------|------------|------------|-------------------|-------------|-------------|-------|
| 2009 (km$^2$) | 5969.8         | 31.73      | 9.9        | 275.64            | 13.49       | 2.29        | 6302.85 |
| 2014 (km$^2$) | 20.55          | 2468.9     | 3.01       | 3.51              | 47.71       | 1.04        | 2544.72 |
|          | 4.66           | 60.89      | 250.37     | 0.56              | 0.2         | 0.07        | 316.85  |
|          | 8.37           | 0.57       | 0.01       | 840.35            | 1.16        | 0.07        | 850.53  |
|          | 0.36           | 0.71       | 2.71       | 3.41              | 128.08      | 0.13        | 135.4   |
|          | 0.47           | 0.26       | 0.06       | 0.36              | 27.75       | 22.52       | 51.42   |
| total    | 6004.21        | 2563.06    | 266.06     | 1123.83           | 218.39      | 26.22       | 10201.77|

### 4. Conclusion

In this paper, the Landsat 5 and Landsat 8 data are used for the analysis of Jinan city land use dynamic monitoring. After pre-processing including mosaic, cutting, radiometric calibration and atmospheric correction, the six samples are provided for supervised classification, then the area and proportion of the land and the transfer matrix are obtained at the end of the paper. From the analysis, the area of construction land, forest land, construction land and unused data are increasing with the cultivated land, grass land, water system decreasing. What’s more, the obvious decreasing change of the land use...
are the cultivated land, which the turn in area of 34.41 km² with turning out area of 333.05 km², and the construction land has increased the most. The reason for that is the maritime economy continues to develop, and urbanization continues to accelerate of Jinan city from 2009 to 2014.

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