Temporal and spatial dynamic change analysis of vegetation coverage based on RS and GIS from 2006-2016 in Gannan County

Ying Zhou*, Jiaxing Qu and Qiong Wu
Heilongjiang Province National Defence Science and Technology Institute, Harbin, China

*Corresponding author e-mail: 65358009@qq.com

Abstract. Based on the Landsat TM and GF1 image data of 2006, 2011 and 2016, the vegetation coverage of the agro-pastoral ecotone (Gannan County, Heilongjiang Province) was inferred, and the influence of slope on vegetation coverage was explored. Based on RS and GIS technology, the vegetation index and the binary model of the pixel were used to quantitatively obtain the vegetation coverage of the study area, and the temporal and spatial variation characteristics and evolution process of vegetation coverage in 10 years were explored. The relationship between slope and average vegetation coverage was quantitatively analyzed. The results showed that the overall coverage of vegetation cover in the study area was good. The sum ratio of medium-high coverage and high coverage between 2006 and 2016 was 87.29%, 87.18% and 87.10% respectively. In 2006-2011, the conversion rate of medium-high coverage and high-coverage to medium-high coverage was 55.5% and 76.8%, respectively; In 2011-2016, the conversion between medium-high coverage and high coverage was strong, and the conversion rates between them were 18.16% and 76.83%, respectively; In the past 10 years, the area ratio of the vegetation change stable area was 64.32% and 65.54%, respectively. The area of vegetation degradation between 2006 and 2011 was 277 km², and the area of vegetation improvement during 2011-2016 was 179 km². The slope was significantly negatively correlated with the average vegetation coverage area, and its regression model was Y = 1728.453 - 39.546X.

1. Introduction
Vegetation coverage refers to the percentage of vertical projection area of vegetation (including leaves, stems and branches) on the ground to the total area of the statistical area[1,2]. It reflects the density of vegetation in the horizontal direction, is an important basic data to describe the ecosystem[3], and is also a key factor to control soil erosion and an important indicator of changes in ecosystem quality[4,5]. The method of sample estimation is a traditional way to extract vegetation information[6]. The disadvantages of this method are high cost, large error and not suitable for monitoring vegetation growth in large area. In recent years, the continuous development of remote sensing technology has made it possible to monitor the vegetation coverage in large areas and even in global areas. Vegetation index is closely related to vegetation coverage[7]. The method to converse vegetation index to vegetation coverage has gradually become a new trend in related fields[8]. In the field of remote sensing application, vegetation index is widely used in qualitative and quantitative estimation of
vegetation coverage. The vegetation index calculated from remote sensing data can directly reflect the vegetation status on the ground surface to create a model of vegetation index for estimating vegetation coverage. The research is focused on the following aspects, that is, firstly, study on spatiotemporal evolution of vegetation coverage and its development trend; secondly, research on vegetation coverage based on the two-group model; thirdly, quantitative analysis of urbanization process and vegetation coverage; fourthly, analysis of factors affecting vegetation coverage change; fifthly, analysis of vegetation coverage and land use. However, most of these studies are concentrated in river basins, lakes, and urban areas. There are relatively few studies in the transitional areas of agriculture and animal husbandry in Northeast China.

The farming-pastoral ecotone is a transition zone with different width between the agricultural and grassland areas in northern China, with relatively simple ecosystem structure, very fragile ecological environment, and high sensitivity to global changes. Regional eco-environmental protection and sustainable development modes have always been the research topic in the region. Based on this, this paper takes Gannan County that is located in the agro-pastoral ecotone as the research object, and Landsat TM and GF1 images in 2006-2016 as the main data sources. Based on RS and GIS technology, and NDVI and pixel binary model, the characteristics of vegetation cover change in Gannan County during the past 10 years are analyzed to explore the vegetation cover and its change law in Gannan County, so as to provide the theoretical basis for grassland protection, land use optimization and ecological environment protection in the region, and the technical reference for agricultural development, soil erosion control, ecological construction and regional sustainable development in the whole region.

2. Study area
Gannan County is located on the right bank of the middle reaches of Nen River in the west of Heilongjiang Province (Fig. 1), with the geographical coordinates between 122°54′E - 124°28′E and 47°35′N - 48°32′N. The study region belonged to the transition zone between the southern foothill and Songnein Plains of Daxing'anling, it is the hilly area in the west and north, and flat plain in the south and southeast. The terrain is high in the northwest and low in the southeast, with the altitude of 160-380 meters. It belongs to the cold temperate continental monsoon climate, and the four seasons are warm and dry: in spring, there is less rain and heavy wind, which is prone to drought; in summer, it is hot and rainy; in autumn and winter, it is drastically cooled, and the earth is frozen. The annual average temperature is 2.6°C, the average annual precipitation is 455.2 mm, and the frost-free period is between 120 days and 132 days. The research area belongs to the semi-agricultural and semi-pastoral counties, which are one of the key counties for national poverty alleviation and development. The soil type is mainly black soil and chernozem, which is suitable for a variety of crop growth. The county is rich in natural resources, mainly including forests such as pine, poplar, eucalyptus and fruit trees.

3. Data and methods
3.1. Data source and collection
The remote sensing data of landsat5 TM and and GF1 in August of 2006, 2011 and 2016 is taken as the main data source in this paper. (http://www.gscloud.cn/). The image is selected in August, which is
a period of vigorous vegetation growth. During this period, remote sensing images can better reflect the growth of vegetation, with relatively few clouds. In addition, the administrative division map of 1:50000, DEM elevation and some field GPS survey data and other related statistical data in the study area of Gannan County are collected.

3.2. Data processing

3.2.1. Data pre-processing. Firstly, according to the remote sensing software ENVI5.3, the data is subjected to the preprocessing such as radiation calibration, geometric correction, rapid atmospheric correction, mosaic and splicing. The method of the image projection is the horizontal axis Mercator projection UTM (Zone51N). Then, the administrative boundary of Gannan County is used to clip the acquired Landsat remote sensing image.

3.2.2. Vegetation index acquisition. The normalized difference vegetation index (NDVI) is vegetation index that is most widely used\textsuperscript{[18]}. The change of surface coverage can be represented by the change of NDVI to a certain extent\textsuperscript{[19]}. The calculation formula is:

\begin{equation}
    NDVI = (B_{\text{near}} - B_{\text{red}}) / (B_{\text{near}} + B_{\text{red}})
\end{equation}

Where: $B_{\text{near}}$ represents the reflection value in the near-infrared band; $B_{\text{red}}$ represents the reflection value in the red band; NDVI is the best indicator of the plant growth state and the spatial distribution density of the vegetation.

3.2.3. The acquisition of vegetation coverage. The pixel binary model is an effective method to inverse the vegetation coverage currently\textsuperscript{[20]}. The principle is that the information $S$ observed by the remote sensing sensor can be expressed as two parts: the information $S_{\text{veg}}$ contributed by the green vegetation component and the information $S_{\text{soil}}$ contributed by the soil component\textsuperscript{[21]}. Vegetation coverage $F_c$ is the area occupied by vegetation cover in the pixel. The calculation formula is:

\begin{equation}
    F_c = (S - S_{\text{soil}}) / (S_{\text{veg}} - S_{\text{soil}})
\end{equation}

The NDVI value of normalized vegetation index is substituted into the phase element binary model to obtain the conversion formula of vegetation cover:

\begin{equation}
    F_c = (NDVI - NDVI_{\text{min}}) / (NDVI_{\text{max}} - NDVI_{\text{min}})
\end{equation}

Where: $NDVI_{\text{min}}$ and $NDVI_{\text{max}}$ represent NDVI values without vegetation cover and that with full vegetation cover, respectively. Combined with the research status of this paper. NDVI values at 5% and 95% of the NDVI image histogram of research area are taken as the $NDVI_{\text{min}}$ value and the $NDVI_{\text{max}}$ to solve the vegetation coverage.

3.2.4. The classification of vegetation coverage. According to the Soil Erosion Classification and Grading Standards issued by the Ministry of Water Resources in 1996\textsuperscript{[22]} and related research results\textsuperscript{[23]}. According to the actual situation of the study area, the vegetation coverage is divided into five grades in this paper(Table 1). Under the support of ArcGIS 10.3, a class of forest inventory data, field survey data and high-resolution Google Earth images are combined to carry out the accuracy verification for the classification results\textsuperscript{[24]}.

| Vegetation coverage type | Vegetation coverage value | Main land use |
|--------------------------|--------------------------|---------------|
| I level (extreme lower)  | $F_c < 0.1$              | water, bareland and building land |
| II level (low)           | $0.1 < F_c < 0.3$        | uncultivated land, wetland |
| III level (middle)       | $0.3 < F_c < 0.65$       | low yield grassland, sandy land |
| IV level (middle-high)   | $0.65 < F_c < 0.8$       | cropland, sparse forest land and high-yield grassland |
| V level (high)           | $0.8 < F_c < 1$          | dense forest land and high quality farmland |
4. Results and analysis

4.1. Dynamic analysis of time change of vegetation cover

Vegetation coverage maps and area statistics for the study area are obtained on basis of RS and GIS (Fig. 2 and Table 2). It can be seen from the analysis in Table 2 that the sum of the high coverage and the high coverage area in the third-phase data is the largest, which are 4174.22 km², 4168.87 km² and 4165.15 km² respectively. Among them, the medium-high coverage area accounts for the largest proportion. The area ratios are 70.84%, 77.19% and 73.16%, respectively, showing a trend of increasing first and then decreasing. In 2011, the area reached a maximum of 3691.31 km². The land application types corresponding to medium and high coverage are mainly cultivated land and high-yield grassland, and the land types in this area are mainly cultivated land and grassland, which is consistent with the structure characteristics of land application in the study area. The area change trend of high-coverage vegetation is opposite to that of mid-cover vegetation, showing a trend of decreasing first and then increasing. The area of reduction and increase are 309.08 km² and 189.06 km², respectively. The middle coverage and low cover area change little, and the middle cover vegetation shows a volatility growth trend. The area increases first and then decreases, and the overall increase is 58.56 km². The low-coverage vegetation shows a fluctuated downward trend, and the area decreases first and then increases, and the overall reduction is 11.84 km². The area of vegetation with extremely low coverage decreases year by year, which is from 183.56 km² in 2006 to 145.90 km² in 2016.

The overall coverage of vegetation cover is good in the research area. During the past 10 years, the mid-high coverage and high coverage area change significantly, and the medium-high coverage area increases by 110.95 km², with an increase of 3.28%. The high coverage area is reduced by 120.02 km², with a decrease of 2.51%. The change in the vegetation area of the middle cover, the low cover and the extremely low cover is small, which is basically in a state of small fluctuations. Among them, the change in the area of low coverage is the smallest, which is from 3% in 2006 to 2.75% in 2016. And the change is only reduced by 0.25%.

Figure 2. Vegetation coverage degree map of different years in Gannan County.
Table 2. Statistics characteristics Vegetation coverage of Gannan County from 2006 to 2016.

| Vegetation coverage classification | 2006     | 2011     | 2016     |
|-----------------------------------|----------|----------|----------|
|                                   | area/km² | proportion (%) | area/km² | proportion (%) | area/km² | proportion (%) |
| I level                           | 183.56   | 3.84     | 169.92   | 3.55       | 145.90   | 3.05          |
| II level                          | 143.24   | 3.00     | 171.70   | 3.59       | 131.40   | 2.75          |
| III level                         | 281.22   | 5.88     | 271.74   | 5.68       | 339.78   | 7.11          |
| IV level                          | 3387.58  | 70.84    | 3691.31  | 77.19      | 3498.53  | 73.16         |
| V level                           | 786.64   | 16.45    | 477.56   | 9.99       | 666.62   | 13.94         |

4.2. Dynamic change analysis of vegetation coverage space

In order to more realistically reflect the spatial variation characteristics of vegetation coverage, the overlay analysis of three data from 2006-2011-2016 is made in this paper according to the spatial analysis of ArcGIS. And the characteristics of vegetation change in 10 years are divided into two stages, namely, the first stage from 2006 to 2011, and the second stage from 2011 to 2016. On this basis, the data of area transfer at different vegetation cover level (Table 3 and Table 4) and the main conversion diagram of the cover type (Fig. 3) are obtained.

Figure 3. Main type conversion map of vegetation coverage in different years.

Table 3. Conversion matrix table of vegetation in Gannan County during 2006-2011 (unit/km²).

|          | 2011     |
|----------|----------|
|          | I level  | II level | III level | IV level | V level |
| 2006     |          |          |          |          |        |
| I level  | 99.39    | 16.13    | 15.26    | 35.98    | 3.16   |
| II level | 40.36    | 37.79    | 32.65    | 56.99    | 3.91   |
| III level| 18       | 34.33    | 58.81    | 150.8    | 9.8    |
| IV level | 25.22    | 53.52    | 169.14   | 2776.86  | 666.56 |
| V level  | 0.58     | 1.47     | 5.37     | 366.93   | 103.2  |
It can be seen from Table 3 that the maximum conversion of medium-high coverage vegetation area between 2006 and 2011 is 914.44 km². Thereinto, 666.56 km² is converted into high coverage, which is mainly in Zhongxing Township, Allen River Basin and eastern Dongyang Town. Due to the implementation of ecological measures such as returning farmland to forests and grasslands, some of the cultivated land become dense forest land or high-quality cultivated land, and the regional ecological environment tends to improve; the second is high-coverage vegetation, 374.35 km² changes, where 366.93 km² is converted to medium-high coverage. It indicates that high-coverage vegetation is the main transfer source of medium-high-cover vegetation, which mainly occurs in the eastern part of Baoshan Township, the south-central part of Chahayang Township and the south of Gannan Town. The jungle land and high-quality cultivated land are mainly converted to general cultivated land. The change of the forest land to cultivated land is driven by economic interests. In order to pursue more economic benefits, local residents have intensified the damage to forest land, making regional ecological environment deteriorated and land use unreasonable. In addition, it is indicated to some extent that the conversion between medium-high coverage and high coverage vegetation is the main conversion type of the region; thirdly, the middle cover vegetation is mainly converted into medium-high cover vegetation with an area of 150.8km². Located in the north of Chahayang Township, the eastern part of Xingsi Town and the western part of Jubao Town, the cultivated land is mainly converted from grassland. The change of grassland to cultivated land originates from the unreasonable reclamation of humans on grassland. In addition, the ecological protection issues is not taken into account during the development process. The influence of climatic conditions and the localized desertification of grassland make the regional ecological environment deteriorated; located in the surrounding of the Nomin River, north of Chahayang Township and west of Jubao Town, the 133.91km²of low-coverage vegetation conversion occurs, which is mainly changed into extremely low coverage and medium-high coverage. The change of wasteland and shoal land to the building and cultivated land are caused by disturbances from surrounding farmers. Due to the land reclamation, the area of wetlands is reduced and the regional ecological environment is further deteriorated. The ultra low coverage vegetation area has the smallest change, which is 70.53 km² totally. Located in Taipinghu Reservoir, Yinhe Reservoir, Yinhe River Basin, and Nomin River Basin, it is mainly converted to medium-high coverage and low coverage, which are transformed by 16.13 km² and 35.98 km² respectively. The area of water area to the shoals and paddy fields are mainly driven by climate impacts and economic interests. With the drop of the water level of the river, and the surrounding farmers have built land around the river. Unreasonable land use has made the local ecological environment deteriorated uninterruptedly. In the future, the protection of wetlands in water area should be increased to promote the rational application of regional land. In general, the first stage of vegetation cover is mainly transferred from low cover to medium-high cover, and the land type is changed from other land types to construction land and cultivated land, which is mainly caused by the increasing demand for human beings for cultivated land and high-quality cultivated land and the increase in demand for buildings due to urbanization.

Table 4. Conversion matrix table of vegetation in Gannan County during 2011-2016 (unit/km²)

|       | 2011 | 2016 |
|-------|------|------|
|       | I level | II level | III level | IV level | V level |
| I level | 84.54 | 25.54 | 12.85 | 21.78 | 1.19 |
| II level | 17.40 | 35.81 | 29.75 | 46.42 | 2.02 |
| III level | 18.61 | 41.84 | 64.61 | 206.33 | 8.38 |
| IV level | 44.58 | 61.83 | 148.46 | 2863.49 | 380.17 |
| V level | 4.79 | 6.70 | 16.06 | 553.28 | 85.79 |
It can be seen from Table 4 that the largest transfer area is medium-high cover vegetation between 2011 and 2016, where 635.04 km² is transformed. Among them, 380.17 km² is converted into high coverage, which is mainly scattered in Zhongxing Township, Jubao Town and Gannan Town.

The change of the cultivated land to the dense forest land benefits from the implementation of national ecological forestry measures such as returning farmland to forests and grassland projects, which makes local ecological environment improved. This also shows that the implementation of ecological policies such as returning farmland to forests has achieved certain results in the region, and the deterioration of the ecological environment has been alleviated. The second is high-coverage vegetation and mid-cover vegetation, which are transformed into medium-high-cover vegetation by 553.28 km² and 206.33 km², respectively. It indicates that high-coverage and mid-cover vegetation are the main source of medium-high-cover vegetation, which is mainly located in the south of Gannan Town, Shuanghe Farm, Chahayang Farm, northwest of Chahayang Township, local part of Gannan Town. The change of the forest land and grassland to the cultivated land is because the local farmers destroy forest grassland for the economic benefit, and the local ecological environment is destroyed to a certain extent. For low-coverage vegetation, the conversion area is 95.59 km², which is relatively small, and the location is concentrated in the eastern part of Taiping Town and the lower reaches of the Allen River. The change of shoal land to the cultivated land is caused by human activities, making some wetlands disappeared and the local ecological environment deteriorated further. The conversion area of the ultra low coverage vegetation is the smallest, which is only 61.36 km². Among them, 25.54 km² is converted into low coverage, mainly in the Nomin River Basin, the west of the Yinhe Reservoir and the northern part of the Taipinghu Reservoir. The change of waters and bare land to the construction sites and cultivated land are the main ways of transformation. Driven by the interests, people have increased the transformation and utilization of wetland resources. The wetland area is reduced, and the cultivated area is further increased, which makes regional ecological environment deteriorated again. Overall, the retention rate of the medium-high coverage is the most highest in 2011-2016 years, which reaches 81.83%. Driven mainly by the economic interests, unreasonable grazing logging makes the arable land increased. In addition, affected by the policy of returning farmland to forest and grass, the middle and high cover degree is also partly converted to medium cover degree and high cover degree. Due to the changes of the arable land to the grassland and dense forest, the vegetation coverage in this area shows a better situation. The vegetation transfer rate of low cover and very low cover is slightly less than their transfer rate, and the change is not very obvious.

4.3. Tempo-spatial evolution analysis of vegetation cover degree
In the spatial analysis of ArcGIS, the superposition analysis of 3 sets of data is carried out in this paper to obtain superimposed data of 2006-2011 and 2011-2016. The quantitative analysis of vegetation coverage changes is carried out to further study the temporal and spatial evolution characteristics of vegetation cover in this area. It is defined as the stable zone where the coverage level of the vegetation is not changed before and after it. It is the improvement area where the degree of vegetation coverage is changed from lower grade to higher grade. It is considered as degraded area where the level of coverage changed from high grade to low grade. On this basis, the area ratios of each vegetation change type are counted to obtain the overall characteristics of vegetation cover change in Gannan County from 2006 to 2011 and 2011-2016 (Fig. 4).
It can be seen from Fig. 4 that the region with stable vegetation cover change in the study area accounts for the majority, about 3076km² in 2006-2011, accounting for 64.32% of the study area, which is mainly distributed in the southwestern part of Zhongxing Township, most areas of Jubao Town and Xingsi Town, the eastern part of Pingyang Town, Baoshan Township and the northern part of Chahayang Township. In areas with the unstable changes of vegetation cover, the area where improvement occurs is about 714 km². Mainly scattered in Zhongxing Township, northwest of Jubao Town, south of Dongyang Town, north of Chahayang Township. Affected by topographic and policy factors, the coverage of vegetation is increased, and the regional ecological environment is improved in these places. The area with degraded vegetation coverage is about 991km², which is mainly distributed in Gannan Town, Shuanghe Farm and Chahayang Farm and surrounding of some rivers. It is mainly because the construction area is increased due to the development of urbanization. In addition, local farmers are driven by the benefit and disafforest to carry out the cultivation, which makes the vegetation coverage deteriorated, and the regional ecological environment destroyed.

In 2011-2016, the area with stable vegetation coverage in the study area is about 3134km², accounting for 65.54% of the study area, dominating the advantage, which is mainly distributed in Pingyang Town, Changshan Township, most of Xingsi Town, Jubao Town, the north and the northwestern part of Chahayang Township. In the unstable region, the area of district with degradation is 734 km², which is mainly located in the part of Zhongxing Township, northeast of Dongyang Town, south of Gannan Town and the lower reaches of the Nomin River. The vegetation coverage is reduced and the regional ecological environment quality is deteriorated, due to the surrounding peasants' deforestation and land reclamation from a lake. Mainly distributed in the south of Xingsi Town, the north of Pingyang Town, the middle of Chahayang Township, the Taiping Lake Basin, and the middle and lower reaches of the Allen River, the area with improved vegetation coverage is 913km², which is mainly due to the implementation of the national policy of returning farmland to forests and grassland and the effectiveness of a series of comprehensive projects remediation for ecological environment. According to the above analysis shows, the vegetation coverage is generally stable, and the proportion of stable area is 64.32% and 65.54%, respectively, during 2006-2016. Among them, the degraded area of vegetation cover from 2006 to 2011 is 277 km² larger than the improvement area; the degraded area of vegetation coverage during 2011-2016 is 179km² less than the improvement area. In 10 years, the degraded area of vegetation cover is 1725 km², and the improvement area is 1627 km². The vegetation is still dominated by degradation, and the ecological environment of the study area has been destroyed. In the future, measures such as returning farmland to forests and grasslands and closing hillsides for afforestation should be strengthened to protect the healthy development of ecological environment at Gannan County.
4.4. The analysis of impact of slope on vegetation coverage change

Surface slope is one of the important topographical features, which indicates the steep extent of the surface unit. The effect of slope on vegetation cover change in the study area is mainly studied in this paper. Based on ArcGIS, the topographic analysis of DEM data in the research area is carried out to obtain slope data. According to the general principles of comprehensive management and planning for soil and water conservation[25] and related research results, the slope is divided into 6 grades in this paper, which are flat slope (less than 5°), slope (5°-15°), gentle slope (15°-25°), steep slope (25°-35°), steep slope (35°-45°) and dangerous slope (greater than 45°). The area table of average coverage of slope and vegetation is obtained by spatial superposition analysis with the grade diagram of vegetation coverage at the study area. Weighted average of area of vegetation coverage grade is taken in the calculation of average coverage area of vegetation to estimate average coverage area of vegetation at each slope. And its formula is as follows:

\[ S = A_1 \times B_1 + A_2 \times B_2 + A_3 \times B_3 + A_4 \times B_4 + A_5 \times B_5 \]  

(4)

In the formula: A1, A2, A3, A4, A5 respectively represent very low, low, medium, middle high and high vegetation coverage grade area. B1, B2, B3, B4, B5 are respectively the corresponding coverage value. The average coverage area of vegetation of various slope at Gannan County is achieved according to the calculation by the formula (4).

![Figure 5. Relationship between slope and average coverage area of vegetation](image)

It is shown in Fig. 5 that the vegetation in this area is mainly concentrated on the flat slope and gentle slope to grow. The sum of proportion of the average coverage area of vegetation is 65.81%, but it is mainly distributed on the flat slope, where the area in 2006, 2011 and 2016 are 45.8%, 44.96% and 46.06% respectively. The area of the risk slope is the least, the average coverage area is only 8.43‰. It is shown that the average coverage of vegetation in the study area decreases with the increase of slope, and the very obvious decreasing trend is shown at its occupied area. Based on this, the correlation analysis between the slope and the average coverage area is completed by the SPSS statistical software in this paper. Pearson correlation coefficient is -0.835, which is a highly negative correlation. According to the significance (P-value) =0.000<0.01, the slope has a significant linear correlation with the average coverage of vegetation, and the regression model of the average coverage and slope of vegetation is \( Y=1728.453-39.546X \) (where Y represents the mean coverage area of vegetation coverage, X represents the slope size). With the increase of the slope, the vegetation absorbs more sun illumination, the transpiration becomes larger. And as the slope rises, affected by the rainfall confluence scour, the rainfall is difficult to preserve and the nutrient is easy to lose, which affects the vegetation growth, and reduces the vegetation coverage area.

5. Conclusion

Based on RS and GIS supporting, Landsat TM and GF-1 imagery in 2006, 2011 and 2016 are taken as the primary data sources, and Gannan County is taken as the study area. The normalized vegetation index and phase binary model are used to obtain vegetation coverage data. The temporal and spatial variation characteristics of vegetation coverage in 10 years are quantitatively analyzed, and the effect of slope on vegetation coverage is also explored, The results shows that:
(1) From 2006 to 2016, the very low coverage area decreased yearly, a total of 37.66 km² is reduced; the low coverage, medium height and middle and high coverage area all show the trend of the first increase and then decrease, where the low cover degree is reduced by 11.84 km²; the middle high degree and the middle high coverage are increased by 58.56 km² and 110.95 km², respectively; the high coverage area is reduced by a maximum of 120.02 km².

(2) The vegetation coverage at Gannan County is generally good, mainly with medium high coverage and high coverage. During 2006-2011, the vegetation area of extremely low coverage, medium coverage and high coverage decreased, and the area of low coverage and medium high coverage increased. The area of high coverage increased the most, with a total reduction of 309.08 km². During the period of 2011-2016, the area of middle coverage and high coverage increased, the areas with level of minimum coverage, the low coverage, the medium-high coverage decreased, and the medium-high coverage area changed the most, with a total reduction of 635.04 km².

(3) The total vegetation coverage in the study area is stable in 10 years, and the proportions of stable area are 64.32% and 65.54% respectively. The degraded area between 2006-2011 is 277 km²; improved area between 2011-2016 is 179 km². The area of vegetation degradation in 2006-2016 is greater than the improvement area, and the ecological environment tends to be deteriorated.

(4) Based on the quantitative analysis of slope and vegetation coverage, the slope of the study area is found to have a high negative correlation with the coverage of vegetation. The Pearson coefficient is -0.835. The regression model of average coverage and slope of vegetation is $Y=1728.453-39.546X$.

Human activities and policy impacts are the main factors of vegetation change in this region. In recent years, soil erosion is becoming more and more serious, which has become a serious restricting factor for economic development in that county. By analyzing the spatial-temporal evolution of vegetation coverage in the study area, water area, tidal flats and woodland are the main sources of area increase of arable land under the current economic interests. Land application in some areas is somewhat unreasonable. In the future, the implementation of river improvement projects and returning farmland to forests and grassland should be increased to promote the healthy optimum development of regional ecological environment.

Acknowledgments
This work was financially supported by Youth Science Foundation of Heilongjiang Province (Grant No. QC2017036).

References
[1] Zhang Wenbo, Fu Suhua, Liu Baoyuan. Error assessment of visual estimation plant coverage [J]. Journal of Beijing Normal University (Natural Science), 2001(03): 402-408.
[2] Qin Wei, Zhu Qingke, Zhang Xuexia, et al. Review of vegetation covering and its measuring and calculating method[J]. Journal of Northwest A & F University (Natural Science Edition), 2006, 9: 163-170.
[3] Niu Baoru, Liu Junrong, Wang Zhengwei. Remote sensing information extraction based on vegetation fraction in Drought and Half-Drought area[J]. Geomatics and Information Science of Wuhan University, 2005(01): 27-30.
[4] Deng Fei, Quan Zhanjun2, Yu Yunjiang. Study on the vegetation coverage change and its impact factors in Wulanmulun river basin during therecent 20 years[J]. Research of Soil and Water Conservation, 2011, 18(3): 137-140+152+283.
[5] Xu Xu , Li Xiaobing, Liang hanwei, et al. Change in vegetation coverage and its relationships with climatic factors in temperate steppe, Inner Mongolia[J]. Acta Ecologica Sinica, 2010, 30(14): 3733-3743.
[6] Zhou Zhaoye, Chu Shaolin, Wang Zhiwei, et al. Analysis of vegetation coverage change based on NDVI——A case study in Ganzhou area, Zhangye city, Gansu [J]. Pratacultural Science, 2008, 25(12): 23-29.
[7] Cheng Hongfang, Zhang Wenbo, ChenFeng. Advances in researches on application of remote sensing method to estimating vegetation coverage[J]. Remote Sensing for Land & Resources, 2008(01): 13-18.
Gai Yongqin, Li Xiaobing, Zhang Li, et al. Land use/cover change and vegetation coverage monitoring by remote sensing: A case study of Miyun, Beijing[J]. Resources Science, 2009, 31(3): 523-529.

Sun Jiuhu, Liu Xiaomeng, Li Yougang, et al. Estimation of vegetation fraction in Beiyunhe district by remote sensing[J]. Research of Soil and Water Conservation, 2006, 6: 97-99.

Su Yuan, Wang Jiezhi. Temporal and spatial characteristics of vegetation cover of Southern Shaanxi in recent 20 years[J]. Research of Soil and Water Conservation, 2018, 25(1): 250-256.

J. Rouse, R. Has, J. Schell and D. Deering. Monitoring vegetation systems in the great plains with ERTS, Proceedings 3rd Earth Resources Technology Satellite-1 Symposium, Greenbelt, NASA SP-351, 1974, pp. 3010-3017.

Guo Fenfen, Fan Jianrong, Yan Dong, et al. Remote sensing estimation on vegetation coverage of Changdu county based on Dimidiate Pixel Model[J]. Soil and Water Conservation in China, 2010 (05): 65-67.

Lei Shengjian, Zhang Fuping, Yan Yuchao, et al. Spatial-temporal changes and future trends of vegetation cover in upper reaches of Heihe river[J]. Bulletin of Soil and Water Conservation, 2016, 36(3): 159-164+370.

Xiao Xiao, Li Jingzhong, Han Bin, et al. Spatial-temporal characteristics of vegetation coverage and its correlation with urbanization in traditional industrial area of Northeastern China[J]. Ecological Science, 2017, 36(6): 71-77.

Wang Ping, Shen Runping. Vegetation cover change effects on climate in the Loess Plateau Region based on CLM Model[J]. Science Technology and Engineering, 2013, 13(20): 5754-5760.

Wang Tong, He Hai, Wu Zhiyong. Analysis of land use and vegetation cover change in Kuye river basin in the last 30 years[J]. Water Resources and Power, 2017, 35(11): 127-130+83.

Xu Youxia, Zhou Xu, Zhao Juan, et al. Vegetation coverage variation features river in Semi-humid and Semi-dry transitional region of Taohe[J]. Bulletin of Soil and Water Conservation, 2016, 36(06): 308-314.

Zhang Xuexia, Ge Quansheng, Zheng Jingyun. Impacts and lags of global warming on vegetation in Beijing for the last 50 years based on remotely sensed data and phonological information[J]. Chinese Journal of Ecology, 2005(02): 123-130.

Xia Zhaohua, Zhang Kebin, Li Rui, et al. Study on the change of vegetation fraction in Agro-pastoral transition area based on NDVI-A case study in Yanchi County, Ningxia[J]. Research of Soil and Water Conservation, 2006(06): 178-181.

TS. Purevdorj, R. Tateishi, T. Ishiyama & Y. Honda. Relationships between percent vegetation cover and vegetation indices[J]. International Journal of Remote Sensing, 2010, 19(18), 3519-3535.

Zhao Taian, Peng Daoli. Vegetation dynamic changes of Miyun county with Multi-Temporal remote sensing image[J]. Journal of Northeast Forestry University, 2013, 41(12): 30-34.

Chen Jin, Chen Yunhao, He Chunyang, et al. Sub_pixel Model for vegetation fraction estimation based on land cover classification[J]. Journal of Remote Sensing, 2001(6): 416-422+481.

Gong Wenfeng, Wu Juan, Wang Xiaofeng, et al. Vegetation coverage dynamic evolution and its forecast based on RS and GIS in Miyun district[J]. Journal of Engineering of Heilongjiang University, 2016, 7(03): 25-31.

Hao Jingfeng, Liu Hongyu, Li Yufeng, et al. Spatio-temporal variation and driving forces of the coastal wetland resources based on the Transition Matrix in Jiangsu province[J]. Journal of Natural Resources, 2010, 25(11): 1918-1929.

Liu Yulin, Wei Ruisheng, Chen Weijie. Present situation of soil and water loss and control measures in Gannan county[J]. Heilongjiang Hydraulic Science and Technology, 2012, 40(01): 274-275.