The Dynamic Research of Forest Vegetation Landscape Pattern in the Southern Mountain Regions of Jinan with the Support of RS and GIS

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***Abstract* — In this paper, the author processed the dynamic research of forest vegetation landscape pattern in the southern mountainous regions of Jinan with the data of the remote sensing images in 2003 and 2012. According to the result of this study, the conclusions are as following: firstly, the change in landscape construction is mainly the degradation of natural landscape, such as grassland and shrub, and semi-natural landscape; secondly, economic forest landscape and farmland patch areas have increased, which means that the number of patches has also increased and the increased fragmentation has become dominant landscape type; thirdly, the mixed forest pattern patches are showing a decreasing trend in the total number of plaque area, which has increased plaque aggregation trend; fourthly, the broad-leaf forest landscape patch area as well as the total number of patches have increased, and the fragmentation also increased.**

Keywords - Southern mountainous regions; Limestone mountains; Vegetation communities

I. INTRODUCTION

Jinan is famous as "Spring City" for the various shapes of the numerous springs. Spring has become the soul and lifeblood of Jinan and the urban culture and the landscape is constructed by spring, which is unique all over the world. The southern mountains are the city's major water conservation area, which is a natural ecological barrier in Jinan and the source of the springs. This region plays an important in role in maintaining the regional ecological environmental balance, reducing floods and other natural disasters, and ensuring environmental and ecological safety. Therefore, enhancing the development and protection of the southern mountains in the important ecological function areas, especially the dynamic of forest vegetation landscape pattern in the future to ensure sustainable development in Jinan, has significant meaning in keeping the ecosystem of the springs and style of “spring”.

II. THE GENERAL SITUATION IN THE STUDY AREA

The southern mountainous area of Jinan is the main research area, which covers of the mountain land. The scope of the northern border reaches to the south downtown of Jinan, while the southern part is close to Taian. The western part reaches to the border of Licheng District and Changqing District. The whole area includes Zhonggong Town, Licheng District, Liubu Town, Xiying Town, Ganggou Town, part of the land in Caishi Town, the offices of Shiliulihe in Shizhong District and the offices of Dangjia. Economic conditions in the research area: township enterprises are still in the developing mode and the main income of the residents comes from farming and forest fruit sales. The annual income of each resident is about 3,000 yuan, ranking the middle class in Jinan.

The research area belongs to the warm temperate continental monsoon climate zone semi-humid areas, which has the characteristic of being dry and windy in spring, hot and rainy in summer, cool and humid in autumn and cold and dry in winter. The annual average temperature is 10 ~ 20 □ and the average annual rainfall of 662.8mm, while the rainy season is the same period of high-temperature. The annual rainfall has large variability of precipitation, which mostly concentrate from June to September. Most of this area has less than 200 frost-free days. The main soil is cinnamon, which is widely distributed by thick bone cinnamon located in the upper part of the soil barren. The hilly soil depth is generally about 35mm and the main soil is middle regosols. The deep loamy soil is rare and hard to become multi-use land. Many places is matrix uncovered rock. The soil PH is 7.O ~ 8.5, with the feature of calcium-rich and easy to leakage, which is not conducive to the development of vegetation. The southern part is higher than the northern part in this region and the ecological environment qualities are extremely different. Part of this region is covered by forest and the resources of vegetation is very prolific and has become a more stable local ecosystem.

III. DATA SOURCES AND RESEARCH METHODS

The original data of this research come from the remote sensing images of southern mountainous area in Jinan in 2003 and 2012. The prior knowledge feature can be obtained by ISO-DATA algorithm to select the training samples. Then the maximum likelihood classification can be used combining visual interpretation to be modified.

Finally, the result of classification can be used to get the landscape platform of these two period to get related data and set up database of geography information by the support of geometric precision correction in ArcGIS10.0. Through FRAGSTATS 3．3 software, we can analyze the forest vegetation landscape pattern of southern mountainous area. Then the dynamic changes of forest vegetation landscape pattern will be revealed[1].

In this study,the landscape of Jinan southern mountainous area can be divided into 11 categories: arborvitae, arborvitae and sumac, pine, shrub grassland, forests, farmland, grassland slope, construction land, unused land, waters and broad-leaf forest. The three species, which are arborvitae, arborvitae and sumac, pine unified structure, can be classified as mixed forest landscape; the shrub grassland and grassland slope landscape can be classified as shrub grassland landscape.

By selecting certain representative landscape construction index, we analyzed the types of forest vegetation in the southern mountain landscape pattern plaque area (CA), the number of plaques (NP), the total length of the border plaques (TE), patch edge density (ED) and other landscape parameters[2].

IV. RESULTS AND ANALYSIS

A. The Analysis of Plaque Area (CA) and the Number of Plaques (NP)

a. Plaque area (CA)

Plaque area is the size of landscape elements and CA measure is an integral part of the various types of landscape, which is the basis for calculating other index.

Ecological significance: the size of its value restricts the type of landscape species diversity in the calculated plaque.

Formula Description: CA is equal to a certain type of tile all the pieces of the area (m^2), divided into 10,000 hectares (ha); that is a type of tile total area[3].

$$CAi=\sum ai \quad (1)$$

CA represents the total area of landscape type I, ai represents a landscape type I each plaque area.

b.The number of plaques (NP)

It may reflect the degree of landscape heterogeneity and fragmentation. Generally speaking, the higher NP means higher landscape fragmentation. NP reflects the spatial pattern of landscape classification status and it is often used to describe the spatial extent Patchy gradient across the landscape. Its value has a close relationship with the fragmentation degree of landscape classification, generally positive correlation. At the same time, the number of patches has a great influence on the development of ecological changes, which can influence the stability of interaction and synergies among species. Moreover, the number of patches on the landscape spread in varying degrees of interference factors are important determinants[4].

Formula Description:NP is equal to a certain type of the total number of patches in the landscape at the type level; and that is equal to the number of patches in the landscape at the landscape level.

$$NP=N \quad (2)$$

N represents the total number of patches of landscape type.

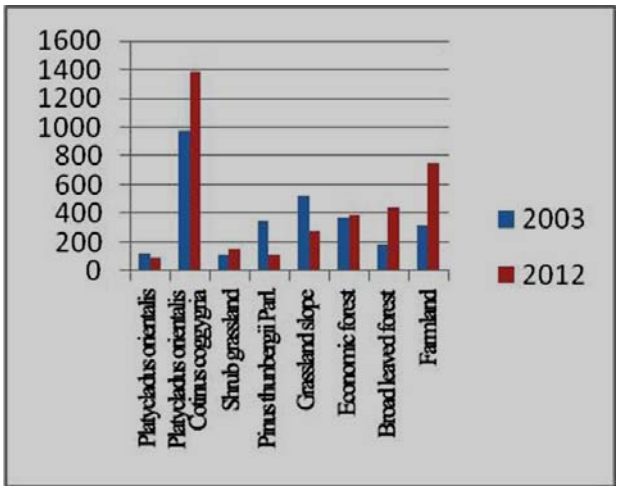

Fig.1 Number of Forest Vegetation Patches (NP) Change Map

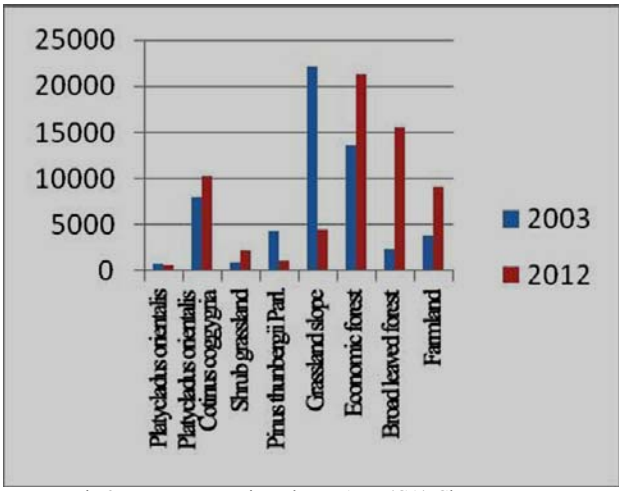

Fig.2 Forest Vegetation Plaque Area (CA) Change Map

We can analyze the quantity and area of each type of forest vegetation landscape changes in the area:

1. Mixed forest landscape

The data in this chart shows the number of mixed forest landscape patches has increased from 1446 in 2003 to 1588 in 2012; however, the area does not necessarily increase even though the number of plaques increased; on

the contrary, the area of forest landscape type decreased from 13207.75 in 2003 to 12,088.25 in 2012.

The main reason for this situation is the need for economic development. Therefore, the artificial forest vegetation has been damaged somehow in order to increase the building land, the mountains roads, the land reclamation and the ground-breaking, and so on.

2. The farmland landscape

Farmland mainly distributes in the surrounding countryside or urban and rural settlements and the number of plaques in the 2003-2012 decade grew by 429, while the area also increased by 5297, which means farmland landscape of the area has been increasing steadily. During this past decade due to the impact of local economic conditions and related policies, the agriculture is one of the main source of income, therefore, the area of farmland has increased .

3. The shrub grassland landscape

The total area and the number of plaques reduced significantly. The number of shrub land patch decreased from 635 in 2003 to 439 in 2012, while irrigation lawn plaque area also reduced by 16416.8. The reason is that the plantation is affected by the development and construction.

4. Economic forest landscape

The type of economic forest landscape has been in the ascendancy whether it was in 2003 or 2012. Its number has increased by 35, but the area has increased by 7817.25 hm^2. Economic forest landscape developed gradually from small patches to large plaque composition. This is because the forest landscape is the main source of local income and the demand for closed forest policy and economic development makes the forest in a dominant position, which will develop steadily in a very long time .

5. Broad-leaf forest landscape

Broad-leaf forest landscape is important for water and soil conservation and broad-leaf forest landscape has the biggest growth in all of the above types of landscape in this area. The number of plaques increased by 253 and the area increased by 13,235hm^2. Since the implementation of the southern mountains closing in the 1990s, the southern mountain forest resources have been well protected. With the protection and development planning strategy, the forest resources of Jinan southern mountain will be under greater protection.

B. The Analysis of the Total Length of the Border Plaques (TE), Patch Boundary Density (ED) Change

a. The total length of patch boundaries (TE).

The size of boundary length can be calculated by calculating the indirect type of landscape patch .

$$TE = E \tag{3}$$

E represents the total length of all plaque landscape boundaries.

b.The edge density (ED)

It can calculate the degree of change in the degree of mosaic plaque size between landscape patches, namely patches by calculating the degree of fragmentation of the landscape pattern edge density.

$$ED = E / A \tag{4}$$

E represents the total length of all boundaries of a plaque type; A represents the total area of a plaque type.

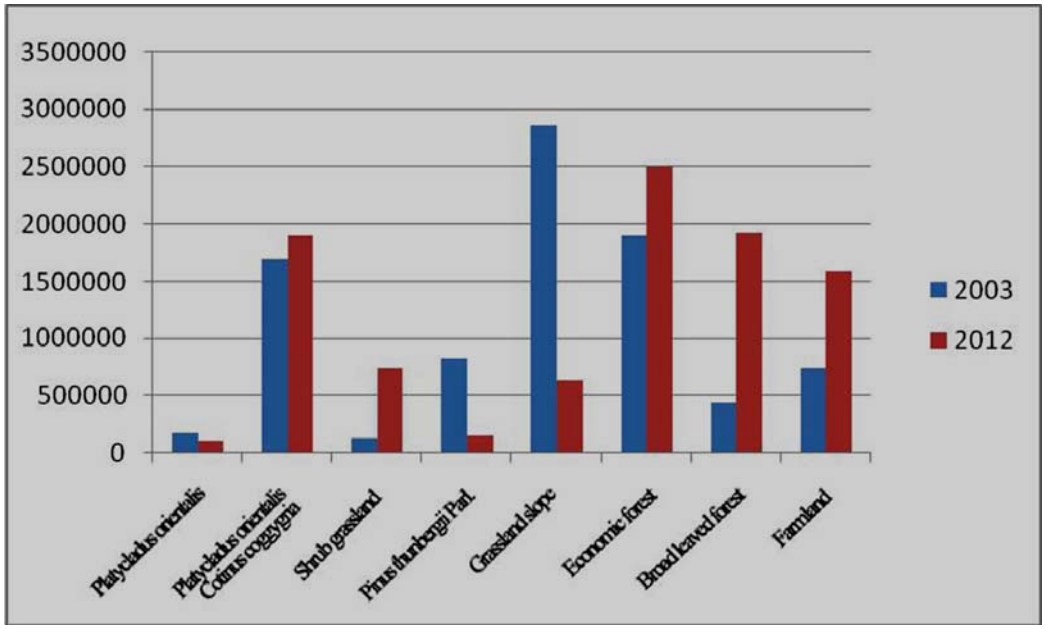

Fig.3 Each Forest Vegetation Landscape Patches Total Length of the Border (TE) Change Map

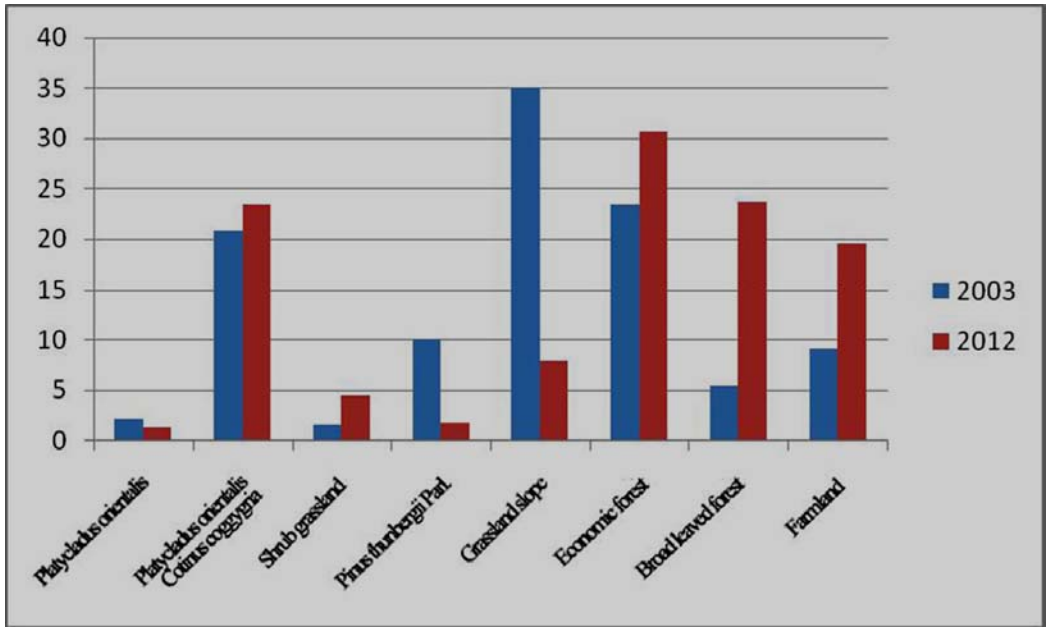

Fig.4 Each Landscape Patches of Forest Vegetation Boundary Density Map (ED) Change Map

For each type of forest vegetation in the landscape, it can be seen from Fig. 3, Fig. 4

In grassland landscape irrigation of study area, the total boundary length and the boundary density decrease sharply as well as the degree of plaque fragmentation. The reason for this situation is that the irrigation mountain meadow landscape lies in the study
area, and it is not close to other landscape types. It is, to some extent, influenced by human activities, thus leading to some damage.

In mixed forest landscape, the total length of the border and its density have reduced. Plaque fragmentation has also reduced to a certain extent. However, the plaque area has increased though the number decreases. The reason for this situation is that other landscape types have been transformed into mixed forest landscape, making it develop into the big plaque.

The total length of the border forest landscape and the boundary density are in the first place. It is the advantage of the southern mountain forest vegetation landscape. The total length of the border and boundary density increases, indicating that there are different types of landscape mosaic, leading to the fragmentation of the economic forest. Forest is this region's main source of income and human economic activities plays an important role in the development of forest landscape .

The total length of the border and the boundary density in broad-leaf forest landscape increased, as well as the plaque fragmentation; the area of the plaque grew and the number increased. This is due to the "development of protection" policy of returning farmland to forests in southern mountainous areas and ecological conservation; therefore, the protection of broad-leaf forest landscape has been strengthened and received good results.

The total length of the border, the boundary density as well as the fragmentation of plaque in farmland landscape increased. Agriculture, the area's second-largest economic pillar for the development of economic activity farmland landscape, played a catalytic role[5]-[23].

V. CONCLUSIONS

(1) The total number of the whole southern mountain plaque shows a decreasing trend and the average patch area increased; in addition, the plaque shows an aggregation trend. The number of plaques decreased from 5040 in 2003 to 4236 in 2012 and the average plaque area grew from 161484m² to 192134 m² from 2003 to 2012.

(2) The economic forest landscape and farmland landscape are the advantageous types in the southern mountainous forest vegetation landscape. The plaque area, the total length of the border and the border densities are in the first place. Economic landscape and farmland landscape are the region's main source of income, which means that human economic activities play an important role in the development of forest landscape and farmland landscape .

(3) In mixed forest landscape, the total length of the border and its density have reduced. Plaque fragmentation has also reduced to a certain extent. However, the plaque area has increased though the number decreases. Mixed forest landscape patches showing aggregation tendency, the other landscape types have a tendency to its transformation. This indicates that under the policy guidance, the southern

mountain forest vegetation has been protected and developed to a certain degree.

(4) In grassland landscape, the total boundary length and the boundary density decrease sharply as well as the degree of plaque fragmentation. The area and the number of plaques reduced, too. In 2003, the shrub grassland landscape still belongs to the advantageous forest vegetation landscape. In 2012, it is degraded remarkably. Therefore, ecological damage is obvious in the development and construction of the southern mountains.

(5) The total length of the border and the boundary density in broad-leaf forest landscape increased, as well as the plaque fragmentation; the area of the plaque grew and the number increased. This is because the southern mountain-related policies to protect the broad-leaf forest landscape has been strengthened and received good results.

CONFLICT OF INTEREST

The authors confirm that this article content has no conflicts of interest.

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