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TEMPORAL AND SPATIAL CHANGES OF LAND USE LANDSCAPE AND TERRAIN GRADIENT EFFECTS IN URBAN PLANNING AREA OF MAOMING CITY

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ABSTRACT

This paper mainly uses GIS technology to study the temporal and spatial changes of land use landscape types and the effect of terrain gradient in Maoming urban planning area. The study is based on the land use data of Globeland30 in 2000, 2010 and 2020, using a combination of the index analysis methods of land use landscape transition matrix, the land use dynamic index, the land use degree index, the land use information entropy and the distribution index and so on. The results indicated that among the land use landscape types, farmland area accounted for the most, followed by woodland. On the whole, the land is mainly arable land, woodland and construction land, followed by grassland, water area and other land. This paper also studied the change of terrain gradient effects of elevation, slope, aspect and terrain niche index of land use landscapes. The conclusions can provide references for the study of landscape pattern change, land use planning and land management decision-making in this area.

KEYWORDS: *Land Use; Landscape; Geographic Information System (GIS); Terrain Gradient; Distribution Index*

INTRODUCTION

Recently, in the study of land use/cover change (LUCC), researchers pay more attention to the relationship between landscape and man-land relation, but less attention to the relationship between landscape change and ecology 0. Terrain factor is an important influence factor on the distribution of land use types. Among terrain factors, elevation and slope have a relatively large impact on landscape change, but few studies have combined them to analyze the impact of terrain gradient change on land use [2, 3]

Maoming is an oil-rich city with a unique position in Guangdong province. With the development in recent years, Maoming has changed a lot. Open-pit mines, a former oil shale mine in Maonan District, Maoming, for example, until 2013 had a harsh ecological environment, degraded soil and poor living conditions in neighboring villages. In 2013, the Maoming city government took over the open-pit mining area and, after years of work, turned it into an ecological park. The area studied in this paper is an urban planning area defined in the "Maoming city master plan (2011-2035)", that is, the administrative area of Maonan district and Dianbai district in Maoming, covering a total area of 2748 square kilometers. This study takes the Maoming city planning area as the research object, the quantitative and visual analysis of land use information and DEM information from 2000 to 2020 in the study area was carried out by means of GIS spatial analysis technology and Excel perspective analysis.

To sum up, the significance of this study lies in the analysis of landscape change characteristics of Maoming urban planning area from 2000 to 2020, it provides basic information for the study of land use landscape pattern change, land use planning and land management decision-making in this area.

STUDY AREA AND DATA SOURCE

Study Area

The urban orientation of Maoming is the world-class petrochemical base, the national characteristic modern agriculture base, the important energy logistics base of Guangdong province, the Green City by the sea. Maoming is suitable for living and traveling. City functions are divided into West Guangdong important port and comprehensive hub city, Maoming-Zhanjiang City Circle important economic center, Maoming's commercial, cultural and political center, the largest energy and petrochemical industrial base in the "pan-pearl River Delta" region.

The study area is selected as the Maoming urban planning area, namely Maonan District and Dianbai District in Maoming (from the master plan for Maoming City (2011-2035)) .The total area is about 2748 square kilometers. The research area is located in the west of Guangdong province, and the Dianbai area is adjacent to the sea, the west of which is adjacent to Wuchuan City, Zhanjiang,the east of which is adjacent to Yangchun and Yangxi County, the south of which is adjacent to the South Sea, and the north of which is Maoming Gaozhou.

This study is based on the analysis of land cover data and DEM data from the Maoming urban planning area, the spatio-temporal change of land use landscape from 2000 to 2020 and the terrain gradient effect of land use landscape were analyzed. The main contents are as follows: (Shown as Fig.1)

The first is the survey of the study area, which gives an overview of the physical geography and economic conditions of the Maoming and Maoming town planning areas, i.e. the Maonan district and the Dianbai district, through the improvement of ecological construction from 2000 to 2020 in the study area, it is proved that the study of land use landscape change in the study area is practical. The other is to explain the source of the data used in this study. Respectively is the surface coverage data and DEM data. Thirdly, the process of extracting land use information and DEM data in the study area is expounded. Fourth, the land use landscape types from the time change, spatial change and land use changes in three aspects of the land use landscape changes in space-time. Fifthly, the terrain gradient effect of the land use landscape in the study area is comprehensively analyzed and studied by using the elevation, slope, aspect and terrain niche index data.

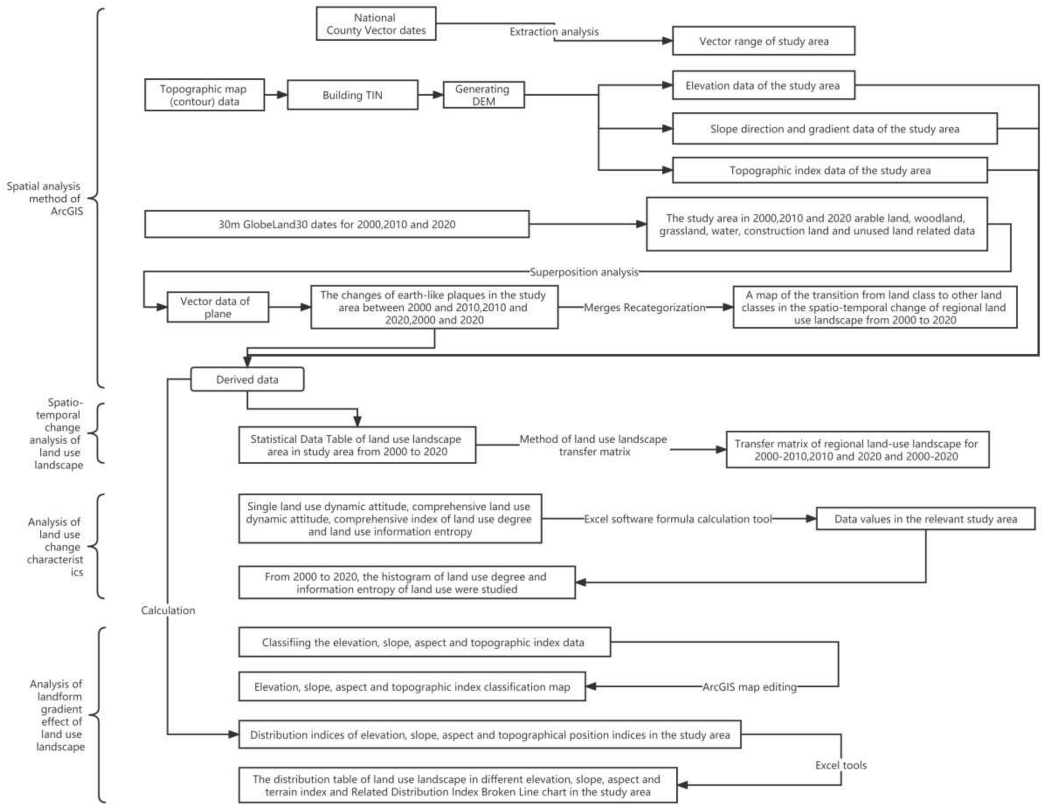


Figure 1: Analysis Roadmap.

Data Source

The data materials used in this study are as follows:

Global land cover data: (http://www.globallandcover.com/) 30m.

Economic statistics, township population, GDP and so on are mainly derived from Maoming statistical yearbook, Maonan District Statistical Yearbook, White Area Statistical Yearbook and other relevant statistical information websites.

Globeland30 is a 30m spatial resolution raster data developed in China and updated by the Ministry of Natural Resources in 2017. Currently, there are 2000, 2010 and 2020 data.

The Globeland30 data is characterized by openness, ease of access and high accuracy. The result shows that the total accuracy is over 83% and the Kappa coefficient is 0.780.82.

In this study, N49 map data of 2000, 2010 and 2020 were selected for download. Fig.2, Fig.3, Fig.4 below are the 2000, 2010 and 2020 regional land use classification maps.

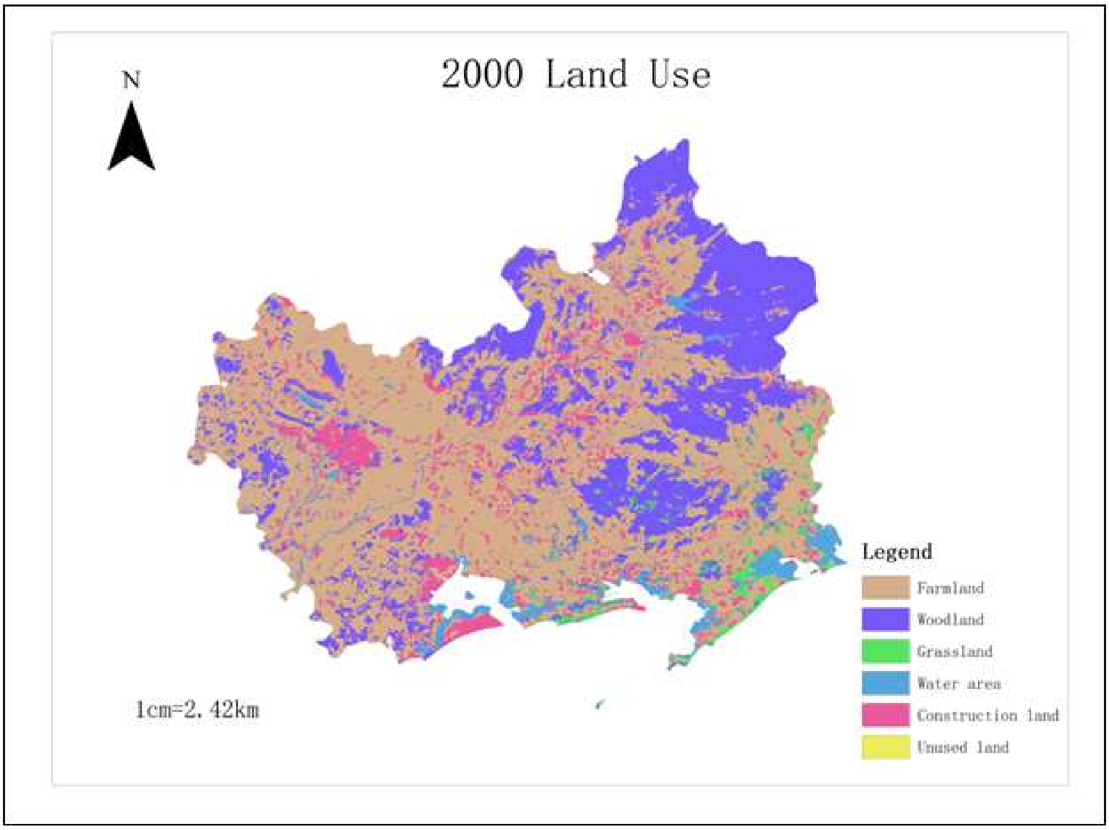


Figure 2: 2000 Regional Land Use Classification Maps.

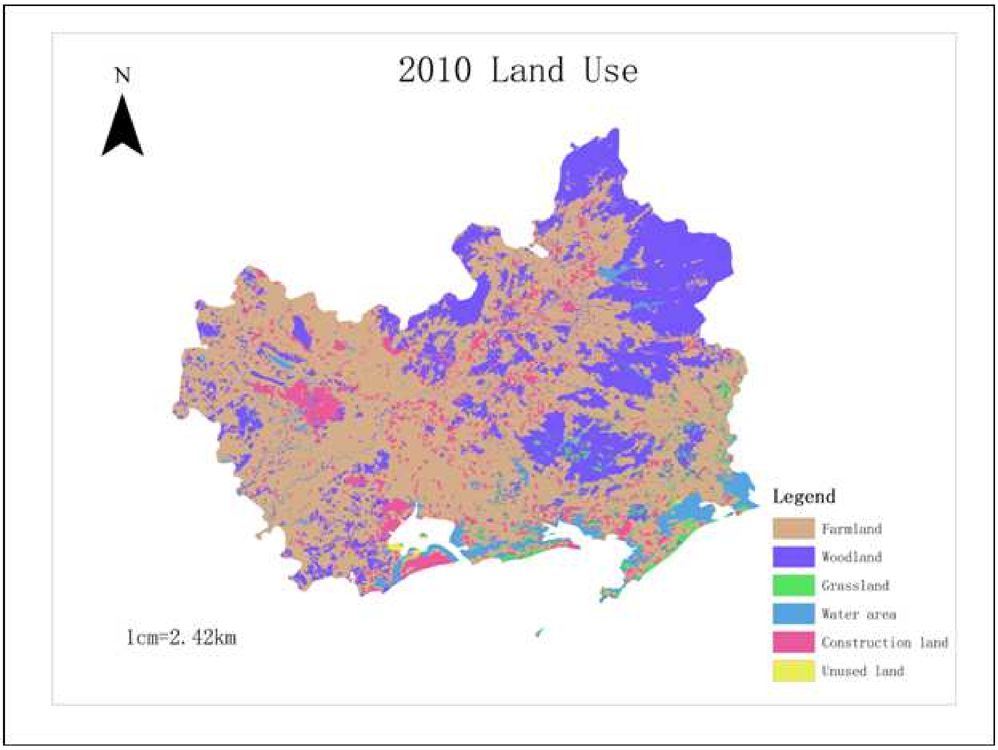


Figure 3: 2010 Regional Land Use Classification Maps.

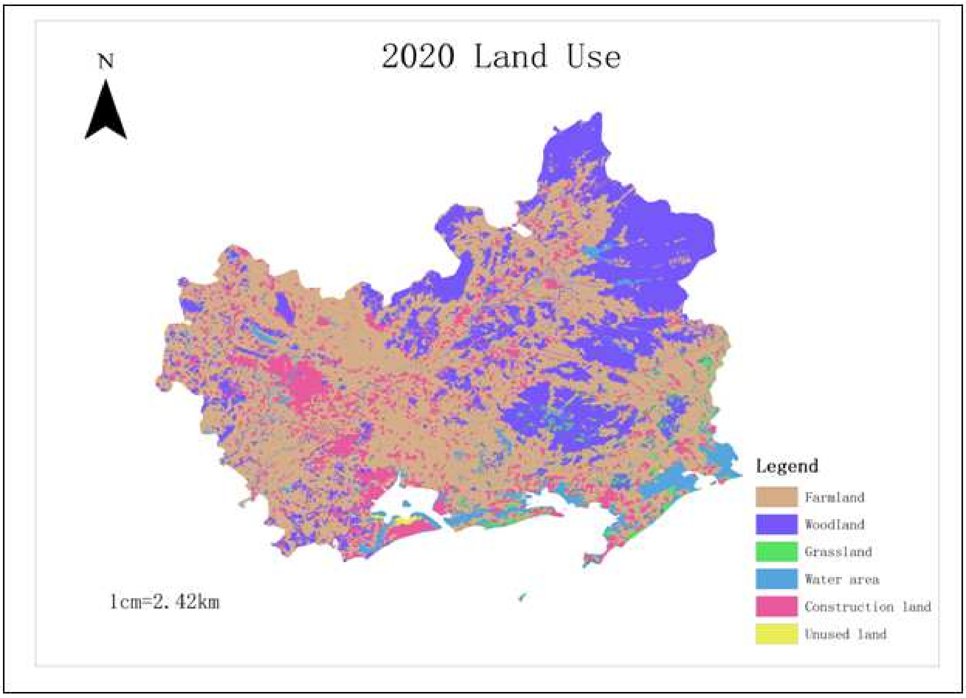


Figure 4: 2020 Regional Land Use Classification Maps.

METHODOLOGY

Land use landscape transition matrix can reflect the structural characteristics of landscape change and the transformation situation and direction among various types, and reveal the transfer information of various types [4,5,6]. The mathematical expression of it is [7]:

$$S_{ij} = \begin{Bmatrix} S_{11} & S_{11} & S_{11} & \dots & S_{1n} \\ S_{21} & S_{22} & S_{23} & \dots & S_{2n} \\ S_{31} & S_{32} & S_{33} & \dots & S_{3n} \\ \dots & \dots & \dots & \dots & \dots \\ S_{n1} & S_{n2} & S_{n3} & \dots & S_{nn} \end{Bmatrix} \quad (i, j = 1,2,3,\dots,n) \tag{1}$$

In the formula: ‘Sij’ for Class ‘i’ into ‘j’ Area: ‘n’ for the number of land use landscape types: ‘i’ and ‘j’ for the transfer before and after the land use types. Based on ArcGIS spatial analysis method, the spatial transformation of different landscape types in the study area in different periods can be obtained by superimposing and analyzing the land use landscape data of two different periods, then the area transition matrix between different landscape types is constructed.

Land use dynamic index can not only quantitatively describe the speed of regional land use change, but also predict the trend of future land use change. The comprehensive land use dynamic index can describe the intensity of regional land use change 7. The single land use dynamic index reflects the quantity change of a certain land use type in a certain time range in the study area. Comprehensive land use dynamic index reflects the intensity of regional land use change [6]. The mathematical expression of the single land use dynamic index is:

$$K=\frac{U_b-U_a}{U_a}\times\frac{1}{T}\times 100\% \quad (2)$$

In the formula, 'K' is the dynamic index of a land-use type during the study period, 'U_b' and 'U_a' are the area of a land-use type at the beginning and end of the study period respectively, and 'T' is the length of the study period (unit year), that is, 'K' represents the annual change rate of land use types in the study area.

The comprehensive land use dynamic index reflects the intensity of regional land use change [6] and its mathematical expression is:

$$LC=\left[\frac{\sum_{i=1}^{n}\Delta LU_{i-j}}{2\sum_{i=1}^{n}LU_i}\right]\times\frac{1}{T}\times 100\% \quad (3)$$

In the formula, 'LU_i' is the area of type 'i' land use type at the beginning of the study, and 'ΔLU_{i-j}' is the absolute value of type 'i' land use type changing to non-type 'i' land use type during the study period 'T' is the length of the study period (in years), that is, 'LC' represents the annual comprehensive change rate of land use in the study area during that period.

The degree of land use is a reflection of the extent and depth of land use, which not only reflects the natural properties of land resources, but also reflects the comprehensive effects of human factors and natural environmental conditions [8]. According to the research results of other scholars, generally speaking, the land use degree is classified as 1 grade for unused land, 2 grade for forest land and grassland water area, 3 grade for arable land and 4 grade for construction land, the higher the grade is, the higher the land use degree is [9]. The mathematical expression of the index of the land use degree is:

$$L_a=100\times\sum_{i=1}^{n}A_i\times C_i \quad (4)$$

In the formula: 'L_a' is the comprehensive index of land use degree; 'A_i' is the grade index of land use degree; 'C_i' is the percentage of grade area of Grade 'i' land use degree; 'n' is the grade number of land use degree.

Land use information entropy can comprehensively reflect the dynamic change of land use types in a certain region in a certain period of time and the degree of its transformation. The higher the entropy value, the lower the order degree and the higher the disorder degree of land use system, the more balanced the development of each factor, on the other hand, the information entropy reaches a maximum when the system is completely balanced [10,11]. The mathematical expression of it is:

$$H=-\sum_{i=1}^{n}p_i\times\log P_i \quad (5)$$

In the formula: 'P_i' is the percentage of each landscape area and 'n' is the number of landscape types.

Among terrain factors, elevation determines local temperature and illumination; slope affects local soil conservation and water conservation capacity; aspect has important influence on local sunshine hours and solar radiation intensity [12]. The terrain niche index can comprehensively reflect the spatial distribution and difference information of terrain conditions [13]. These factors directly affect the land cover, soil moisture, climate, ecological environment and human activities in local areas, thus affecting the landscape pattern of land use. The mathematical expression for the terrain niche index is:

$$T = \log\left[\left(\frac{E}{\overline{E}}+1\right)\bullet\left(\frac{S}{\overline{S}}+1\right)\right] \tag{6}$$

In the formula, ‘T’ is the terrain position, ‘E’ and ‘ $\overline{E}$ ’ is the elevation value of any point in the space and the average elevation value of the area where the point is located, ‘S’ and ‘ $\overline{S}$ ’is the slope value of any point in the space and the average slope value of the area where the point is located.

The distribution index is used to describe the distribution of different landscape on the terrain gradient. The distribution index is a standardized, dimensionless index [14]. The mathematical expression of it is:

$$P_{ie} = \frac{S_{ie}}{S_i} \times \frac{S}{S_e} \tag{7}$$

In the formula: P_{ie} is the distribution index of type 'i' land use landscape on terrain factor E, 'e' is the terrain factor, which represents elevation, slope, aspect and terrain niche index respectively; S_{ie} is the area of type 'i' land use landscape under grade 'e' of terrain factor, S_i is the area of type 'i' land use landscape, S_e is the total area of land use landscape under grade 'e' of terrain factor S is the area of the study area. When the distribution index P_{ie} = 1, it shows that the proportion of type 'i' landscape on terrain factor 'e' is equal to that of type 'i' landscape in the study area. When P_{ie} > 1, it shows that the proportion of landscape type 'i' is larger than that of landscape type 'e' in the study area, and that the landscape factor 'e' is the dominant position of the landscape type distribution On the contrary, when P_{ie} < 1, the terrain factor 'e' is the inferior position of the land use landscape type distribution [15]. It indicates that the terrain grade is not suitable for the distribution or development of the corresponding land use landscape.

SPATIO-TEMPORAL CHANGE ANALYSIS OF LAND USE LANDSCAPE

Present Situation of Land Use Landscape

According to the information shown in **Table 1 and Fig. 5**, the area of arable land in Maoming is the largest in the urban planning area, and is widely distributed, mainly in low-lying areas of less than 50m. Woodland is mainly distributed in the hilly, low-mountain and mid-high-mountain areas above 200m elevation. The water area is mainly distributed in the river Mehua River, Mei River, Baisha River, Xiaodong River and the surrounding areas of Bohe port, Jeddah Port and Jipa Port. Grassland area is less, sporadic distribution in the southeastern waters nearby. Other land area is the smallest, mainly bare land, bare rock and so on.

Table 1: Statistics of Land Use Landscape Area in the Study Area from 2000 to 2020

Landscape Type	2000 year		2010 year		2020 year	
	Acreage (km^2)	Proportion (%)	Acreage (km^2)	Proportion (%)	Acreage (km^2)	Proportion (%)
Arable Land	1605.83	58.43	1629.74	59.30	1517.48	55.21
Woodland	753.97	27.43	727.34	26.46	729.06	26.53
Grassland	65.43	2.38	57.42	2.09	49.05	1.78
Water Area	88.95	3.24	118.35	4.31	123.13	4.48
Construction Land	232.56	8.46	211.56	7.70	326.14	11.87
Unused Land	1.60	0.06	3.93	0.14	3.47	0.13
Total	2748.34	100.00	2748.34	100.00	2748.34	100.00

Temporal Change Characteristics of Land Use Landscape

According to the analysis of **Table 1**, the landscape types of land use in the study area from 2000 to 2020 generally present the pattern of arable land being dominant, forest land and construction land being secondary, grassland, water area and other land being subsidiary. Its main performance is: arable land, construction land, forest land and unused land dynamic change, grassland continued to reduce, water continued to rise.

Spatial Change Characteristics of Land Use Landscape

Quantitative Change Characteristics of Landscape Types

According to **Table 2, Table 3, Table 4** analysis, 2000-2020 in the study area of land use landscape conversion mainly between arable land and construction land, and mainly for the transfer of arable land, construction land into; The second is between arable land and woodland, between construction land and arable land, between woodland and arable land and construction land, mainly represented by the transfer of woodland, construction land, arable land, woodland and construction land.

Table 2: Study on Regional Land Use Landscape Transition Matrix from 2000 to 2010

2000 2010	Arable land	Woodland	Grassland	Water area	Construction land	Unused land	Total
Arable Land	1790.78	9.18	0.19	0.22	15.00	0.00	1815.36
Woodland	3.74	685.99	0.05	0.17	0.54	0.00	690.49
Grassland	0.13	0.15	14.27	0.59	0.08	0.00	15.21
Water Area	0.52	4.58	5.88	72.16	0.18	0.25	83.58
Construction Land	8.92	1.23	0.80	2.79	129.64	0.00	143.39
Unused Land	0.00	0.00	0.30	0.00	0.00	0.00	0.30
Total	1804.09	701.13	21.50	75.93	145.44	0.25	2748.34

Table 3: Study on Regional Land Use Landscape Transition Matrix from 2010 to 2020

2010 2020	Arable land	Woodland	Grassland	Water area	Construction land	Unused land	Total
Arable Land	1716.46	4.07	0.32	1.55	2.05	0.00	1724.47
Woodland	26.92	672.43	0.00	0.00	0.53	0.00	699.88
Grassland	0.09	0.00	10.33	0.00	0.00	0.00	10.42
Water Area	2.28	0.35	1.05	87.20	0.22	1.57	92.67
Construction Land	60.51	9.88	0.53	3.27	143.68	0.05	217.92
Unused Land	0.19	0.00	0.00	1.27	0.00	1.52	2.99
Total	1806.46	686.73	12.23	93.29	146.49	3.14	2748.34

Table 4: Study on Regional Land Use Landscape Transition Matrix from 2000 to 2020

2000 2020	Arable land	Woodland	Grassland	Water area	Construction land	Unused land	Total
Arable Land	1699.47	8.94	1.54	0.73	13.82	0.00	1724.50
Woodland	27.45	678.49	0.05	0.18	1.32	0.00	707.49
Grassland	0.13	0.03	9.93	0.62	0.16	0.00	10.87
Water Area	3.60	4.38	5.98	69.16	0.36	0.00	83.47
Construction Land	66.79	11.36	2.24	3.17	135.24	0.00	218.81
Unused Land	0.09	0.00	0.21	2.91	0.00	0.00	3.21
Total	1797.52	703.19	19.95	76.77	150.91	0.00	2748.34

Spatial Variation Characteristics of Landscape Types

In the middle part of the southwest region of the study area, namely, the south streets in the downtown area of Maoming city, the transformation of arable land into construction land is obvious, and the transformation of arable land into construction land is mainly, further confirmed the expansion of urbanization in the study area. In the central part of the study area and the northeast of the central part, the conversion of arable land into forest land is remarkable, mainly distributed in Naho town, Shalang town and Xiadong town. The land use landscape in the whole study area is quite different on the spatial scale (**Fig. 5)**.

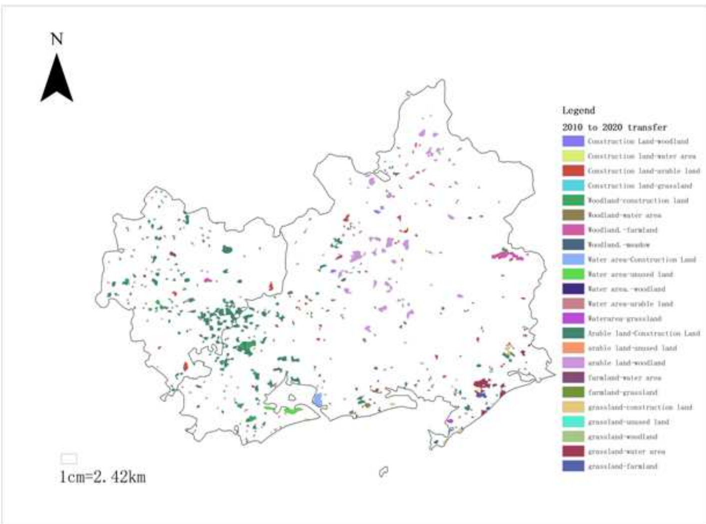


Figure 5: The Spatio-Temporal Change of Regional Land Use Landscape from 2000 to 2020.

ANALYSIS OF LAND USE CHANGE CHARACTERISTICS

Land Use Dynamics

In the past 20 years, the annual change range of each landscape in the study area is 5.93%, and the land use dynamic index varies greatly in different time periods. The dynamic index of comprehensive land use landscape increased continuously, which indicated that the intensity of human activities had gradually increased the impact on the land use landscape in the region. According to the research results of experts and scholars, the comprehensive dynamic index of land use type is a very slow change type from 0% to 3%. Therefore, the land use change in the study area is relatively slow, and the structure tends to be stable **(Table 5, Table 6).**

Table 5: Single Land Use Landscape Dynamics in the Study Area from 2000 to 2020

Single Land Use Landscape Dynamics			
Year	**2000-2010**	**2010-2020**	**2000-2020**
Arable Land	-0.15%	0.74%	0.29%
Woodland	0.37%	-0.02%	0.17%
Grassland	1.40%	1.71%	1.67%
Water Area	-2.48%	-0.39%	-1.39%
Construction Land	0.99%	-3.51%	-1.43%
Unused Land	-5.93%	1.33%	-2.69%

Table 6 Comprehensive Land Use Landscape Dynamics in the Study Area from 2000 to 2020

Year	2000-2010	2010-2020	2000-2020
Comprehensive land use landscape dynamics	0.10%	0.21%	0.14%

Degree of Land Use

According to Fig. 6, the land use index in the Maoming urban planning area from 2000 to 2020 decreased slightly and then increased significantly. According to the related research, the national average land use degree index is 231, and the land use index of the study area in 2000, 2010 and 2020 are all higher than 231. From 2000 to 2010, the pattern of land use in the Maoming urban planning area was less reasonable, but the degree of land use was still higher, and the degree of land use is high.

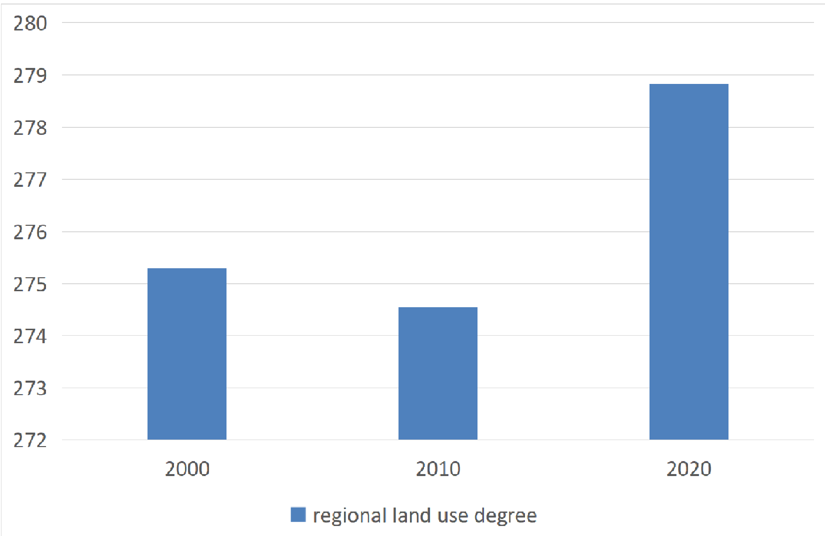


Figure 6: Study on Regional Land Use Degree from 2000 to 2020.

Information Entropy of Land Use

According to Fig. 7, land use information entropy increased slightly between 2000 and 2010, and significantly between 2010 and 2020. It shows that the land use system in the study area has a high degree of disorder and a low degree of order, and the development of each factor is relatively balanced. And the development between 2000 and 2010 is not obvious, 2020 has significant development.

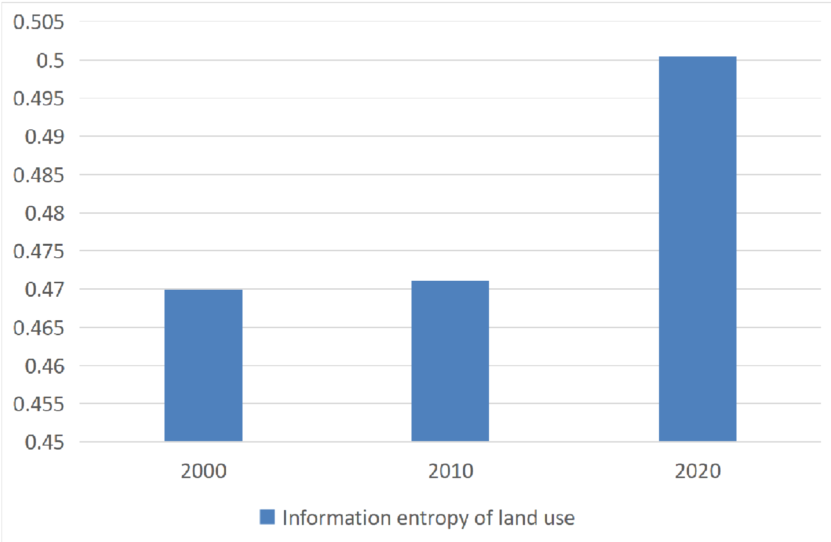


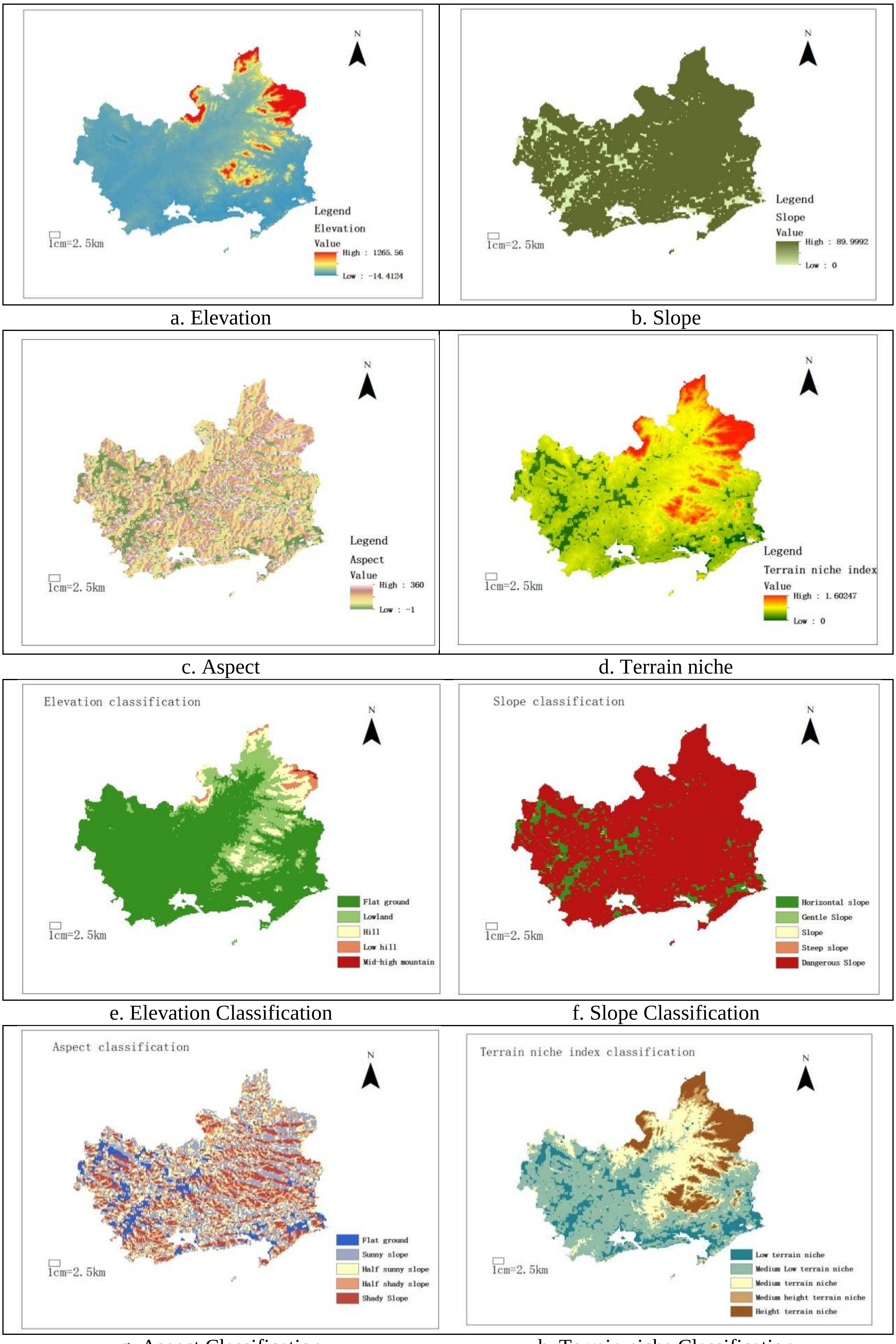
Figure 7: Study on Regional Land Use Degree from 2000 to 2020.

ANALYSIS OF TERRAIN GRADIENT EFFECTS OF LAND USE LANDSCAPE

In this paper, the terrain gradient effects of land use landscape in Maoming urban planning area is analyzed by using four terrain factors, namely elevation, slope, aspect and terrain niche .The following table7 classifies elevation, slope, aspect and terrain niche maps according to the characteristics of topography, landform and landscape distribution in the Maoming urban planning area (**Table 7, Fig. 8)**.

Table 7: Classification of Terrain Factors in the Study Area

Classification	1	2	3	4	5
Elevation	Flat ground	lowland	hill	Low hill	Mid-high mountain
	<50m	50~200m	200~500m	500~900m	>900m
Slope	horizontal slope	Gentle Slope	Slope	Steep slope	Dangerous Slope
	0~5°	5~15°	15~25°	25~35°	>35°
Aspect	Flat ground	Sunny slope	Half sunny slope	Half shady slope	Shady Slope
	-1°	South slope (157.5~202.5°) Southwest slope (202.5~247.5°)	West slope (247.5~292.5°) Southeast slope (112.5~157.5°)	East slope (67.5~112.5°) North west slope (292.5~337.5°)	North slope (337.5~22.5°) Northeast slope (22.5~67.5°)
Terrain niche index	Low terrain niche	Medium Low terrain niche	Medium terrain niche	Medium height terrain niche	Height terrain niche
	<0.35	0.35~0.5	0.5~0.65	0.6~50.8	>0.8



a. Elevation b. Slope

c. Aspect d. Terrain niche

e. Elevation Classification f. Slope Classification

g. Aspect Classification h. Terrain niche Classification

Figure 8: Spatial Distribution of Terrain Factors in the Study Area.

Elevation Effect of Land Use Landscape

For all types of land use landscape, with the elevation of the rise, are decreasing trend. The arable land, grassland, construction land and unused land were in the dominant position ($p > 1$), while the woodland was in the inferior position ($p < 1$). In other elevation grading areas, the situation reversed, only forest land was in the dominant position ($p > 1$) , arable land, grassland, building land and unused land were in the inferior position ($p < 1$) . With the increase of elevation, the dominant position of forest land gradually rose, and arable land, grassland, construction land and unused land became inferior position, in which the grassland decreased slowly, followed by construction land and unused land, the waters between the Pingba District and hilly areas increased slightly, but overall they remained at a disadvantage (**Table 8)**.

This indicates that with the increase of elevation, the advantage of natural ecosystem (mainly forest land) is gradually strengthened, human activity is gradually weakened, and the higher elevation (> 50m) is more suitable for ecological protection (**Fig. 9)**.

Table 8: Distribution of Land Use Landscape at Different Elevations in the Study Area

Landscape type	Flat ground		lowland		hill		Low hill		Mid-high mountain	
	Acreage (km^2)	Proportion (%)	Acreage (km^2)	Proportion (%)	Acreage (km^2)	Proportion (%)	Acreage (km^2)	Proportion (%)	Acreage (km^2)	Proportion (%)
Arable land	1368.12	67.52	228.42	47.70	15.66	8.29	0.82	1.65	0.00	0.00
Woodland	247.04	12.19	226.97	47.40	168.54	89.17	48.76	98.35	4.66	100.00
Grassland	19.59	0.97	3.46	0.72	1.13	0.60	0.00	0.00	0.00	0.00
Water area	99.22	4.90	7.32	1.53	3.01	1.59	0.00	0.00	0.00	0.00
Construction land	288.74	14.25	12.70	2.65	0.68	0.36	0.00	0.00	0.00	0.00
Unused land	3.52	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	2026.23	100.00	478.87	100.00	189.01	100.00	49.58	100.00	4.66	100.00

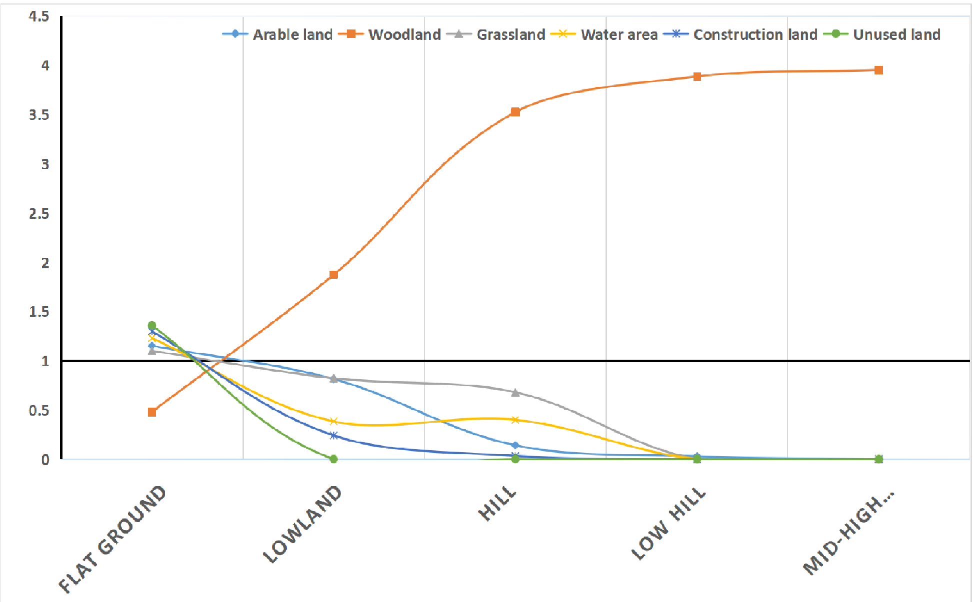


Figure 9: Distribution Index of Different Elevations in the Study Area.

Slope Effect of Land Use Landscape

For all types of land-use landscape, with the rise of slope, the area of all types of land use landscape first decreased and then increased.

In horizontal slope area, the water area, unused land, construction land and arable land are all in the dominant position ($p > 1$), and the water area distribution has absolute superiority ($p = 2.98$). Grassland and woodland were in an inferior position ($p < 1$). In the gentle slope area, the water area, the construction land and the arable land are in the superiority position ($p > 1$), the forest land is still in the inferior position ($p < 1$). In the steep slope area, only the arable land was in the dominant position ($p > 1$), and all other types of land were in the inferior position ($p < 1$). To the dangerous slope area, only forest land was in the dominant position ($p > 1$) , water area, unused land, grassland, construction land and arable land were in the inferior position ($p < 1$) (**Table 9)**.

From the analysis, it can be concluded that the slope of 25° will be regarded as a turning point of the change of land use landscape type, and the land use landscape type which is closely related to human production and life will increase slightly in the region with the slope of less than 25°, however, the landscape types, such as woodland and grassland, which are little influenced by human beings are gradually reduced. In the case of slopes greater than 25°, the reverse is true (**Fig.10)**.

Table 9 Distribution of Land Use Landscape in Different Slopes in the Study Area

Landscape Type	horizontal slope		Gentle Slope		Slope		Steep slope		Dangerous Slope	
	Acreage (km^2)	Proportion (%)	Acreage (km^2)	Proportion (%)	Acreage (km^2)	Proportion (%)	Acreage (km^2)	Proportion (%)	Acreage (km^2)	Proportion (%)
Arable Land	149.43	67.79	395.44	49.94	380.08	58.78	346.98	61.50	328.04	62.44
Woodland	8.77	3.98	289.56	36.57	171.52	26.53	123.38	21.87	112.13	21.34
Grassland	1.62	0.73	8.10	1.02	7.89	1.22	3.98	0.71	3.04	0.58
Water Area	26.55	12.05	12.91	1.63	14.97	2.32	24.83	4.40	31.55	6.00
Construction Land	33.80	15.33	85.77	10.83	71.51	11.06	63.66	11.28	49.27	9.38
Unused Land	0.26	0.12	0.00	0.00	0.60	0.09	1.38	0.24	1.33	0.25
Total	220.44	100.00	791.77	100.00	646.57	100.00	564.22	100.00	525.36	100.00

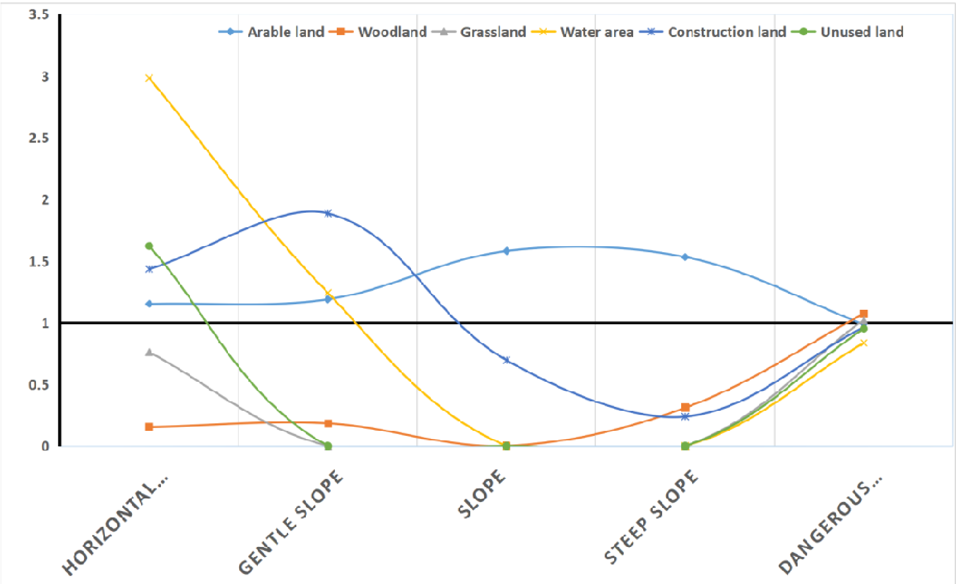


Figure 10: Distribution Index of Different Slopes in the Study Area.

Slope Effect of Land Use Landscape

With the change of slope direction, the landscape area of different types of land use fluctuates. The water area, construction land and arable land are all in the dominant position ($p > 1$), and the water area distribution has absolute superiority ($p = 2.99$). Grassland, unused land and woodland were at a disadvantage ($p < 1$). On the sunny slope, water area, construction land and arable land were in an inferior position ($p < 1$), while grassland and woodland were in superior position ($p > 1$). The situation is the same in the semi-sunny slope grading area. The arable land, water area, construction land and unused land were in the dominant position ($p > 1$), while the woodland and grassland were in the inferior position ($p < 1$). Arable land, water area and unused land were in the dominant position ($p > 1$), while construction land, woodland and grassland were in the inferior position ($p < 1$) (**Table 10**) (**Fig.11**).

Table 10: Distribution of Land Use Landscape in Different Slope Directions in the Study Area

Landscape type	Aspect		flat ground		Sunny slope		Half sunny slope		Half shady slope	
	Acreage (km^2)	Proportion (%)	Acreage (km^2)	Proportion (%)	Acreage (km^2)	Proportion (%)	Acreage (km^2)	Proportion (%)	Acreage (km^2)	Proportion (%)
Arable land	149.43	67.79	395.44	49.94	380.08	58.78	346.98	61.50	328.04	62.44
Woodland	8.77	3.98	289.56	36.57	171.52	26.53	123.38	21.87	112.13	21.34
Grassland	1.62	0.73	8.10	1.02	7.89	1.22	3.98	0.71	3.04	0.58
Water area	26.55	12.05	12.91	1.63	14.97	2.32	24.83	4.40	31.55	6.00
Construction land	33.80	15.33	85.77	10.83	71.51	11.06	63.66	11.28	49.27	9.38
Unused land	0.26	0.12	0.00	0.00	0.60	0.09	1.38	0.24	1.33	0.25
Total	220.44	100.00	791.77	100.00	646.57	100.00	564.22	100.00	525.36	100.00

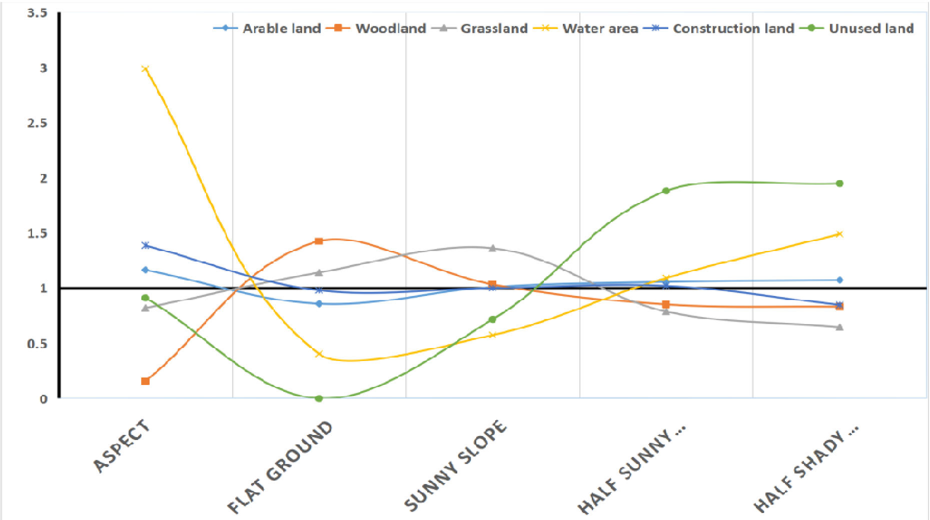


Figure 11: Distribution Index of Different Slope Directions in the Study Area.

Terrain Niche Effect of Land Use Landscape

With the increase of the terrain niche index, there are four types of landscape types in the grading area. Arable land is increasing first and then decreasing; forest land is increasing continuously; construction land and unused land are decreasing continuously; grassland and water area are fluctuating.

In the low terrain, arable land, grassland, water area, building land and unused land were in the dominant position ($p > 1$), and water area had absolute superiority ($p = 4.55$). The woodland was in the inferior position ($p < 1$). The arable land, grassland, construction land and unused land were in the dominant position ($p > 1$), while the water area and forest land were in the inferior position ($p < 1$). In the middle terrain, farmland and woodland were in the dominant position (p > 1), while water area, grassland and building land were in the inferior position (p < 1). In the medium-high terrain and high terrain, only forest land was in the dominant position (p > 1), but water area, farmland, grassland and building land were in the inferior position (p < 1) (**Table 11) (Fig.12)**.

Table 11: The Distribution of Land Use Landscape Index in Different Terrain Niche in the Study Area

Landscape type	Low terrain niche		Medium Low		Medium terrain niche		Medium height terrain niche		Height terrain niche	
	Acreage (km^2)	Proportion (%)	Acreage (km^2)	Proportion (%)	Acreage (km^2)	Proportion (%)	Acreage (km^2)	Proportion (%)	Acreage (km^2)	Proportion (%)
Arable land	193.76	59.75	938.77	71.04	385.66	64.56	64.10	40.39	40.91	11.81
Woodland	11.46	3.53	137.16	10.38	169.06	28.30	86.41	54.45	297.34	85.83
Grassland	5.34	1.65	12.79	0.97	1.45	0.24	0.95	0.60	1.94	0.56
Water area	58.13	17.92	37.22	2.82	5.10	0.85	2.99	1.88	4.74	1.37
Construction land	54.72	16.87	193.06	14.61	36.10	6.04	4.25	2.68	1.49	0.43
Unused land	0.90	0.28	2.55	0.19	0.00	0.00	0.00	0.00	0.00	0.00
Total	324.31	100.00	1321.54	100.00	597.37	100.00	158.70	100.00	346.44	100.00

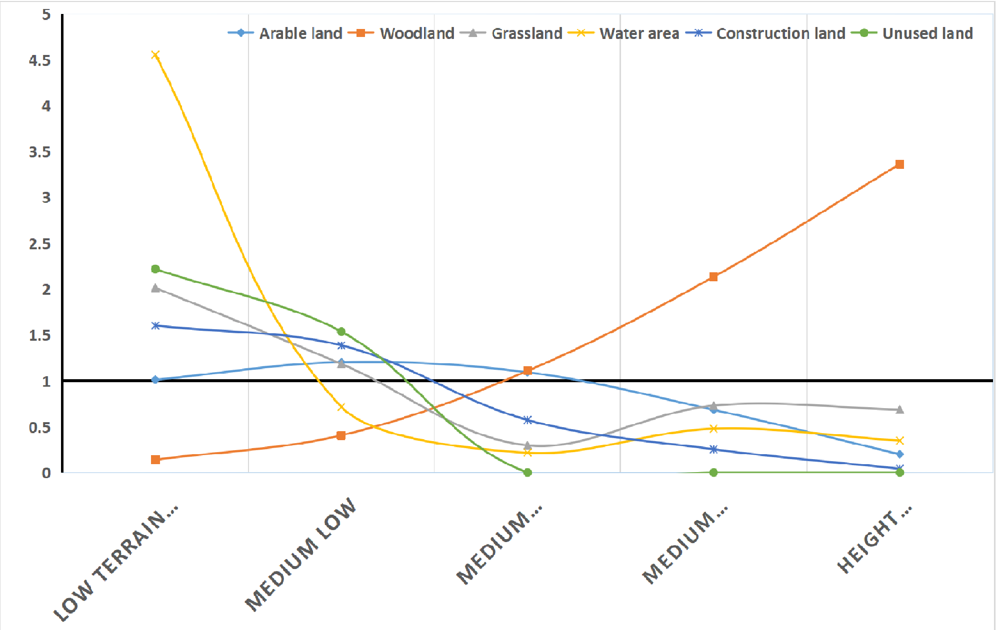


Figure 12: Distribution Index of Different Slope Directions in the Study Area.

CONCLUSION

The study on the present situation of land use landscape types shows that the area of arable land accounts for the most, followed by woodland. And the land use landscape type also has the characteristic in the space distribution, in which the arable land and the forest land distribution has the characteristic. The landscape types of land used in the study area from 2000 to 2020 are mainly arable land, woodland and construction land, grassland, water area and other land.

The dynamic index of the land use landscape in the study area continues to increase, which indicates that the intensity of human activities has gradually increased the impact on the land use landscape in the study area, from 2000 to 2010, the land use pattern was unreasonable, and from 2010 to 2020, the situation improved greatly, the land use pattern was reasonable, and the land use degree was high; The land use information entropy indicates that the development of each factor is relatively balanced, and the development is not obvious from 2000 to 2010, and the development is remarkable from 2020.

The study of the effect of elevation shows that with the increase of elevation, the advantage of natural ecosystem (mainly forest land) is gradually strengthened, the human activity is gradually weakened, and it is more suitable for ecological protection at higher elevation. On the gradient, the gradient of 25° will be regarded as a turning point of the change of land use landscape type, and in the area with the gradient of less than 25°, the land use landscape type which is closely related to human production and living has slightly increased, however, the landscape types, such as woodland and grassland, which are little influenced by human beings are gradually reduced. In the case of slopes greater than 25°, the reverse is true. On the slope, the water area has absolute superiority in the flat land, while the grassland and woodland have the superiority in the sunny and semi-sunny land, and the arable land, the water area, the construction land and the unused land have the superiority in the shady and semi-shady land. On the terrain niche index, the water area has absolute superiority in the low terrain position, the middle-low terrain position, the arable land, the grassland, the construction land and the unused land are all in the superiority position.

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