

RESEARCH ARTICLE

STUDY ON THE SPATIOTEMPORAL DIFFERENTIATION CHARACTERISTICS OF "MOUNTAINS, RIVERS, FORESTS, FIELDS, LAKES, AND GRASS CITIES" IN THE TAI'AN SECTION OF THE YELLOW RIVER BASIN

Lei Zhang, Li Shi*, Fei Wang, Haodong Shang, Xiaomeng Zhou

School of Tourism, Taishan University, Taian 271000, China
*Corresponding Author Email: 1291009063@qq.com

This is an open access article distributed under the Creative Commons Attribution License CC BY 4.0, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

ARTICLE DETAILS

Article History:

Received 08 May 2023
Revised 11 June 2023
Accepted 14 July 2023
Available online 18 July 2023

ABSTRACT

The natural environment of the Tai'an section of the Yellow River Basin is complex and diverse, the land use function and structure have distinct regional and cultural characteristics. This article is based on literature review, field research and remote sensing image interpretation to construct an analysis variable database. Based on models such as land use dynamics and transfer matrix, the spatiotemporal differentiation and variation characteristics in this area are analyzed. Discovery: ①As a representative area with significant natural background characteristics of "mountain water field", forest land, cultivated land, and water bodies constitute the main matrix and corridor of land use. ②Over time, the distribution and composition of the spatial distribution in the Tai'an section of the Yellow River Basin have undergone significant changes. The proportion of arable land, forest land and grassland areas to the total land use area has decreased overall, the proportion of building land, water bodies, and unused land has increased. Over 20s, the spatial distribution structure and composition in the study area have undergone significant changes. ③Between 2000 and 2020, cultivated land and construction land constituted the main body and background of land use conversion in this area. This study can provide reference for promoting the coordinated development in the Tai'an section of the Yellow River Basin.

KEYWORDS

Land use; Spatiotemporal differentiation; Tai'an section of the Yellow River Basin

1. INTRODUCTION

The Tai'an section of the Yellow River Basin is unique, and it overlaps with the jurisdiction of Tai'an City, except for a few towns in Ningyang and the southern part of Xintai. It is the area with the highest elevation mountains in the Shandong. As a typical area in the eastern section of the Yellow River basin with multiple overlapping characteristics, such as active urban area and resource sensitive area, the research area has also brought problems such as destruction of ecological resources, reduction of natural restoration capacity, and decline of ecological barriers around Mount Taishan, restricting the optimal layout of regional land space and organic coordination of human land relations. Therefore, it is extremely necessary to evaluate the spatiotemporal differentiation and ecological risk status of the Tai'an section of the Yellow River Basin.

Important discussions have been proposed to promote regional coordination and economic and social development. The study has become a hot topic of attention for scholars at present (Alisa et al., 2011). It can be seen from the integration that current scholars' research on mountains, rivers, forests, fields, lakes, and grasses in the Yellow River Basin focuses on scientific connotations, mechanism systems, improvement of ecosystem services, ecological processes and implementation path, and there is relatively little research on the precise understanding of the spatiotemporal differentiation laws of natural elements such as mountains, rivers, forests, fields, lakes, and grasses (Liu et al., 2018; Quang et al., 2008; Kong, 2013; Zhang et al., 2018). The analysis of its classification relationship and information graph with urban space is insufficient, and there has been no research on the special geographical

area of the Tai'an section (Cao et al., 2013). In view of this, this project plans to use the Tai'an section, evaluate the spatiotemporal differentiation and evolution characteristics of its landscape, forest, farmland, lake, and grassland cities, provide background for more comprehensive, systematic, and precise protection, control, and restoration of landscape, forest, farmland, lake, and grassland, and optimizing spatiotemporal layout of construction land.

2. RESEARCH AREA AND DATA SOURCE

The physical geography characteristics of Tai'an section are prominent, and the land use function and structure have distinctive regional and human characteristics. This section is based on literature review, field research, and remote sensing image data extraction to construct an analysis variable database. Based on models, the spatiotemporal differentiation and change characteristics in the area are analyzed, laying the foundation for future research (Liao et al., 2015). By comparison, it was found that the space of Shanshui, Lintian, Hucaocheng can be further classified: production (arable land), living (construction land), and ecological (forest land, grassland, water area). Therefore, can cover the space of Shanshui, Lintian, Hucaocheng. Therefore, this study integrates the space into six major land types (Zhong et al., 2016).

3. RESEARCH METHODS AND MODEL CONSTRUCTION

3.1 Land Use Dynamic Degree Model

This indicator reflects the changes in the quantity, space, and type combination of a certain land use type within a certain period of time in

Quick Response Code



Access this article online

Website:
www.environmentecosystem.com

DOI:
10.26480/ees.02.2023.48.53

the region. It is mainly used to measure the speed and magnitude of changes in different land use types in the study area(Paukert et al., 2011). The calculation formula is:

$$K = \frac{U_b - U_a}{U_a} \times \frac{1}{T} \times 100\% \tag{1}$$

3.2 Land Use Classification Analysis Model

The transformation between different land types is often mainly bidirectional, that is, while the land type is transferred out to other land types, there are also other land types that are transformed into this land type (Han et al., 2015). Referring to relevant research, this article introduces a model measure the transformation trend. The specific can be found in reference (Zhou et al, 2016).

4. THE SPATIAL DISTRIBUTION STATUS OF MOUNTAINS, RIVERS, FORESTS, FIELDS, LAKES, AND GRASS CITIES IN THE TAI'AN SECTION OF THE YELLOW RIVER BASIN

As a representative area with significant natural background characteristics of "mountain water field" bodies constitute the main matrix and corridor.

Figures 1 and 2 found the Tai'an section is widely distributed in study. As an important part of the mountainous area in central Shandong, forest land is mainly the mountainous space. According to integration, the forest land in Tai'an section is mainly composed of shelter forests and shrubbery, which is mainly distributed in the north of Daiyue District in Mount

Taishan area and around Mount Taishan and Culai Mountains in the southeast of Daiyue District. The forest was 7.5% in the study area; Affected by the Mount Taishan tectonic belt, the water area of Tai'an section, is widely distributed, showing a spatial distribution trend of "one side (Dongping Lake) and one line (Dawen River) and multiple points (Tianyi Lake, Tianping Lake, etc.)" (Figure 1). Further statistics show that the water was 5.5% of the study area; As an important part of the development of Shandong provincial capital economic circle and Jitai city, the urban and rural economic belt in Tai'an section is developing actively, and the spatial distribution of construction land changes rapidly and significantly. As shown in Figure 2, by 2020, the construction land has reached 17%, which further reveals that construction land shows two characteristics. Frist, the space of urban is mainly distributed in blocks in Mount Taishan At the intersection of Daiyue and other districts, as well as the county seats of Xintai, Feicheng, and Dongping counties and cities, rural construction land is widely distributed in a dotted pattern throughout the research area; Comparatively speaking, the spatial distribution of grassland and unused land is significantly regional and different. On the one hand, grassland is distributed along Mount Taishan Mountain and Culai Mountain in the extension of forest land according to the altitude level; on the other hand, it also presents a distribution trend of parallel belt, cluster and scattered points in Xintai City, the middle of Feicheng City and north of Dongping was 6.3% of land use area of the study area; Driven by ecological migration, renovation and overall relocation of old villages in Dongping County, as well as the ecological protection and restoration project of Dongping Lake, unused land of Tai'an section is significant. It is in towns such as Laohu Town, Xinqu Town, Dongping Street, and Zhoucheng Street along Dongping Lake in Dongping County, accounting for 0.9% land use .

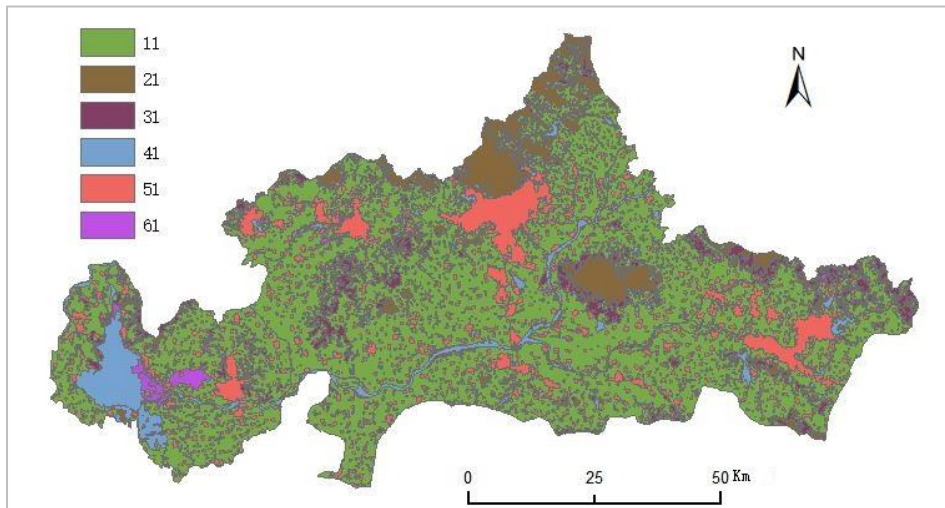


Figure 1: Spatial distribution status of mountains, rivers, forests, fields, lakes, and grass cities in the Tai'an section of the Yellow River Basin (2020)
 Note: In the figure, 11 represents arable land, 21 represents forest land, 31 represents grassland, 41 represents water body, 51 represents construction land, and 61 represents unused land

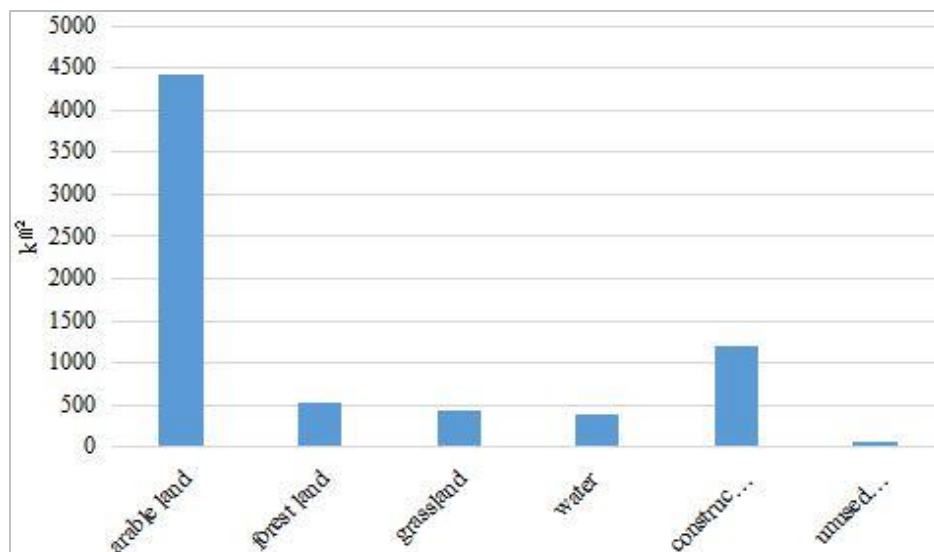


Figure 2: Composition characteristics of mountains, rivers, forests, fields, lakes, and grass cities in the Tai'an section of the Yellow River Basin (2020) (Km²)

5. TEMPORAL AND SPATIAL DISTRIBUTION CHANGES OF MOUNTAINS, RIVERS, FORESTS, FIELDS, LAKES, AND GRASSLANDS IN THE TAI'AN SECTION OF THE YELLOW RIVER BASIN

Over time, the distribution and composition of the landscape, forests, fields, lakes, and grass cities in the Tai'an have undergone significant changes.

5.1 Spatial Distribution Changes

① Cultivated land. From Table 1, it can be seen that there are certain time periods of variation in Tai'an section. In 2000, the cultivated land area in the study area was 4703.6Km², and in 2010, it was 4497.72Km². By 2020, the cultivated land area had changed to 4414.026Km². The cultivated land area had changed to 289.4Km², the change was particularly significant between 2000 and 2010 (Table 1). Further comparison reveals that there is also a certain regional differentiation in the changes in arable land space from 2000. The reduction of arable land is mainly distributed along the Great Wall Road in the southern part of Daiyue District and along Dongyue Street in the western part, around Dongping Lake in Dongping County, and around the county towns of Xintai and Feicheng (Figure 3).

② Forest land. Based on Table 1, it is found that scale of Tai'an section changed slightly from 2000 to 2020, with area decreasing from 574.09 Km² in 2000 to 525.63 Km² in 2020. This to some extent indicates that the stability of forest land resource structure, as ecological backgrounds, is strong, but the trend of forest land resource transfer is beginning to show. From Figure 3, during 20 years, the forest land transferred from the Tai'an section was mainly scattered in a dotted pattern along the Dongping Lake and Dawen River, as well as on the north and south sides of Feicheng City.

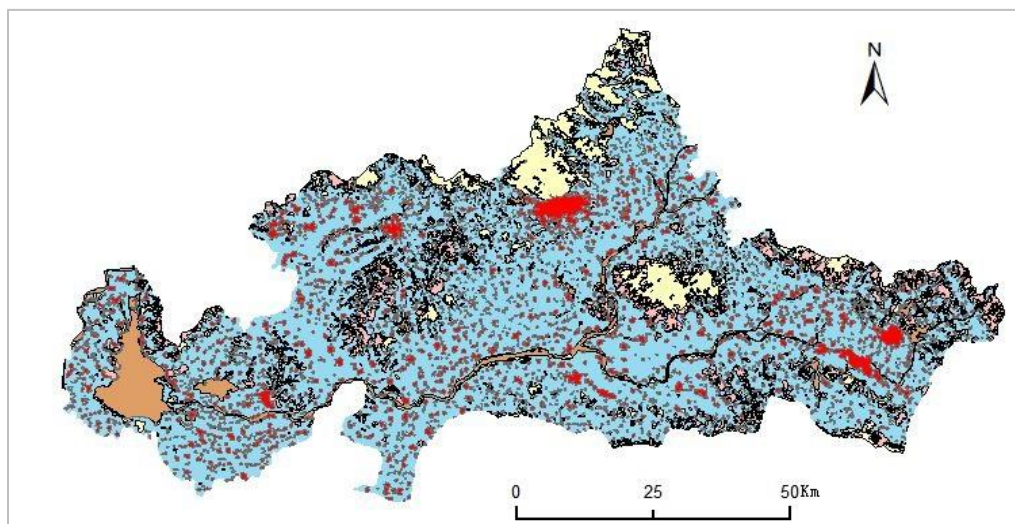
③ Water. Based on Table 1, the water area in Tai'an section increased from 341.21Km² in 2000 to 387Km² in 2020, which indicates that the

function of aquatic ecosystem in Tai'an City has been continuously enhanced in recent years. According to Figure 3, the newly added water use land in the Tai'an section is mainly distributed in the southern section of Dongping County, ecological protection and restoration of Dongping Lake implemented in the Tai'an section .

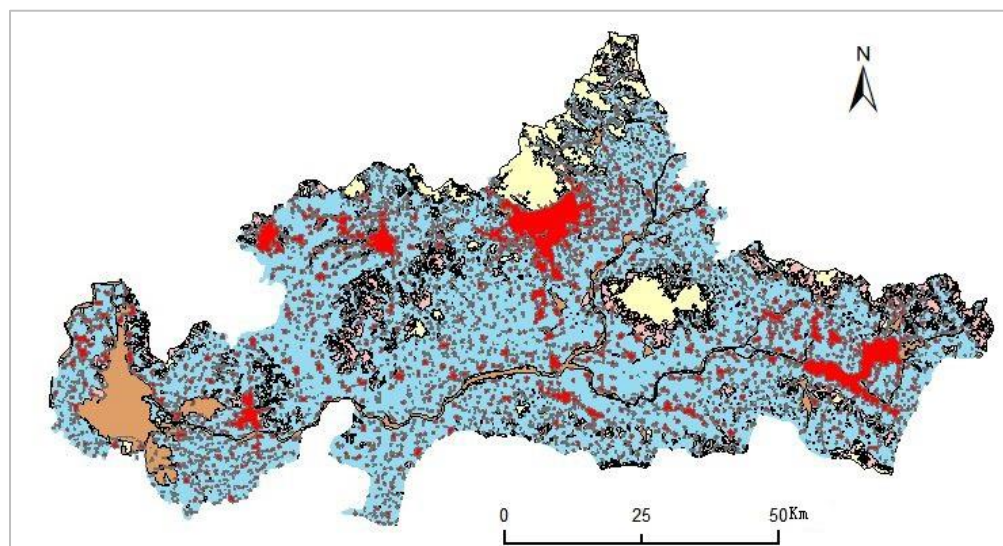
④ Construction land. Between 2000 and 2020, the spatial expansion of building land in the Tai'an section significant, with land area increasing 826.02 Km² in 2000 to 1192.71 Km² in 2020. As a direct carrier of human activities, building land space in the research area directly reflects the increasing activity of urban-rural. Based on Figure 3, it is found that, over time, the area of new building land in the study area is spread around the main urban area of Tai'an City (Daiyue District, Mount Taishan District) and shows a significant westward and southward expansion trend; On the other hand, there is a dot filling expansion around the urban areas of Xintai City, Feicheng City, and Dongping County.

⑤ Grassland. Based on Table 1, it was found that during the study period, the grassland area in the Tai'an section showed a continuous decreasing trend, with the decrease mainly concentrated between 2000 and 2010. Further comparison shows that the grassland reduction areas are in Xintai City, the south of Tianyi Lake in Daiyue District and the foot of Mount Taishan Mountain in the north (Figure 3).

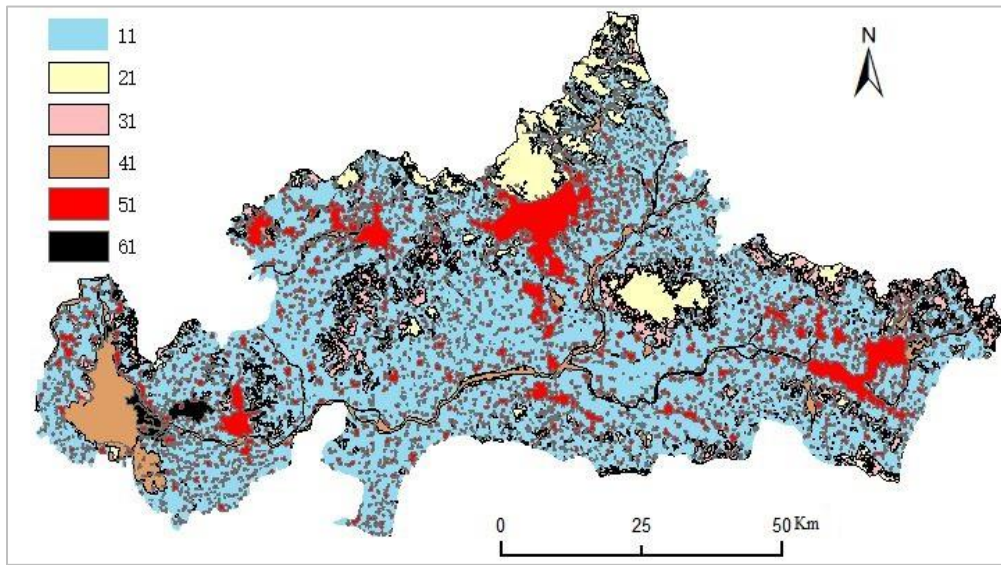
⑥ Unutilized land. In terms of scale, compared to other land types, unused land of study area is the smallest (less than 1% in all three periods), but the changes are significant. Between 2000 and 2020, increased from 0.32% to 0.94%, which indirectly reflects the continuous improvement of study area. Based on Figure 3, driven by ecological restoration, immigration, and comprehensive rural improvement, the newly added unused land was mainly distributed in clusters along Dongping Lake in Dongping County.



a 2000



b 2010



c 2020

Figure 3: Spatial and temporal distribution and change trend of mountains, rivers, forests, fields, lakes, and grass cities in the Tai'an section of the Yellow River Basin

Note: In the figure, 11 represents arable land, 21 represents forest land, 31 represents grassland, 41 represents water body, 51 represents construction land, and 61 represents unused land

Table 1: Distribution Scale and Variation Characteristics of Mountains, Rivers, Forests, Fields, Lakes, And Grass Cities in The Tai'an Section of The Yellow River Basin From 2000 To 2020

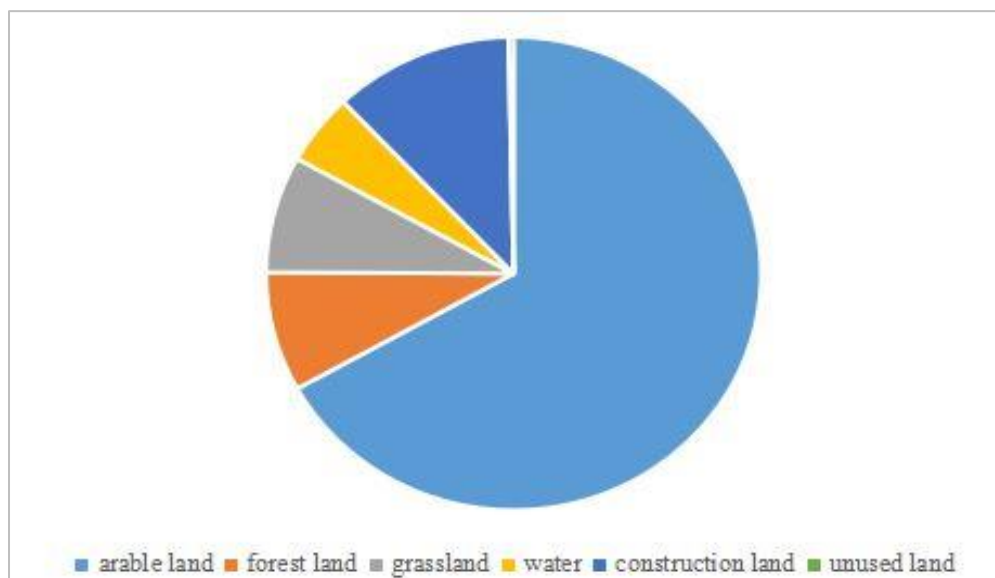
	2000Year		2010Year		2020Year	
	Area(Km ²)	Proportion(%)	Area(Km ²)	Proportion(%)	Area(Km ²)	Proportion(%)
Arable Land	4703.61	66.92	4497.72	63.99	4414.20	62.81
Forest Land	574.09	8.17	528.76	7.52	525.63	7.48
Grassland	561.16	7.98	444.75	6.33	442.75	6.30
Water	341.21	4.85	412.18	5.86	387.00	5.51
Construction	826.02	11.75	1125.45	16.01	1192.71	16.97
Unused Land	22.61	0.32	19.93	0.28	65.73	0.94

5.2 Changes in Structure And Composition

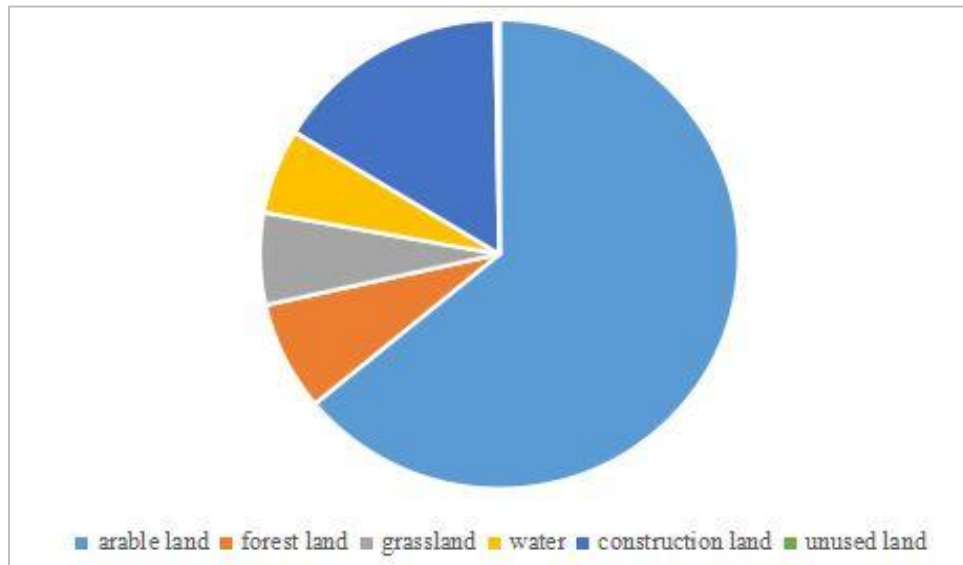
Based on the analysis of the spatial distribution and changes in Tai'an section. From Figure 4, it can be seen that from 2000 to 2020, the landscape of study area were mainly composed of arable land. The sum of the three accounted for over 85% area of Tai'an section. By 2010, arable area in the research area was 66.9%, construction land was 11.8%, and forest land was 8.2%; Compared to 2000, in 2010, the proportion down to 64% and 7.5%, while the proportion of building land increased to 16%; By

2020, the proportion was 62.8%, 17%, and 7.5%, respectively. Overall, over time, the proportion of building land continuously increasing, proportion of arable land and forest continuously decreasing. This indirectly reflects the overall weakening of the ecosystem period and the strengthening socio-economic carrier.

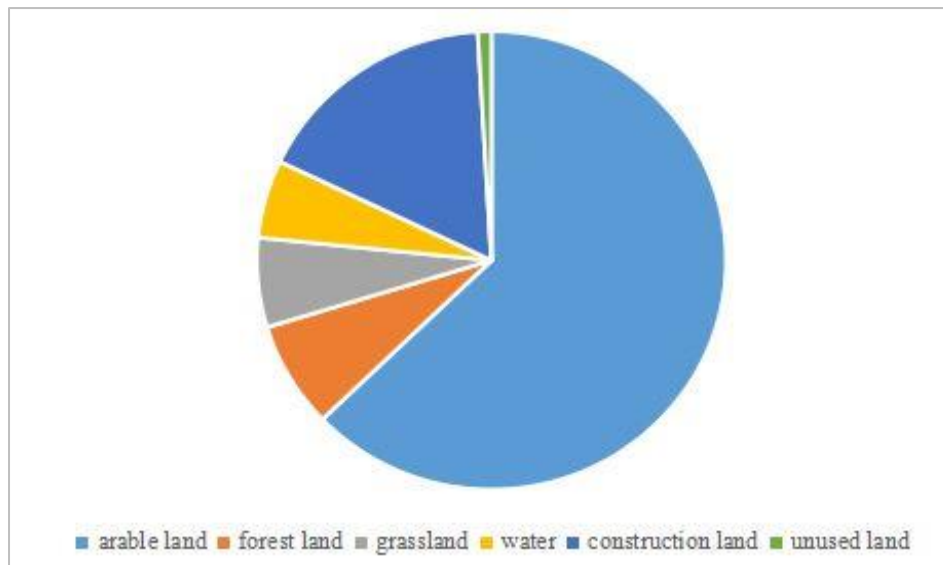
Compared to others, exhibit certain changing characteristics. Among them, over time, the proportion of grassland area continues to decrease, unused overall increases.



a 2000



b 2010



c 2020

Figure 4: Structure and composition changes of mountains, rivers, forests, fields, lakes, and grass cities in the Tai'an section of the Yellow River Basin

Table 2: Transfer Matrix Between Mountains, Rivers, Forests, Fields, Lakes, Grasslands, and Cities in The Tai'an Section Of The Yellow River Basin			
2000-2020year	Conversion area(Km ²)	2000-2020year	Conversion area(Km ²)
11-11	4076.62	41-11	21.12
11-21	12.12	41-21	1.28
11-31	20.80	41-31	1.38
11-41	87.58	41-41	283.35
11-51	484.47	41-51	5.10
11-61	21.75	41-61	27.33
21-11	41.83	51-11	150.78
21-21	499.92	51-21	1.51
21-31	11.26	51-31	2.13
21-41	8.03	51-41	3.84
21-51	11.44	51-51	667.22
21-61	1.51	51-61	0.49
31-11	114.27	61-11	8.91
31-21	10.51	61-21	0.17
31-31	406.62	61-31	0.44
31-41	3.65	61-41	0.30
31-51	22.85	61-51	1.24
31-61	3.11	61-61	11.54

Note: In the figure, 11 represents arable land, 21 represents forest land, 31 represents grassland, 41 represents water body, 51 represents construction land, and 61 represents unused land

6. CHARACTERISTICS OF TRANSFORMATION AND VARIATION OF MOUNTAINS, RIVERS, FORESTS, FIELDS, LAKES, AND GRASS CITIES IN THE TAI'AN SECTION OF THE YELLOW RIVER BASIN

This paper constructs measure transformation change characteristics in the study area (Table 2). It was found that between 2000 and 2020, there were significant changes in the transformation in the Tai'an section.

Change in the spatial classification of cultivated land in the Tai'an. The transferred out area of cultivated land in the study area was 626.7 Km², while the transferred in area was 336.9 Km²; Further statistics show that transferred to construction land (77.3%), the middle part of Mount Taishan and Xintai, north Feicheng. Grassland (33.9%) and construction land (44.8%) are the main sources of new cultivated land and are in Daiyue District and Xintai City, and along Dongping Lake.

By comparison, the study period, the main source of transferred forest land was farmland, while the secondary source of transferred forest land was grassland and construction land, while the main source of transferred forest land was farmland and grassland.

During the research period, there was a significant change area of the Tai'an section. Between 2000 and 2020, 56.2 Km² of the water body, while the area converted from other land types to water bodies reached 103.4 Km²; Statistics show that the main destinations of the transferred water bodies are unused land (27.3 Km²) and cultivated land (21.1 Km²), while the newly added water bodies are mainly composed of cultivated land (87.6 Km²); Further integration revealed that the main changes were concentrated along the Dongping Lake in the western Dongping County, with new water bodies in part of Dongping Lake and reduced in the eastern area of Dongping Lake.

According to the integration, among them, the transferred construction land area reached 525.1 Km² and the transferred was 158.8 Km². The integration shows that the conversion of research area is closely related to space, with in the transferred and transferred construction land area being 92.3% and 95%, respectively.

Compared to other land types, the conversion scale of grassland and unused land is relatively small but with significant changes. Shifts to farmland and construction land, while newly added grassland is mainly composed of forest land and farmland; The newly added unused land was mainly composed of arable land and water bodies, while construction land was the main source of transfer of unused land.

7. RESEARCH CONCLUSION AND PROSPECTS

- (1) In the study area, forest land is in Daiyue District in Mount Taishan District and around Mount Taishan and Culai Mountains in the southeast of Daiyue District, while the water body presents a spatial distribution trend of "one side (Dongping Lake) and one line (Dawen River) and multiple points (Tianping Lake, Tianyi Lake, etc.)".
- (2) With time going on, the spatial distribution and composition in the Tai'an section have undergone significant changes. The spatial distribution structure and composition in the study area have undergone significant changes, in the past 20 years, the arable land, forest land, and grassland areas decreased, while the proportion of building land, and unused were increased.
- (3) As time goes on, cultivated land and construction land was the background of land use conversion in this area, this means the study area were in good development level.

Expanding entire Shandong section of the Yellow River Basin, strengthening the analysis and in-depth analysis of representative regions and land types, measuring the evolution mechanism of the spatial evolution in multiple ways, and constructing specific paths to promote the optimal layout of water core of future research in this article.

ACKNOWLEDGMENT

This work was supported by grant from Shandong Province Social Science Popularization and Application Research Project (2022-SKZC-18) and Scientific Research Fund for Young Teachers of Taishan University in 2022.

REFERENCES

- Alisa A., Wade, David M., Theobald, Melinda J., Laituri. 2011. A multi-scale assessment of local and contextual threats to existing and potential U.S. protected areas. *Landscape and Urban Planning*, 2(27): 215-226.
- Cao J.J., Zhou Y., and Ye Q.Q. 2013. Analysis of Spatial Pattern Changes of Cultivated Land Resource in Jiangnan Plain. *Economic geography*, 33(11):130-135.
- Han H.R., Yang C F., and Song J.P. 2015. The Spatial-Temporal Characteristic of Land Use Change in Beijing and Its Driving Mechanism. *Economic geography*, 35(5):148-154.
- Kong L.J. 2013. Joint Law Enforcement in the Mekong River Basin between China, Laos, Myanmar and Thailand: Legal Foundation and Mechanism Consolidation. *Southeast Asian studies*, (2):68-73.
- Liao C.H., Feng Z.M., Li P., et al. 2015. Monitoring the spatio-temporal dynamics of swidden agriculture and fallow vegetation recovery using Landsat imagery in northern Laos. *Acta Geographica Sinica*, 70 (4):591-603.
- Liu J.Y., Ning J., Kuang W.H., et al. 2018. Spatio-temporal patterns and characteristics of land-use change in China during 2010-2015. *Acta Geographica Sinica*, 73(5): 789-802.
- Paukert C.P., Pitts K.L., Whittier J.B., et al 2011. Development and assessment of a landscape-scale ecological threat index for the Lower Colorado River Basin. *Ecological Indicators*, 11: 304-310.
- Quang B.L., Soo J.P., Paul L.G., et al. 2008. Cremers. land-use dynamic simulator (LUDAS): A multi-agent system model for simulating spatio-temporal dynamics of coupled human landscape system. I. Structure and theoretical specification. *Ecological Informatics*, 3(2):135-153.
- Zhang L., Li J., Wu Y.D. 2018. Peasant Households' Livelihood and Differential Characteristics of Land Use in Multi-Ethnic Symbiosis Area: A Case Study of Zhengjiashuang Village in Eryuan County of Yunnan. *Economic geography*, 38(9):183-190.
- Zhong Y.C., Feng J., and He X.R. 2016. The Different Impacts of Rail Transit on Urban Land Use between Different Sections: A Case Study of the No.2 Rail Transit Line in Wuhan. *Areal Research and Development*, 35 (5):86-93.
- Zhou S.G., Shao Q.Q., and Cao W. 2016. Characteristics of land use and land cover change in the Loess Plateau over the past 20 years. *Journal of Geo-information Science*, 18(2):190-199

