

Study on land use and land cover change in Tianfu new area based on RS&GIS

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Abstract. Land use has taken on more significance as a result of population increase and urbanization, particularly in emerging nations. The management of natural resources like water, vegetation, and arable land is made easier by the direct observation of land use changes in particular locations at different periods through the use of land categorization photographs. This investigation of land use changes and their features in Tianfu New Area, Chengdu, is based on land satellite imagery from 2011 and 2021. Process the data, extract the land use Stochastic matrix, and do a thorough analysis using remote sensing and GIS tools. The findings show that there are five different forms of land usage in Tianfu District between 2011 and 2021: arable land, construction land, unused land, forest land, and water area, with arable land continually making up the greatest share of the overall area. The conversion of arable and forest land, along with relatively minor changes in the water area, has resulted in the highest rise in the area used for building among all other forms of land use. Additionally, there are large geographical disparities in land use changes, with the north and south of Tianfu New Area experiencing fewer major changes than the south.

Keywords: land use, landcover, change detection, remote sensing, Chengdu.

1. Introduction

One of the topics that are raising more and more concern in the context of the present global transition is the change in land use and land cover and its effects on the environment. Although they are quite distinct, land use and land cover are frequently confused. Land usage is frequently impacted by human, socioeconomic, and political influences on the land, and land cover may be regarded as the physical and chemical features of the land surface [8]. Policies are frequently the driving forces behind land use change, and given the continuing urbanization and population expansion in emerging nations, the loss of forest, agriculture, and water areas appears unavoidable [4, 5]. The search for appropriate development strategies has long been a concern for researchers.

Land use and land cover change detection is to determine changes within one period and compare them with another period to reflect the percentage increase or decrease of specific features. By calculating the annual change in forest cover area, afforestation or deforestation can be easily determined, and change detection techniques can also be used to detect changes in the shape of water bodies. Geospatial technologies such as remote sensing and geographic information systems can help determine the subtle changes in an area over a period of time, completing many applications such as

drought research [1]. Remote sensing images are widely used in land use and land cover mapping in GIS environments, which can obtain spatiotemporal scale information of different surface features and are recognized as powerful tools [2, 3]. Since 1970, scientists have been using various remote sensing technologies to obtain satellite data to determine changes in land use/land cover. Recent research has focused on evaluating the potential of satellite data for classification, monitoring, analysis, and quantification of land use change.

The southernmost part of Chengdu City is home to Tianfu New Area, which was a major industry hub before 2013. Since then, the area has progressively transformed into a commercial and high-tech hub [6]. This paper uses remote sensing, GIS-related software, a land use stochastic matrix, and other methods to conduct a thorough analysis of the 2011 and 2021 Landsat Satellite imagery data in order to understand the current situation and existing problems of land use in Tianfu New Area, as well as study the changes and characteristics of land use in the past 10 years. It is practical to offer references for upcoming ecological environment conservation and sustainable land resource development.

2. Study area

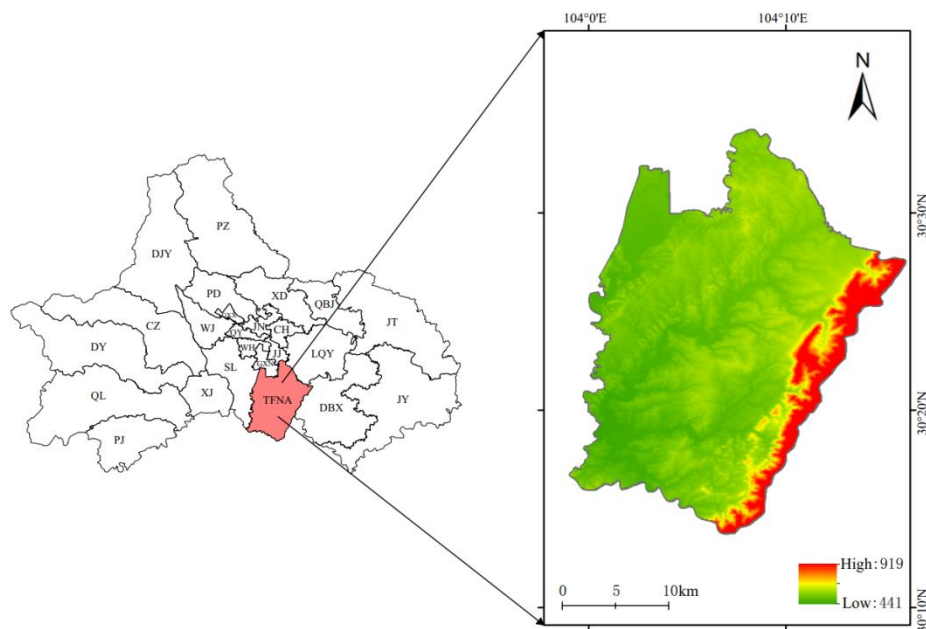


Figure 1. Study area.

The Tianfu New Area is located in Chengdu, Sichuan Province, China. It was founded in November 2013 and is governed over 4 development zones and 5 streets. There are about 700000 people living in this 157.6 square kilometer region [7] positioned between 103.89° E and 104.30° E and 30.45° N and 30.75° N, respectively. Land use has seen significant modifications since it was founded. To accommodate the demands of the urbanization process and people's living environments, agricultural land has been reduced, ecological environment protection land has grown, and transportation facilities land has increased. To fulfill the objectives of efficient and sustainable urban growth, urban planning and land use management must continually be strengthened.

3. Materials and methods

The data used in this study is the Satellite imagery data including the study area obtained through the open data of the geospatial data cloud platform. The selected time nodes are May 2011 and May 2021, respectively. The former is TM image data, and the latter is OLI image data. The cloud content of both is within 5%.

The researchers cropped the entire remote sensing image in Arc-GIS10.7 software and performed preprocessing steps such as radiometric calibration and atmospheric correction. For the convenience of interpretation, researchers used false color synthesis to synthesize the image bands of 2011 and 2021. Before interpreting, the tool in ENVI software synthesizes the bands of two years into a band group and then uses the maximum likelihood method in the classification function of ENVI software to classify the band group into five categories: construction land, cultivated land, forest land, water area, and unused land. After completing the classification, perform sample separability verification on the classification results, and then perform post-classification processing such as category merging and spot removal. Finally, convert the results into SHP vector format to prepare for subsequent processing. In Arc-GIS10.7 software, the two layers converted into vectors are fused and superimposed respectively, and then the Stochastic matrix of land use type at different times is calculated and the dynamic map of land use type is made with Excel PivotTable.

4. Results and discussion

4.1. Land use structure statistics

The statistics of land use types and structures in Tianfu New Area from 2011 to 2021 are shown in Table 1. Table 1 shows that in the data statistics of 2011 and 2021, the cultivated land area was the largest, accounting for 64.95% and 56.14% of the total area of the study area, respectively. Next was construction land, which was the third largest area in 2011 and the second largest area from 11.96% to 2021, accounting for 27.40% of the total area. The forest area was the second largest from 2011, From 22.15% to 2021, it will be the third largest in terms of area. The percentage of water area, which makes up 14.07% of the total area, is comparatively stable, at 0.89% and 0.93%, respectively. Last but not least, there is barren ground, which will have an area percentage of 0.05% in 2011 and 1.45% in 2021, respectively. The chart shows that Tianfu New Area has a lot of land resources, which may offer solid assurances for the city's future growth. It can be inferred by utilizing the dynamic degree to indicate the yearly change rate of the various land use categories in Tianfu New District that: It can be said that the build-up has the largest change, with an average annual growth rate of 9.7%; the forest area takes the second place, decreasing by 4.9% annually; the cultivated land area decreasing by 1.6% annually; and the water area has the smallest rate of change over the period 2011–2021, with an annual change rate of bare land area increasing at an annual rate of 83.2%. Comparatively speaking to other sorts of development during the last ten years, the change in the water area has been quite little. The order of these categories' yearly change rates may thus be deduced to be: uncultivated land, forest, cultivated land, water area, and building land. The first three kinds have rather high yearly change rates. However, woods and plantation land become increasingly significant because there isn't much barren land.

Table 1. Area and percentage of each land use category.

Land use category	2011		2021	
	Area, km ²	% of land	Area, km ²	% of land
Plantation	364.46	64.95	315.03	56.14
Build-up	67.09	11.96	153.76	27.40
Forest	124.28	22.15	78.95	14.07
Waterbody	5.00	0.89	5.24	0.93
Barren land	0.30	0.05	8.15	1.45

4.2. Land use transfer matrix

The land use of Tianfu New Area has undergone significant changes between 2011 and 2021, mainly due to changes in the construction land area in the north-south direction. In Tianfu District, the area of construction land, water bodies, and unused land has increased, and correspondingly, the types of land use have also changed. From Table 1 and the annual rate of change, we can see that among all types of land in Tianfu New Area, the area of construction land has the largest change, with a total area of 153.76 km², with an average annual increase of 9.63 km². It can be seen from Table 2 that the area from cultivated land is 92.60 km², and a small part from forest land. The second is cultivated land, whose area has decreased by 49.43 km², including 40.62 km² for forest and 15.91 km² for construction. The forest land area decreased by 45.43 km², of which 6.75 km² became farmland. The area of unused land increased by 7.85 km², mainly from 4.82 km² of cultivated land. Compared with other types, the change in water area is the smallest, with an increase of only 0.24 km².

Table 2. Matrix of the change of land use types in the Tianfu New District.

2021 2011	Plantation	Build-up	Forest	Waterbody	Barren land	Total
Plantation	257.85	15.91	40.61	0.62	0.04	315.03
Build-up	92.60	49.12	9.85	2.13	0.05	153.76
Forest	6.75	1.17	70.75	0.15	0.14	78.95
Waterbody	2.43	0.59	0.13	2.09	0.00	5.24
Barren land	4.82	0.31	2.94	0.02	0.07	8.15
Total	364.46	67.09	124.28	5.00	0.30	561.13

2011-2021 is the period of rapid construction of Tianfu New Area. The construction land has increased significantly, and the corresponding cultivated land and forest will inevitably decrease, which is also related to the policy guidance of Tianfu New Area. From the current land use mode, there is still a lot of development space for Tianfu New.

4.3. Land use dynamic change

The dynamic change of land use is an indicator for evaluating the trend of land type and area change in a research area, mainly reflected in quantitative changes. In order to identify the problems in the research area and find better solutions, it is necessary to analyze the current land use situation based on local characteristics, providing a reference basis for future land resource management. With the help of the Spatial analysis and image superposition function in Arcgis10.7 software, this paper has produced the dynamic change map of land use in Tianfu New Area from 2011-2021 (Figure 2).

According to Figure 2, from 2011-2021, the land use change of Tianfu New Area in the north is larger than that in the south. The urban area mainly expands from south to north, mainly concentrated in the northwest and also in the northeast. The industrial focus is on manufacturing, and due to policy influence, the transformation of forests and arable land into construction land is inevitable; Sporadic forest degradation on the east side, but the forest land in the mountain protection area on the east side is well preserved; There is still a large area of arable land on the south side, which is also related to the positioning of the south as an agricultural high-tech development zone; In addition, the distribution of water bodies is mostly concentrated in forests and artificial lakes within built-up areas.

Overall, there are significant spatial and regional differences in land use changes in Tianfu New Area, which are closely related to its high terrain in the east and low terrain in the west, as well as the development of various industries.

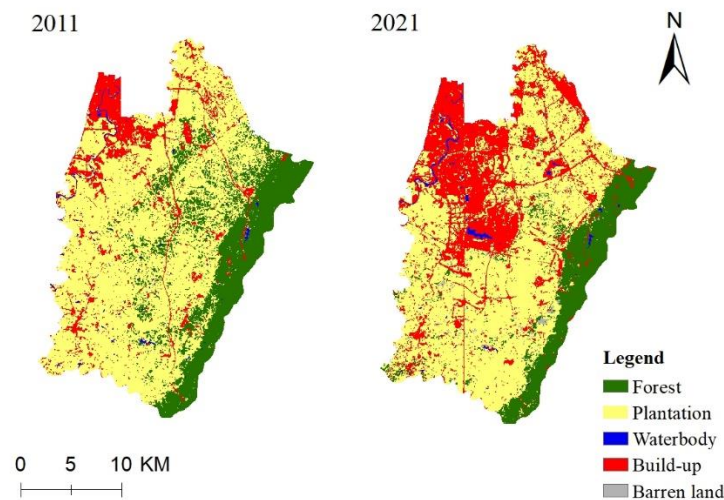


Figure 1. Landuse map of Tianfu new area in 2011 and 2021.

5. Conclusion

This article focuses on the features of recent land use changes in Chengdu Tianfu New Area and the present situation there. The data of two land satellite pictures in 2011 and 2021 were thoroughly evaluated using remote sensing, GIS-related software, land use Random matrix and other approaches. The distribution of land use categories in Tianfu New Area may be shown to be unbalanced on the generated land use map. This research takes five different types of land use into account: structures, water features, forests, farmed land, and unused land. It is clear from the matrix and land use map that since Tianfu New Area was established in 2013, both the population and the built-up areas have grown. The increasing demand for land for residential reasons, as well as the growth in population and development activities, which render the land unfit for agriculture, maybe the primary causes of the decline in forests and arable land. While restoring farmland and building new cities, consideration should also be given to the management of barren land and environmental preservation.

However, this article only uses two years' worth of remote-sensing photos for comparison. More photos can be thoroughly studied in the future to track changes in land use features and organize rational human activities. In addition, since the land use change in Tianfu New Area is the result of various factors, more research on these factors needs to be done to develop resource management techniques that are more effective in achieving the sustainable use and development of the area's land resources.

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