



Analysis of Spatial and Temporal Changes of Impervious Surface in Guilin Based on CLCD

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Abstract. With the increasing emphasis on ecological environment, the study of impervious surface has become one of the hot topics studied by many scholars. This paper takes Guilin as an example, adopts China Land Cover Dataset (CLCD), takes the four years of 1991, 2001, 2011 and 2021 as the research time points, extracts the percentage of impervious surface to be analyzed, and combined with the data of Guilin Economic and Social Statistical Yearbook of 2011 to 2021 to carry out the correlation analysis research of the percentage of impervious surface. The study shows that: during 1991-2021, the total impervious surface percentage of Guilin increased from 0.485% to 1.357%, of which the period with the largest relative growth rate is 1991-2001, the largest absolute increase is 2011-2021; the impervious surface percentage of Guilin's urban districts is far more than that of the counties, and Qixing District currently has the largest impervious surface percentage, and Yanshan District is at the bottom of the list of urban districts, and Lingui District is at the top of the list in the city in terms of both absolute and relative growth rates; There is a significant positive correlation between the percentage of impervious surface in Guilin and the districts and counties with the GDP of secondary and tertiary industries, and the correlation with the non-agricultural/urban population is not significant overall.

Keywords: Impervious surface; Guilin; secondary and tertiary GDP; correlation

1 Introduction

Impervious surfaces are common artificial landscapes such as roads, squares, and buildings that do not allow water to infiltrate into the ground [1-2]. It is important to study the spatial and temporal evolution of impervious surfaces because impervious surfaces are also important indicators of ecological quality and urbanization processes [3-4], and increases in impervious surfaces can disrupt surface runoff and groundwater activity and cause the destruction of urban biodiversity [5]. The relationship between impervious surfaces and urban thermal environmental effects has also been conducted [6-8]. However, due to the influence of data downloading and processing, the analysis of impervious surfaces based on long time series is still rare, and there are also few related studies for Guilin. In this paper, we use the annual China Land Cover

Dataset (CLCD) (<https://doi.org/10.5281/zenodo.5816591>) published by the team of Profs. Yang Jie and Huang Xin of Wuhan University for the years 1990-2021. This data is based on all available Landsat data on Google Earth Engine, constructing spatio-temporal features, combining with Random Forest classifier to obtain the classification results, and proposing a post-processing method including spatio-temporal filtering and logical inference to further improve the spatio-temporal consistency of CLCD. Finally, based on 5463 visual decoding samples, the overall accuracy of CLCD reaches 80% [9]. The spatio-temporal evolution analysis of long time series of impervious surfaces in Guilin by these data aims to reveal the change process of impervious surfaces and related factors in Guilin over the past 30 years, and to provide certain references for the next step of urban development and ecological protection in Guilin.

2 Overview of the Study Area

Guilin is located in the southwestern part of the Nanling Mountain System, at the southern end of the Xiang-Gui Corridor, in the northeastern part of Guangxi Zhuang Autonomous Region, with a longitude of 109°36'50"-111°29'30" east and a latitude of 24°15'23"-26°23'30" north, and a length of 236 kilometers from north to south and a width of 189 kilometers from east to west. It borders Hunan Province in the north and northeast, Hezhou of Guangxi Zhuang Autonomous Region in the southeast[10].

3 Data Analysis

3.1 Analysis of Impervious Surface Change in Guilin, District and County

In this paper, by extracting the impervious surface data of Guilin as a whole (Table 1) and the districts and counties of Guilin (Table 2) in the CLCD for the years 1991, 2001, 2011, and 2021, the changes of impervious surface in Guilin were analyzed and studied in time and space, respectively, and the following results were obtained. For the sake of simplicity, IS will be used to represent impervious surface in the following.

Table 1. Total Impervious Surface Percentage and Changes in Guilin, 1991-2021 Unified

Particular year	Percentage of IS in Guilin (%)	Absolute growth (%)	Relative growth rate
1991	0.485		
2001	0.735	0.250	51.50%
2011	1.010	0.275	37.41%
2021	1.357	0.347	34.36%

(1) The total impervious surface percentage in Guilin will increase from 0.485% to 1.357% between 1991 and 2021, which is an increase of nearly 1.8 times. Among them, the period with the largest relative growth rate is 1991-2001, which is about

51.50%, and the largest absolute increase is 2011-2021, with a percentage increase of about 0.347% (Table 1).

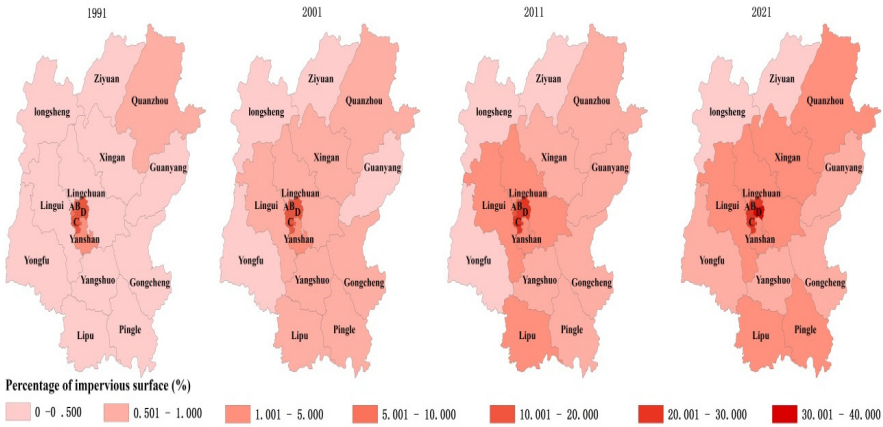


Fig. 1. Trends in Percentage of Impervious Surface by District and County in the Guilin, 1991-2021(Where A is Xiufeng, B is Diecai, C is Xiangshan, and D is Qixing)

Table 2. Percentage of Impervious Surface and Change Statistics of Guilin Districts and Counties, 1991-2021

Guilin counties and districts	1991	2001	2011	2021	1991-2021	1991-2021
	Percentage of IS (%)	Percentage of IS (%)	Percentage of IS (%)	Percentage of IS (%)	Relative growth rate (%)	Absolute increase (Km ²)
Diecai	11.637	16.276	21.156	28.114	141.60	8.550
Gongcheng	0.364	0.569	0.716	0.970	166.74	12.918
Guangyang	0.340	0.471	0.622	0.863	153.63	9.653
Qixing	10.072	18.655	26.976	33.260	230.23	16.546
Linghuan	0.493	0.884	1.333	1.787	262.32	29.702
Lingui	0.496	0.852	1.360	2.269	357.53	39.948
Lipu	0.498	0.797	1.053	1.297	160.38	14.073
Longsheng	0.050	0.080	0.115	0.174	245.72	2.994
Pingle	0.498	0.774	0.957	1.293	159.74	14.954
Quanzhou	0.573	0.727	0.947	1.156	101.98	23.215
Xiangshan	13.157	17.200	20.927	25.005	90.05	10.895
Xingan	0.442	0.675	0.938	1.165	163.81	16.857
Xiufeng	9.155	12.810	18.457	24.650	169.26	6.684
Yangshuo	0.356	0.535	0.713	0.988	177.23	9.030
Yanshan	1.082	1.896	2.816	4.086	277.68	9.082
Yongfu	0.217	0.325	0.463	0.643	196.03	11.914
Ziyuan	0.066	0.095	0.165	0.265	302.26	3.844

Note: District names are in red, the rest are county names.

(2) In 1991, among the districts and counties in Guilin, the top five in terms of percentage of impervious surface were Xiangshan District, Diecai District, Qixing Dis-

trict, Xiufeng District and Yanshan District, and the bottom five were Longsheng County, Ziyuan County, Yongfu County, Guanyang County and Yangshuo County; and by 2021, the top five counties in terms of percentage of impervious surface were Qixing District, Diecai District, Xiangshan District, Xiufeng District, and Yanshan District, and the bottom five were Longsheng County, Ziyuan County, Yongfu County, Guanyang County, and Gongcheng County (Table 2 and Figure 1).

(3) In terms of relative impervious area increase, Lingui District, Ziyuan County, Yanshan District, Lingchuan County and Longsheng County ranked in the top five, while Xiangshan District, Quanzhou County, Diecai District, Guanyang County and Pingle County ranked in the bottom five. In terms of absolute area increase, Lingui District, Lingchuan County, Quanzhou County, Xing'an County, and Qixing District ranked in the top five, while Longsheng County, Ziyuan County, Xiufeng District, Diecai District, and Yangshuo County ranked in the bottom five (Table 2 and Figure 1).

(4) The coefficient of variation of the percentage of impervious surface in each district and county decreased from 161.276% in 1991 to 155.759% in 2021 during the period 1991-2021 in Guilin. It indicates that the variability of the percentage of impervious surface among districts and counties is decreasing, but still at a high level (Table 2).

3.2 Correlation Analysis of Percentage of Impervious Surface

In order to analyze the relevant influencing factors of impervious surface changes, this paper combines data from the Guilin Economic and Social Statistical Yearbooks 2012 and 2022 (the statistics are for 2011 and 2021) [11-12], and conducts correlation analysis between impervious surface changes and urban/non-farm population, and the GDP of secondary and tertiary industries in Guilin and Guilin districts and counties.

Through Pearson correlation analysis, the correlation coefficient value between the total percentage of impervious surface and the GDP of secondary and tertiary industries in Guilin from 1991 to 2021 can be obtained as 0.974, and it shows significance at the 0.05 level; the correlation coefficient value between the percentage of impervious surface and the urban population of Guilin (in 10,000 people) is 0.948, and it fails to be verified at the 0.05 level of significance.

The correlation coefficient value between the percentage of impervious surface in Guilin districts and counties in 2011 and the GDP of secondary and tertiary industries in 2011 is 0.676, and it shows significance at the 0.01 level; the correlation coefficient value between the percentage of impervious surface in Guilin districts and counties in 2011 and the non-farm population in Guilin districts and counties in 2011 is 0.844, and it shows significance at the 0.01 level.

The correlation coefficient value between the percentage of impervious surface in Guilin districts and counties in 2021 and the GDP of secondary and tertiary industry in 2021 is 0.599, and it shows significance at the 0.05 level; and the correlation coefficient value between the percentage of impervious surface in Guilin districts and counties in 2021 and the urban population in Guilin districts and counties in 2021 is 0.386, and it has not been verified at the 0.05 significance level.

4 Conclusion

Combining the above analyses, this paper arrives at the following understanding:

(1)The total percentage of impervious surface in the municipal jurisdiction of Guilin is far more than that of the counties and districts in Guilin, in which the percentage of impervious surface in Yanshan District of Guilin ranks last among the municipal jurisdictions of Guilin, which is closely related to the development orientation of Yanshan District in building an urban area of science and education clusters, a sight-seeing and recreation area that combines modern agriculture and tourism services, and a modern new industrial agglomeration area [13].

(2)During the period 1991-2021, Lingui District of Guilin ranked first in both the relative growth rate of impervious surface and the absolute growth rate. In July 2014, Guilin Municipal Party Committee and municipal government officially moved to the office of the Venture Building in Lingui New District, and in 2015, Lingui withdrew from the county and established a district [14], relying on its population and location advantages, the growth rate of socio-economic development has been accelerated.

(3)Through Pearson correlation analysis, it can be seen that there is a significant positive correlation between the percentage of impervious surface in Guilin and each county and district and the GDP of secondary and tertiary industries, and the correlation with non-agricultural/urban population as a whole is not significant.

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