Spatiotemporal Evolution of Urban Greening Level in China from 2000 to 2017 and Its Influencing Factors: Postprint

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Abstract

Urban greening constitutes a crucial component of urban construction and an essential pathway toward achieving urban ecological civilization and ecological livability. This study examines 292 prefecture-level and above cities in China, characterizing the spatiotemporal evolution and influencing factors of urban greening levels from 2000 to 2017 through methods including coefficient of variation, Theil index, spatial autocorrelation, and geographical detector. The results indicate: (1) During 2000-2017, China' s urban greening level demonstrated a phased fluctuating growth pattern, with a national increase of 6.73%. The western region exhibited the most significant improvement in greening level, transforming the "east-central-west"gradually decreasing greening pattern maintained from 2000-2014 into a greening pattern characterized by a leap from coastal areas to inland regions. (2) Both the overall disparity in China' s urban greening levels and the disparities among the eastern, central, and western regions exhibited a declining trend during 2000-2017. Analysis of Theil index trends reveals that the overall disparity was primarily attributable to intra-regional differences, with both intra-regional and inter-regional differences gradually diminishing. (3) The eastern region formed stable hotspot areas of considerable scale, while the western region developed localized hotspots alongside stable coldspot areas of certain scale, thereby accentuating the transition from the "east-central-west" decreasing pattern to a coastal-to-inland leaping pattern. (4) Natural factors constitute fundamental influences on urban greening levels, whereas economic development level and government management function as phased critical factors that drive the evolution of urban greening patterns across different periods.

Full Text

3.1.2 Urban Greening Level and Regional Differences

The coefficient of variation and Thiel index were employed to analyze the urban greening level and its regional disparities in China. The results indicate that from 2000 to 2017, the overall inequality in urban greening levels across the country exhibited a declining trend. The coefficient of variation decreased from 0.354 to 0.256, representing a reduction of 30.67%. The Thiel index declined from 0.132 to 0.071, with inter-regional inequality showing an expanding trend while intra-regional inequality tended to narrow. Intra-regional inequality served as the primary contributor to overall inequality.

The spatial distribution of urban greening levels underwent significant changes between 2000 and 2017. High-level greening cities were predominantly concentrated in the eastern coastal areas, specifically the Yangtze River Delta, Beijing-Tianjin-Hebei region, and Pearl River Delta. In contrast, low-level greening cities were clustered in Yunnan, Guizhou, and Gansu provinces. Generally, high-level greening areas were located along the eastern coast, while low-level greening areas corresponded primarily to plateau and mountainous regions.

[Figure 3: see original paper]

Moran' s I values for the urban greening index were 0.23, 0.24, and 0.23 for the years 2000, 2010, and 2017, respectively, all greater than zero with significance levels below 0.01 and confidence levels above 99%. This demonstrates that China' s urban greening level exhibited significant positive spatial autocorrelation characteristics. The Moran' s I values remained relatively stable throughout the study period, indicating that the spatial clustering pattern of urban greening levels tended toward stabilization. Hotspot areas formed large-scale, stable agglomerations in the eastern regions, while coldspot areas formed large-scale, stable clusters in the western regions.

[Figure 5: see original paper]

3.3 Analysis of Influencing Factors

3.3.1 Variable Selection

Based on existing research findings, the influencing factors of urban greening levels can be categorized into three groups: natural environmental factors, economic development factors, and government management factors. Natural environmental factors include precipitation (X) and temperature (X). Economic development factors include GDP (X), per capita GDP (X), and the proportion of secondary industry (X). Government management factors include the urbanization rate (X).

The geographical detector method requires that independent variables be categorical data. Therefore, continuous variables were discretized using the natural

breaks classification method. Precipitation and temperature data were obtained from the DEM dataset, with precipitation showing a correlation coefficient of 0.22 with urban greening levels in 2000, and per capita GDP showing a correlation coefficient of 0.15.

3.3.2 Geographical Detector Analysis

The Geographical Detector method was employed to analyze the influencing factors of urban greening levels (Y) and their spatiotemporal differentiation. This statistical method detects spatial heterogeneity and identifies driving factors by comparing the consistency between independent variables (X) and dependent variables (Y).

[Figure 6: see original paper]

The analysis revealed that from 2000 to 2017, natural factors such as precipitation constituted the foundational influence on urban greening levels. Economic development and government management emerged as key driving factors at different stages. In 2000, precipitation, GDP, and the proportion of secondary industry explained 39.23%, 32.50%, and 14.75% of the variation in urban greening levels, respectively. By 2010, the explanatory power of precipitation, GDP, and per capita GDP was 38.60%, 18.67%, and 16.99%, respectively. In 2017, precipitation, GDP, and the proportion of secondary industry accounted for 33.96%, 23.96%, and 10.28% of the variation, respectively.

Overall, precipitation demonstrated the strongest explanatory power for urban greening levels throughout the study period, with its influence showing a gradual decline. Economic factors, particularly GDP and industrial structure, played significant but varying roles across different time periods. The combined effects of these factors drove the spatial evolution of urban greening levels in China.

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Spatiotemporal Evolution of Urban Greening in China and the Affecting Factors Between 2000 and 2017

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Abstract: Urban greening has emerged as a major priority of urban development and represents a significant step toward realizing sustainable urban civilization with ecological livability. This research aimed to examine the current level of urban greening in China and provide scientific support for designing and constructing high-quality urban green spaces. We analyzed the spatiotemporal differentiation of urban greening and its influencing factors using coefficients of variation, Thiel indices, EDSA, and geographical detectors. Our findings revealed that China' s urban greening index grew with fluctuations and exhibited stage-change characteristics, with its growth rate increasing to 6.73% during the 2000-2017 study period. While eastern China consistently led in urban greening, the urban greening index of western China increased significantly, surpassing that of central China. China' s overall inequality and regional disparity in urban greening declined during the study period. The coefficient of variation decreased from 0.354 to 0.256, reflecting a reduction in the overall urban greening gap. The Thiel index decreased from 0.132 to 0.071, with inter-regional inequality tending to expand and intra-regional inequality tending to narrow. These findings reinforce that both inter- and intra-regional inequalities were shrinking, with intra-regional inequality serving as the main contributor to overall inequality. The spatial distribution of urban greening changed dramatically between 2000 and 2017. High-level greening cities were mainly distributed in the eastern coastal areas of the Yangtze River Delta, Beijing-Tianjin-Hebei,

and the Pearl River Delta, while low-level greening cities were clustered in Yunnan, Guizhou, and Gansu. Generally, high-level greening cities were located along the eastern coast, while low-level greening areas corresponded to plateau and mountainous regions. Moran' s I values were greater than zero with small variability, illustrating that the urban greening level had positive correlation agglomeration characteristics in its spatial distribution. The spatial relationship of urban greening followed a trend of stabilization. Regions with large-scale and stable hotspots formed in the east, while a large-scale and stable coldspot formed in the west. These changes showed that the greening level increased from coastal to inland more significantly than it gradually decreased from east to west in China. Finally, natural factors such as precipitation were found to be foundational influences on urban greening level. Economic development and government management were key metrics at different stages, each serving as a driving factor that promoted the spatial evolution of urban greening in its respective period.

Keywords: urban greening level; spatiotemporal evolution; influence factor; China

Note: Figure translations are in progress. See original paper for figures.