

Mapping the Vanishing and Transformation of Urban Villages in China: A Tale of Three Cities

Wenyu Zhang^{a,b}, Yiqiu Liu^a, Rui Cao^{a*}

^a Thrust of Urban Governance and Design, The Hong Kong University of Science and Technology (Guangzhou), Guangzhou, China, wenyu.zhang@u.nus.edu, yliu886@connect.hkust-gz.edu.cn, ruicao@hkust-gz.edu.cn

^b Department of Geography, National University of Singapore, Singapore, Singapore

* Corresponding author

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Abstract:

Urban villages in China are a byproduct of rapid urbanization and represent a unique form of informal settlements that play an irreplaceable role in urban development. However, due to inefficient management and planning, these areas face significant challenges related to sanitation, fire safety, and social security, making them a focal and complex issue in urban governance (Liu et al., 2010). As urban renewal initiatives accelerate across the country, the transformation of urban villages has become a critical research topic, which plays a significant role in contributing to the United Nations' sustainable development goals for cities (Tu et al., 2024). Monitoring these changes and understanding the patterns and rules governing land-use dynamics are essential for grasping the broader implications of urbanization (Cao et al., 2025). Despite its importance, existing research often remains limited to case studies, lacking systematic and comparative analyses across different regions (Chen et al., 2022). With advancements in geospatial technologies and artificial intelligence, we can access multiple sources of geospatial data to map the dynamic changes of urban villages on a large scale, supporting sustainable urban development (Cao et al., 2023). To this end, this study explored the renewal patterns and spatiotemporal evolution of land use in urban villages across three representative cities in China.

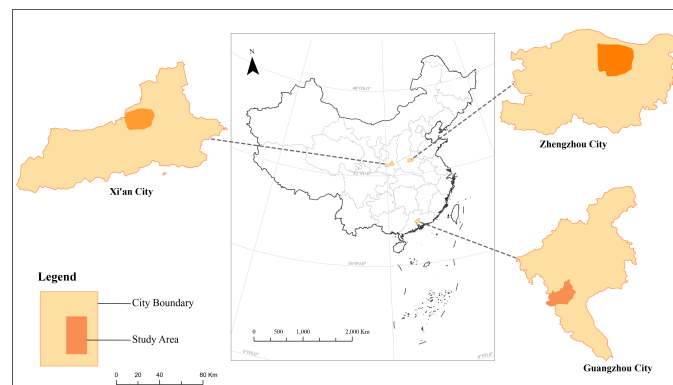


Figure 1. Study areas.

Three mega-cities in China were selected to reflect regional diversity: Guangzhou in the south, Zhengzhou in the center, and Xi'an in the west, as shown in Figure 1. Using Google Earth's very-high-resolution remote sensing imagery and aligning the analysis with urban village renewal policies specific to each city, time points were chosen for comparative evaluation. Guangzhou and Xi'an focused on the years 2015, 2019, and 2023, while Zhengzhou analyzed the years 2009, 2016, and 2022. A deep learning-based framework was proposed to identify the spatiotemporal changes of urban villages across regions and time periods. Specifically, a deep learning-based image segmentation method was first applied to accurately delineate urban village boundaries across these periods. This was then combined with multi-source geospatial data to categorize the vanishing and transformed urban village areas into six distinct types: partially demolished, vacant land, construction site, completed buildings, green space, and other land-use types, reflecting the stage and type of urban renewal process. Based on the identification results, both quantitative and qualitative analyses were conducted, enabling the identification of land-use changes and facilitating cross-city comparisons to highlight regional similarities and differences.

The findings revealed a significant reduction in the number and area of urban villages over time, with notable variations in the rate and patterns of reduction among cities. As shown in Figure 2, the current land use of urban villages that were

demolished within the study period in the research area was mapped. By 2022, urban villages in Zhengzhou had almost disappeared, although large areas of vacant land remained following demolition. Xi'an experienced more rapid changes in urban village numbers and areas, whereas Guangzhou's urban core showed the smallest demolition footprint over the past eight years. These outcomes reflect the different levels of economic development and urban renewal strategies of the respective cities. Additionally, each city exhibited unique spatial distributions and temporal evolution patterns in the renewal process. Cross-city comparisons underscored significant regional differences. Zhengzhou relied heavily on policy-driven interventions, while Guangzhou and Xi'an adopted a more gradual, policy-guided approach that prioritized incremental development.

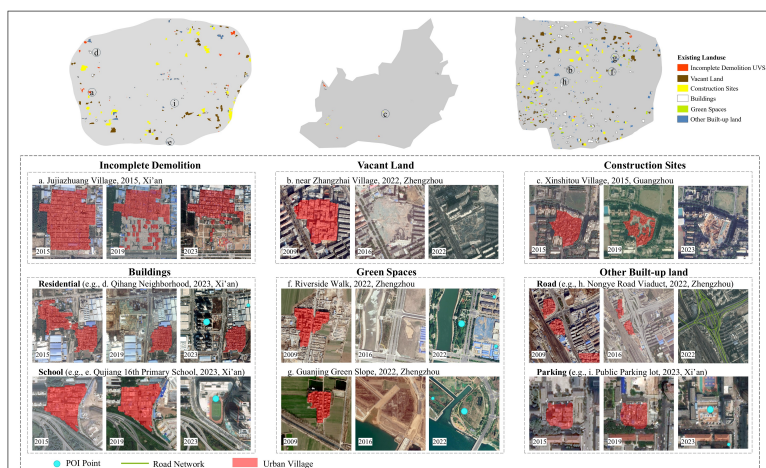


Figure 2. Identification results of the vanishing and transformation of urban villages.

Through a dynamic and cross-regional perspective, the results provided valuable insights into the transformation patterns and land-use changes of urban villages in China. Strengthening post-demolition land redevelopment and enhancing service facility construction in rapidly updating cities can help reduce land vacancy. In contrast, slower renewal cities like Guangzhou and Xi'an require tailored policies to promote balanced regional development. Urban planners should also seize opportunities for post-demolition land reuse to address urban climate challenges, ensuring that these transformations contribute to broader environmental and social objectives.

By integrating very-high-resolution remote sensing imagery with deep learning methodologies, this study effectively captured and analyzed the renewal processes of urban villages across different regions of China. The findings highlight significant differences among urban villages in Guangzhou, Zhengzhou, and Xi'an. Through the integration of multi-source geospatial data, cross-regional dynamic comparisons provided valuable insights into typical renewal patterns, offering a robust scientific foundation for the development of region-specific urban renewal strategies. Future research can consider incorporating higher spatial and temporal resolution data to investigate the socioeconomic and environmental impacts of urban village transformations, providing stronger theoretical and practical support for achieving more efficient and equitable urban renewal outcomes. This can greatly promote sustainable urban development and contribute invaluable knowledge to global informal settlement redevelopment from a Chinese perspective.

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