Postprint: Conceptual Evolution and Reconstruction of Classification Systems for Urban Fringe Areas

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Abstract

Urban fringe areas represent the most dynamically changing regions within the urbanization process. Scientific understanding of their systematic framework constitutes a crucial component for promoting sustainable urban development and serves as a significant research subject in geography and planning disciplines. This study provides an in-depth exposition on the conceptual evolution of fringe areas based on literature with relevant keywords spanning 1991–2021. By analyzing the essential connotations of related concepts, the theoretical connotation of the urban fringe area system is articulated along the principal axis of "characteristic elements–research perspective–derived concepts," constructing a classification system encompassing urban-rural fringe, intercity fringe, and urban-wildland fringe. The findings indicate that academic consensus regarding the related concepts and connotations of fringe areas is largely unified. Compared with alternative concepts, urban fringe area offers a more balanced analytical perspective and better international consensus. Through analyzing the flows of socio-economic elements between urban and rural areas, land, population, and economy emerge as the key elements that characterize fringe areas. In the coming period, research on urban fringe areas must further refine the theoretical framework, enhance data and information collection to establish multi-element, multi-scale, and multi-dimensional evaluation index systems, and urgently expand dynamic studies on small and medium-sized cities and long-term temporal sequences, thereby fully elucidating regional coupling relationships to achieve rational urban spatial planning and sustainable development.

Full Text

Conceptual Evolution and Classification System Reconstruction of Urban Fringe

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Abstract

The urban fringe represents the most dynamic region in the urbanization process. Scientifically understanding the structural framework of fringe areas constitutes crucial content for promoting sustainable urban development and serves as an important research subject in geography and planning disciplines. Based on literature from 1991 to 2021 related to relevant subject terms, this study provides an in-depth exposition of the conceptual evolution of fringe areas. By analyzing the essential connotations of related concepts and following the main thread of "characteristic elements–derivative concepts," we interpret the theoretical implications of the urban fringe system and construct a classification system encompassing urban-rural fringe, urban-urban fringe, and urban-field fringe.

Our findings reveal that academic understanding of related concepts and their connotations regarding fringe areas has reached basic consensus. Compared with alternative concepts, "urban fringe" offers a more balanced analytical perspective and demonstrates better international uniformity. Analysis of urban-rural socioeconomic factor flows indicates that land, population, and economy constitute the key elements characterizing fringe areas. In future research, urban fringe studies should further refine theoretical frameworks, strengthen data collection to construct multi-element, multi-scale, and multi-dimensional evaluation indicator systems, and urgently expand dynamic research on small and medium-sized cities over long time series. Such efforts will facilitate full exploration of inter-regional correlations and couplings, ultimately achieving rational urban spatial planning and sustainable development.

Keywords: urban fringe; connotation identification; cognition system; research overview

1 Introduction

Building sustainable cities and communities represents one of the global sustainable development goals. As urbanization advances worldwide, urban spatial

structures and morphologies undergo continuous transformation, accompanied by high-frequency, high-intensity flows and exchanges of human-land system elements during spatial expansion. As the outer circle of urban expansion, the urban fringe simultaneously experiences spatial influences from both internal and external human-land systems, exhibiting strong social, economic, and environmental sensitivity and interactivity. Overall, the urban fringe constitutes a geographically connected yet relatively independent territorial entity and serves as an interactive bond and geographical interface for energy and material exchange between different regions. These characteristics make the urban fringe a hotspot in geography most closely associated with urban planning. Meanwhile, rapid industrialization and urbanization have induced significant changes in urban-rural territorial structures, industrial structures, and social structures. From a geo-ecological perspective, the urban fringe also represents a fusion zone where natural environments intersect with human living spaces, particularly the convergence area between urban space and ecological space under rapid urbanization, bearing functions of urban ecological environment and sustainable development.

For urban fringe zones that possess both integration features and multiple meanings, spatial cognition and conceptual expression exhibit different emphases and variations, generating numerous related concepts. Previous research has focused on conceptual evolution and characteristic manifestations of fringe areas, while relatively less attention has been paid to discriminating similar concepts and analyzing characteristic elements across different concepts, which to some extent weakens effective elaboration of urban fringe zones from different perspectives. Addressing this cognitive gap, this study conducts a detailed review of literature from the past 30 years, selecting typical articles based on citation counts to clarify cognitive and understanding biases among related concepts. Using this as a starting point, we clarify the interrelationships between urban fringe and similar concepts under different observation objects, and explain the logical relationships among characteristic elements, research perspectives, and derivative concepts. On this basis, we expand the classification system of fringe areas and construct a "urban-rural fringe–urban-urban fringe–urban-field fringe" framework to interpret and cognize fringe spaces from different observation perspectives, providing theoretical supplementation and connotation excavation for urban-rural geography research and sustainable urban-rural planning and spatial governance.

1.1 Historical Evolution of Urban Fringe Concept

The concept of urban fringe can be traced back to Howard's garden city theory and Burgess's concentric zone model proposed in 1925. In the same year, German geographer Louis formally introduced the concept of urban fringe from an urban ecological perspective. Subsequently, numerous domestic and foreign scholars conducted a series of studies, generally considering the urban fringe as a composite transitional zone influenced by multiple factors. Although its

connotation has been elaborated from different perspectives, most studies have made adaptive adjustments to the concept to varying degrees. In reality, due to the dynamic and complex nature of transitional spaces, the concept of urban fringe remains unclear, and the demarcation of spatial scope contains uncertainties. Based on this understanding, this study uses the CNKI (China National Knowledge Infrastructure) core database and Web of Science core database as data sources to conduct bibliometric analysis of urban fringe-related concepts from 1991 to 2021.

1.2 Related Concepts and Literature Analysis of Urban Fringe

Bibliometric analysis based on subject terms reveals that differences between Chinese and English literature mainly manifest in two similar concepts: "urban-rural junction" (城乡结合部) and "urban fringe" (城市边缘区). The term "urban-rural junction" appears primarily in Chinese articles, accounting for 53.24% of Chinese publications, while "urban fringe" constitutes only 0.74%. In English literature, "urban fringe" dominates at 64.10%, whereas "urban-rural linkage" accounts for 24.04%. This indicates that "urban-rural junction" possesses distinct Chinese characteristics, while "urban fringe" is more commonly used internationally.

Early classification primarily relied on changes in land use types, making land element characteristics the main basis for regional type division. However, as urban-rural areas continue developing, differences in land use types gradually diminish, and reliance solely on land use can no longer meet regional division demands. Therefore, scholars have integrated other features to identify fringe areas, considering them as transitional zones combining land, economic, and demographic characteristics. Related studies indicate that urban fringe areas also contain inner and outer edges, with connections in population, society, economy, land use, and spatial characteristics serving as important identification criteria.

1.3 Statement and Discrimination of Related Concepts

Literature review reveals slight differences in concepts and expressions regarding urban fringe in domestic research, primarily stemming from divergent cognition and understanding of the fringe's essential features. Therefore, accurately grasping the emphasis and essential connotation of each concept becomes fundamental for clarifying the intrinsic characteristics and analytical perspectives of fringe areas, as well as a prerequisite for constructing fringe classification systems. Systematic analysis of each related concept is necessary to more accurately understand the diverse features and complexity of urban fringe, providing more in-depth and comprehensive support for fringe classification and theoretical research.

[Figure 1: see original paper]

1.3.1 Urban-Rural Junction In the 1980s, land and planning departments proposed the concept of "urban-rural junction" (城乡结合部) based on local characteristics. This concept defines a zone centered on cities that includes parts of urban built-up areas and parts of rural natural and economic convergence zones. In a narrow sense, urban-rural junction refers to areas where non-agricultural industries are developed but still contain certain pure agriculture and part-time agriculture, administratively managed by suburban townships rather than urban street offices, with population density between urban built-up areas and general suburban rural areas. In March 2002, the "Notice of the State Council on Strengthening Urban and Rural Planning Supervision and Management" first officially defined the urban-rural junction in official documents, including two types: construction land with mixed state-owned and collective ownership, and agricultural land surrounded by state-owned construction land. Scholars have conducted extensive research on land use, farmland protection, and land management in urban-rural junctions.

Literally, "urban-rural junction" fully embodies the mutual integration characteristics between urban and rural areas, aligning with China's current urban-rural relations and expressing the dual urban-rural characteristics of transitional zones. However, certain inadequacies exist. First, originating from urban planning, the concept primarily serves territorial spatial planning and construction, lacking composite features of population, economy, and natural landscape when demarcating special transitional zones between urban and rural areas, thus failing to fully reflect the gradual multi-faceted differences between urban and rural areas. Second, sociological issues have become a research hotspot in urban-rural junctions, with in-depth discussions on public health, educational resources, and public security. However, research on ecological issues and natural landscapes is relatively lacking, generalizing the concept and scope of urban-rural junction and creating certain overlaps with geographical perspectives on urban-rural transitional zones.

1.3.2 Urban-Rural Interlaced Belt In the 1990s, Chen Youqi proposed the concept of "urban-rural interlaced belt" (城乡交错带) from the perspective of urban-rural interaction, integrating social, economic, and cultural factors based on the urban fringe belt. This concept defines a territorial entity adjacent to urban and rural built-up areas, subject to strong interactive interference between urban and rural areas, encompassing multiple elements including socio-economy and regional culture. "Interlaced" signifies the integration of multiple elements between urban and rural areas, representing the evolutionary process of urban-rural relations. China's urban-rural relations have evolved through stages of "differentiation, opposition, integration, and integration," with integration being the ultimate goal. China is currently experiencing a critical transition period from urban-rural integration to integration.

The urban-rural interlaced belt contains integrated urban-rural relations, while urban-rural integration represents both China's current goal and the next stage

following urban-rural integration. The concept should be adjusted appropriately according to changes in urban-rural relations, making it a dynamic, 贯穿式 concept rather than a stage-specific one. Meanwhile, the manifestation of urban-rural relations differs spatially—preliminary urban-rural integration has been achieved in some southeastern coastal regions, while development lags in northwestern and northeastern regions. Therefore, urban-rural relations exhibit not only temporal but also spatial differences, and the concept of urban-rural interlaced belt should fully consider spatiotemporal variations to propose a "interlaced belt" concept suitable for the new era.

1.3.3 Urban Shadow Area The urban shadow area represents an manifestation of unbalanced urban spatial development, including the projection of population activity aggregation/dispersion, physical spatial morphological changes, and service industry layout in geographical space. During the outward overflow of material elements, external urban areas bear the overflow and undergo landscape and functional changes, enhancing material flows inside and outside the space. This promotes urban morphological changes through "overflow-backwash" effects, evolving from a single-core to a mixed multi-core morphology, with shadow areas forming between cores. At the macro level, research takes urban agglomerations as objects, proposing the concept of metropolitan shadow area based on element agglomeration, diffusion, and spillover effects. The metropolitan shadow area refers to unevenly developed regions within a tightly integrated symbiotic region of spatial and economic development, where non-core areas cannot fully accommodate element diffusion when production factors dominate, thus forming a "metropolitan shadow effect." At the micro level, research is based on urban circle-core structure models, proposing the concept of urban central shadow area from a "population-industry" integrated mechanism based on physical spatial morphology.

1.3.4 Peri-Urban Area In the 1990s, the concept of peri-urbanization emerged in some developing countries where traditional urban structure theory and growth pole theory were not applicable, integrating regional features with certain improvements. China's peri-urban areas represent transitional zones between urban and rural areas that exhibit different characteristics under dual urban-rural radiation during the transition from rural social spatial order to new order. Compared with other concepts, peri-urban areas emphasize the driving force of urban development, representing a state concept produced under dynamic process driving forces. Under market forces, social forces, government forces, and other types of forces, different manifestations appear at different development stages.

Spatial research on peri-urbanization concentrates on geography and urban-rural planning perspectives. The geographical perspective focuses on micro land elements, emphasizing spatial change characteristics of land and interactions among characteristic factors. The planning perspective focuses more on macro spatial morphology, examining spatial layout of urban-rural elements and

characteristic manifestations. Peri-urban areas encompass more driving factors, but research on driving forces primarily focuses on macro-scale manifestations, with non-significant features caused by weaker forces not receiving adequate consideration. In spatial expression, peri-urban areas cover more comprehensive content, with more dispersed spatial distribution and larger territorial areas. Urban-rural junction, urban-rural transitional belt, and urban fringe represent refined expressions of peri-urban areas and constitute important spatial manifestations of peri-urbanization.

1.3.5 Urban-Rural Interface Interface primarily refers to system boundaries with maintenance and exchange functions, finding important applications in geology, metal materials, and interaction design. From a geographical perspective, the interface concept extends to spatial domains, forming spatial interface theory. Spatial interface emerges under certain conditions when resource elements of different natures interact. Initially, geographical interface research focused on natural interfaces, conducting empirical studies on mountain-plain transitional zones and other natural landscapes. Building upon natural interfaces, research shifted from tangible natural elements to intangible human elements.

John O. Browder proposed in 1989 that the urban-rural interface is not merely a spatial concept of "peri-urban area" or the junction between urban and rural areas, but rather a network where urban and rural social, economic, and cultural elements intertwine. As an extension of spatial interface concepts, the urban-rural interface exhibits not only general characteristics of spatial interfaces but also stronger complexity, dynamism, and sociality among elements. Internationally, empirical research on the urban-rural interface has examined population, economy, and land aspects, while domestic research has conducted more substantial basic theoretical studies on this basis. Conceptually, the urban-rural interface tends toward an equal theoretical perspective between urban and rural areas, emphasizes interactions with urban-rural elements in formation mechanisms, and focuses on continuous spatial expression of socio-economic elements in driving characteristics.

2 Connotation Discrimination of Urban Fringe

Related concepts in fringe areas provide detailed elaboration and analysis of internal driving elements. Different analytical perspectives adopted by various concepts lead to differences in endogenous dynamics. Therefore, establishing quantitative relationships among related concepts, characteristic elements, and research perspectives will provide a foundation for deeply exploring the essential connotation of fringe areas. To clearly and quantitatively explain the connotation of urban fringe, this study selected 100 highly-cited articles to construct a quantitative analysis framework of "characteristic elements–derivative concepts" (Figure 2). Considering time span and article proportion, we selected 45 articles on urban fringe, 20 on urban-rural junction, 15 on peri-urban areas, 10

on urban-rural interlaced belt, and 10 on urban shadow area.

Studies defining fringe areas primarily through urban characteristics are classified as urban perspective, including urban population proportion, non-agricultural economic indicators, public facility quantity, construction land proportion, and nighttime light index. Those defining fringe areas mainly through rural characteristics are classified as rural perspective, including agricultural labor proportion, primary industry proportion, agricultural land proportion, and forest coverage rate. Studies incorporating both urban and rural characteristic indicators are defined as suburban perspective. Among these, urban perspective accounts for 43.22%, rural perspective for 7.09%, and suburban perspective for 49.69%.

In the manifestation characteristics of urban fringe, six categories of indicators are selected as characteristic elements: land, population, economy, nature, public facilities, and buildings. Among these, land characteristics constitute the most important feature, with 81.93% of literature involving land features. Population and economy serve as auxiliary features, appearing in 83.23% of literature. Nature, public facilities, and buildings function as secondary features, appearing in 45.16%, 47.10%, and 3.23% of literature respectively, with 16.77% of literature involving multiple characteristic elements.

Assigning equal weight to each mentioned characteristic element, we calculated characteristic factors for different elements (Table 1). The three elements of land, population, and economy exhibit different regional characteristics across urban, rural, and suburban perspectives, with proportion differences among different regional perspectives being less than 14.00%. Although widely applied in regional spatial characteristics, their insignificant differentiation across regional perspectives may lead to unclear demarcation. Nature and public facility characteristic elements appear less frequently but show significant regionalization—nature elements exhibit rural and suburban characteristics, while public facilities show urbanization characteristics. Only 1.94% of urban-perspective literature involves nature elements, while only 3.23% of suburban-perspective literature involves public facility elements, and no rural-perspective literature addresses public facilities. Building elements appear too infrequently to show clear regionalization characteristics.

Among the three perspectives, derivative concepts similar to urban fringe also demonstrate regionalization characteristics. Urban shadow area primarily adopts an urbanization perspective, focusing on urban-led development with obvious urban regional features. Similar patterns appear in peri-urban areas, with 64.00% of articles explaining peri-urbanization from an urban perspective. However, differences exist as peri-urban area research also includes rural and suburban perspectives, with smaller quantity differences between these two viewpoints. Urban-rural junction and urban-rural interface concepts are dominated by suburban perspectives, with only small portions of urban-rural junction literature examining urban and rural perspectives, while urban-rural interface literature does not involve these perspectives. Urban fringe and

urban-rural interlaced belt are also suburban-perspective dominated, but urban fringe additionally shows strong urban perspective characteristics with some articles discussing rural perspectives, demonstrating composite features across three perspectives. Urban-rural interlaced belt does not involve rural perspectives but includes some urban-perspective research.

[Figure 2: see original paper]

3 Classification System Reconstruction of Urban Fringe

3.1 Inductive Method and Theoretical Construction

Based on the internal driving forces of fringe areas, using element spatial migration methods enables demonstration of fringe area manifestations and types at broader scales and perspectives. This process reveals that fringe area classification systems contain more forms and possibilities requiring further improvement and expansion. The essence of fringe area formation lies in edge effects manifested as interactive differences among different territorial entities in spatial domains. Taking the urban environmental system as a research unit, edge effects exist both internally and externally (Figure 3). From a systematic perspective, three heterogeneous units—urban, rural, and field—exist within the system, generating two edge effects: between urban and rural areas, and between rural and field areas. Externally, differences in spatial scale, force magnitude, and driving force types among different systems manifest as edge effects in the form of urban-urban fringe areas. From a spatial perspective, under three spatial states of separation, tangency, and intersection among urban environmental systems, edge effects manifest as urban-field fringe, urban-urban fringe, and urban-rural fringe. When the distance (D) between two systems is small, intense interweaving forms urban-rural fringe; when D is moderate, certain interactions form urban-urban fringe; when D is large, independent existence forms urban-field fringe.

[Figure 3: see original paper]

3.2 Reconstructed Classification System

3.2.1 Urban-Rural Fringe Urban-rural fringe refers to transitional zones between urban and rural areas formed under edge effects, dominated by socio-human elements and supplemented by natural environmental elements. Most similar concept research concentrates on urban-rural fringe, with urban-rural junction and urban-rural interlaced belt being most representative. Urban-rural fringe formation originates from pressure release during urban development stages. When pressure reaches urban internal bearing capacity limits, it transfers partially toward rural areas. This pressure exhibits imbalance in all directions, creating irregular spatial and social morphologies in fringe areas. Rural development does not remain completely independent from cities; while bearing partial pressure, fringe areas with interpenetrating urban and rural functions form.

When rural areas actively undertake urban pressure, numerous urban-suburban joint enterprises emerge in fringe areas, changing suburban-subordinate relationships. Two-way factor flow patterns between urban and rural areas integrate cities and villages into a whole that promotes and supports each other, forming integrated fringe areas (Figure 4a), with formation mechanisms closer to urban-rural junction. When rural areas passively bear urban pressure, high-tech and cultural-educational industries begin permeating suburban areas, forming directional fringe areas (Figure 4b), more consistent with urban-rural interlaced belt expressions.

[Figure 4: see original paper]

3.2.2 Urban-Urban Fringe Urban-urban fringe refers to characteristic transitional zones between adjacent urban environmental systems due to differences in natural environment, socio-economy, and other elements. Taking urban environmental systems as research units, differences among heterogeneous units manifest spatially as edge effects. From a spatial geometry perspective, urban-urban fringe represents transitional zones when two urban environmental systems are tangent in spatial position relationships. In spatial scale, urban-urban fringe represents transitional zones at medium-scale research perspectives, similar in scale to metropolitan shadow areas within urban shadow areas. The difference lies in that urban shadow areas center on urban core effects, analyzing inhibitory effects of cores from social and population perspectives under multi-core interactions, whereas urban-urban fringe takes urban environmental systems as holistic research objects, placing core and non-core areas in equally important positions to comprehensively demonstrate spatial manifestations of edge effects between different systems from an integrated perspective.

3.2.3 Urban-Field Fringe Urban-field fringe refers to transitional zones formed between urban environmental systems and subsystems that are spatially distant and feature significantly different natural elements due to natural environmental barriers. Urban-field fringe can be viewed as an extended model of urban-rural fringe. From a spatial perspective, urban-field fringe represents transitional zones presented by edge effects when two systems are separated, divided into two modes: fringe between urban built-up areas and fields, and fringe between rural areas gradually transitioning to fields (Figure 5). In some urban regions, due to topographical factors, no obvious rural areas surround urban built-up areas, which directly border fields, forming fringe areas integrating urban built-up areas with fields. In spatial scale, urban-field fringe represents transitional zones at large-scale perspectives, dominated by natural environmental elements, supplementing urban fringe system theory and constructing a more complete urban fringe system.

[Figure 5: see original paper]

4 Discussion and Outlook

4.1 Revealing Connotation Speculation and Perfecting Framework Systems

Edge effects constitute important interactions among components of urban environmental systems, involving territorial entities such as cities, villages, and fields. Within urban environmental systems, edge effects between urban and rural areas have accumulated abundant research results, forming a rich conceptual connotation system. However, urban-field fringe and urban-urban fringe also represent important manifestations of edge effects in urban environmental systems, with insufficient research on their interaction mechanisms. Under this background, we argue that future research should deeply reveal differentiated features of different territorial entities in space, innovatively construct theoretical systems and research frameworks for fringe areas of multiple territorial entities, give full play to multidisciplinary linkage mechanisms, promote integration of fringe theory with interdisciplinary methods, expand research perspectives, deepen theoretical results from rural perspectives, enhance the value of rural subjects in research, and break the situation dominated by single perspectives lacking multi-element regional linkages.

4.2 Multi-Dimensional Indicator Optimization for Precise and Efficient Evaluation

Urban fringe areas possess complex attribute characteristics, requiring a scientific indicator evaluation system for regional division to ensure precise spatial identification. Therefore, under a perfected fringe architecture system, multi-dimensional, multi-attribute, and multi-scale characteristic indicator systems must be constructed. In research content, social, economic, population, and environmental elements fuse into attribute characteristics, while refined differences in infrastructure, technical support, and architectural landscape cannot be ignored. In research scale, fringe areas participate in material element cycles at large spatial scales, while small cycles within systems require more accurate grasp of element flows and interactions. In temporal scale, edge effects constitute a dynamic process exhibiting different characteristics at different stages, creating complexity in fringe area feature changes. In identification methods, effective combination of quantitative and qualitative approaches provides possibilities for efficient fringe area identification. Emerging data such as POI data, mobile signaling data, and nighttime light data will facilitate integration with traditional data. Developing acquisition, analysis, fusion, and quantitative expression technologies for multi-source heterogeneous data will build fringe area data support systems and scientific management platforms, ensuring effective communication between data and promoting synergy between urban fringe and urban systems.

4.3 Improving Growth Mechanisms to Promote Sustainable Development

The potential value and growth mechanisms of fringe areas constitute important supports for promoting sustainable urban development. Urban-rural fringe embodies urban-rural integration relationships while simultaneously hindering further integration. Breaking barriers between urban and rural areas and establishing urban-rural integrated feedback mechanisms will facilitate high-quality collaborative development with balanced resource allocation. In natural environmental aspects, integrating ecological civilization thought and advocating green development, establishing a community with a shared future for mankind has become the main ideology for urban development in the new era. Urban-field fringe ensures independent development spaces for natural environmental systems and urban-rural areas to guarantee ecosystem stability and health. Moreover, existing research tends to focus on large cities, leaving considerable research space for edge effects in small and medium-sized cities and between cities. Therefore, more comprehensive regional empirical studies and theoretical deductions are urgently needed to further deepen understanding of fringe area formation mechanisms, shifting research directions from spatial quantity expansion to quality improvement in fringe areas. By constructing improved fringe area growth mechanisms, clarifying fringe types and development needs, and scientifically formulating urban development policies, we can further promote sustainable urban development.

5 Conclusions

1) Urban fringe constitutes a complex and extensive concept whose connotation presents multiple features under different research perspectives. Domestic scholars use "urban-rural junction" as the subject term to express fringe areas, while international academia uses "urban fringe." Through subject term comparison, urban fringe demonstrates more comprehensive connotations, better temporal continuity, and superior international uniformity.

2) Through constructing a "characteristic elements–derivative concepts" analytical framework, we find that 84.42% of territorial spatial evolution research in fringe areas focuses on interactions among land, population, and economic elements. The roles of other characteristic elements require deeper exploration.

3) Using edge effects as the forming force, fringe area entity units exist in three territorial spaces: urban, rural, and field, with urban-rural fringe being the most important manifestation. From systematic and integrated perspectives, we reconstruct the fringe area system, building an integrated urban fringe classification system comprising urban-rural fringe, urban-urban fringe, and urban-field fringe.

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