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# Hierarchical Dynamic Adaptive Management of Territorial Space: An Analytical Framework Integrating Complex Adaptive System Theory

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**Abstract**

With the fundamental establishment of China's territorial spatial planning system featuring the integration of multiple plans, transitioning from static blueprint-centric regulation to dynamic implementation governance against rising uncertainties stands as a core challenge in advancing spatial governance modernization. The current patch-based management suffers from excessive rigidity and insufficient adaptability amid the evolving complexity of territorial systems. To tackle this issue, this paper develops a holistic framework for the hierarchical adaptive dynamic management of territorial space based on Complex Adaptive System (CAS) theory. Drawing on the CAS perspective, this study proposes a Five-in-One evaluation criterion as the value benchmark for spatial adjustment, constructs a five-tier hierarchical governance logic aligned with China's administrative system, and designs differentiated regulatory strategies based on stable and change-prone spatial zoning. This research provides a new paradigm that combines theoretical depth and practical operability to boost the scientificity and implementation effectiveness of territorial spatial planning and helps facilitate the transformation of the territorial spatial governance system toward greater resilience and adaptability.

**Keywords:** territorial spatial planning; adaptive management; patch-based management; spatial governance; stable zones and change-prone zones

## 1. Introduction

Since the release of the Opinions of the Central Committee of the Communist Party of China and the State Council on Establishing and Supervising the Implementation of the Territorial Spatial Planning System in 2019, China has basically built a nationwide territorial spatial planning system featuring the integration of multiple plans. This system aims to integrate various types of spatial plans into a unified blueprint to enhance the efficiency and coordination of spatial governance [1]. Nevertheless, the establishment of the planning system does not inherently translate into improved governance performance. A prominent contradiction has emerged in practice: territorial space functions as a complex adaptive system defined by uncertainty, nonlinearity, and self-organization [2,3], while the prevailing patch-based management model (a parcel-by-parcel land-use governance model built on standardized survey basemaps), despite its essential foundational role in the early stage of planning reform, still follows a linear static control logic and has exposed practical adaptability deficiencies in the Chinese context [4,5]. Such tensions between rigid

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blueprint planning and dynamic spatial realities are further exacerbated by multifaceted uncertain disturbances, including global climate change, public health emergencies such as COVID-19, rapid technological iteration, and fluctuating market dynamics [6–8].

Accordingly, international research on spatial governance has undergone a paradigmatic shift from the pursuit of a static optimal blueprint toward resilient and adaptive governance solutions [9,10]. First proposed by Holling for ecosystem management [11], adaptive management emphasizes learning-by-doing to tackle inherent uncertainties and has been extensively applied to natural resource governance [12]. In parallel, early urban complexity scholarship argued that cities are not reducible to simple tree-like structures but exhibit interconnected and semi-lattice relations [13]. Later, Batty explicitly conceptualized cities as complex systems characterized by emergence, scaling, and nonlinear interactions, while Fotheringham and Brunsdon highlighted the importance of local forms of spatial analysis and scale-sensitive spatial heterogeneity [14,15]. The subsequent development of adaptive governance further underscores the importance of multi-level networks, participatory learning, and decentralization for managing coupled social-ecological systems [16]. Recent studies have further integrated resilience and complexity theories into urban and regional spatial governance, advocating that spatial planning systems should be endowed with the capabilities to resist external disturbances, enable self-reorganization, and maintain long-term development [7].

Some good practices from both global and national contexts have provided useful references for this shift. Internationally, adaptive spatial governance has been reflected in practices such as long-term climate adaptation planning, dynamic ecosystem management, and resilience-oriented urban-regional planning, where monitoring, evaluation, and iterative adjustment are emphasized instead of one-off blueprint control. Nationally, China's recent territorial spatial planning reform has also accumulated relevant practices, including the establishment of ecological protection redlines, permanent basic farmland protection, urban development boundaries, the dual evaluation of resource–environment carrying capacity and territorial spatial development suitability, and the "one-map" implementation supervision platform. These practices indicate that spatial governance is increasingly moving toward a combination of rigid bottom-line control and dynamic adaptive adjustment. However, how to integrate these experiences into a coherent hierarchical adaptive management framework remains insufficiently explored.

Nevertheless, notable research gaps remain in the existing literature. First, although adaptive governance theories are well established internationally, their applications are predominantly rooted in the polycentric and collaborative governance contexts of Western societies [17]. Few systematic theoretical frameworks and practical approaches have been developed to tailor these theories to China's distinctive, strictly hierarchical administrative system, characterized by strong top-down governance. Second, existing research predominantly addresses adaptive governance principles at the macro level, while few deliver operational methodologies that effectively connect high-level strategic design, meso-level regional coordination, and micro-level local implementation for targeted spatial application [18]. Specifically, balancing the rigid stability of strategic spatial frameworks with the flexible development demands of local spaces [19] continues to pose a prevailing challenge to China's territorial spatial governance.

Therefore, this study aims to address the aforementioned research gaps by integrating complex adaptive system theory with China's territorial spatial planning and by answering the following three core scientific questions: First, theoretical foundation (Why): Why should territorial spatial governance shift from static control to dynamic adaptive management? What are the scientific criteria for evaluating and guiding reasonable spatial transitions? Second, governance structure (Who & How): Under China's five-tier ad-

ministrative system, how can a hierarchical adaptive management framework with clear responsibilities, rights, and collaborative efficiency be established? Third, methodological pathway (What & Where): How can zones requiring rigid protection versus flexible guidance be spatially identified, and how can differentiated adaptive management strategies be formulated? To answer these questions, this study systematically constructs a localized analytical framework covering theoretical basis, governance structure, and operational pathways, so as to provide theoretical and methodological support for the dynamic adaptive transformation of territorial spatial governance.

The remainder of this paper is organized as follows: Section 2 elaborates the theoretical foundations and research methodology supporting this study. Section 3 analyzes the practical dilemmas and transformation demands of China's current territorial spatial management, providing a realistic basis for the framework construction. Sections 4 and 5 constitute the core research outputs of this paper, which respectively construct the hierarchical governance logic and the operational methodological framework of differentiated adaptive regulation. Section 6 discusses the theoretical contributions and limitations of this study. Section 7 concludes the main findings and puts forward future research prospects.

## 2. Theoretical Foundations and Analytical Criterion System

### *2.1. Theoretical Foundations: Complex Adaptive System and Adaptive Management*

This section systematically sorts out two core theoretical foundations of this study: Complex Adaptive System theory and adaptive management theory, both of which constitute the logical starting point for the construction of the hierarchical dynamic adaptive management framework.

#### 2.1.1. Territorial Space as a Complex Adaptive System

Proposed by John H. Holland and colleagues at the Santa Fe Institute, CAS theory elaborates how complex macroscopic properties emerge from numerous interacting agents that modify their behaviors through experiential learning [9]. Its core characteristics consist of agent initiative, self-organization, adaptability, nonlinearity, and emergence [10]. From the perspective of CAS theory, territorial space functions not as a static physical carrier but a dynamically evolving living system [20]. More importantly, conceptualizing territorial space as a CAS provides methodological implications for planning practice: it requires planners to replace fixed-state prediction with continuous monitoring, feedback-based evaluation, and adaptive adjustment mechanisms. The system agents range from multi-level governments and enterprises to local communities and individuals, whose decisions and behaviors are conditioned by multiple factors such as market conditions, policy arrangements, and social culture, collectively shaping the evolution of land-use patterns. Rather than the mechanical implementation of a static planning blueprint, such spatial evolution represents the adaptive responses of the system through internal factor restructuring and functional adjustment under internal and external disturbances [21]. The identification of this inherent nature of territorial space lays the essential foundation for developing a dynamic adaptive management framework. Specifically, viewing territorial space as a CAS implies three methodological transformations in spatial planning: (1) replacing static blueprint control with continuous monitoring and iterative adjustment; (2) shifting from single-objective optimization toward multi-dimensional evaluation and trade-off analysis; and (3) transforming uniform regulation into differentiated governance according to spatial stability and change potential. It shifts the paradigm of spatial planning from pursuing a single ultimate optimal solution to establishing a learning-oriented, adjustable governance framework that steers and governs the persistent dynamic evolution of territorial systems.

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#### 2.1.2. Adaptive Management: From Ecosystems to Spatial Governance

The theory of adaptive management [11] regards managerial practices as hypothesis-testing experiments and enables continuous optimization of governance strategies through a closed-loop cycle of design, implementation, monitoring, evaluation, and adjustment, thereby facilitating iterative learning from practical operations [22,23]. Originally developed for ecological and natural resource management [24], adaptive management has been gradually incorporated into urban and regional planning over recent decades, delivering an innovative governance approach to cope with uncertainties including climate change and market fluctuations [25,26]. The application of adaptive management theory to territorial spatial planning requires recognition of the inherent limitations of static planning. It redefines spatial planning as a continuous learning and dynamic adjustment process, with the core goal of improving the resilience and adaptability of the entire territorial spatial system [27].

### *2.2. The Five-in-One Scientific Criterion for Evaluating and Guiding Spatial Changes*

This study adopts three qualitative research methods to construct the hierarchical dynamic adaptive management framework and certify the rationality of the findings: (1) Theoretical deduction: starting from Complex Adaptive System theory and adaptive management theory, this study deduces the basic principles of spatial adaptive governance and verifies the theoretical validity of the framework through internal logical consistency. (2) Institutional analysis: combined with China's five-tier administrative system, this study designs the hierarchical governance logic and demonstrates the institutional applicability of the framework through its compatibility with the existing planning management system. (3) Typological construction: this study classifies territorial space into stable zones and change-prone zones and proposes differentiated regulation strategies while confirming the practical rationality of the framework through its responsiveness to current patch-based management dilemmas.

Given that spatial change represents a normal state of territorial system evolution, the core task of spatial planning has shifted from restraining spatial transitions to guiding them in a rational manner [28]. Effective guidance, however, requires solid theoretical foundations and explicit directional principles. Accordingly, this study develops a Five-in-One criterion system, serving as the fundamental benchmark and analytical tool for evaluating the rationality of spatial changes and implementing adaptive spatial governance. The term "Five-in-One" refers to the synergistic collaboration of five complementary dimensions to form a unified decision-making framework rather than combining discrete elements into one single entity.

**Resource and environment criterion (bottom-line principle)**—As a rigid constraint for spatial evolution, this criterion requires all spatial changes to comply with regional resource and environmental carrying capacity and sustain ecosystem integrity and regional ecological security [29]. Rooted in sustainable development and ecological resilience theories, it emphasizes full adherence to non-negotiable ecological thresholds in territorial governance.

**Social development criterion (people-oriented principle)**—Grounded in spatial justice theory, this humanistic principle requires spatial changes to adapt to population dynamics and advance social equity and public welfare [30]. It focuses on the social impacts of spatial resource allocation for diverse groups and underscores the vital role of planning in safeguarding public health, conserving cultural heritage, and strengthening community identity.

**Market economy criterion (efficiency principle)**—Based on the institutional economics of market-based resource allocation, this efficiency-oriented criterion requires

spatial changes to align with market mechanisms and promote the intensive and efficient utilization of land resources. It emphasizes planning-led spatial optimization to coordinate territorial layout with industrial locational advantages and improve overall economic operational efficiency [31].

**Policy and regulation criterion (legitimacy principle)**—As a normative constraint, this criterion requires all spatial changes to be conducted within the institutional framework of national laws, regulations, and strategic policies [32]. It safeguards the procedural legitimacy of spatial governance and ensures that local spatial adjustments align with national macro-strategies, including major functional zoning and carbon peaking and carbon neutrality goals.

**Planning coordination criterion (systematic principle)**—This systematic criterion emphasizes multi-scale and cross-departmental coordination for all spatial changes to prevent systemic failures stemming from scale mismatch and sectoral fragmentation [33]. It underscores vertical strategic transmission across administrative levels from national to local governments and horizontal functional collaboration among departments of natural resources, transportation, environmental protection, and other relevant authorities.

Collectively, the five interrelated criteria constitute a multidimensional analytical framework, as shown in Figure 1. This framework enables comprehensive evaluation of spatial evolution within change-prone zones and provides a scientific foundation for the adaptive governance of territorial space in subsequent methodological applications.

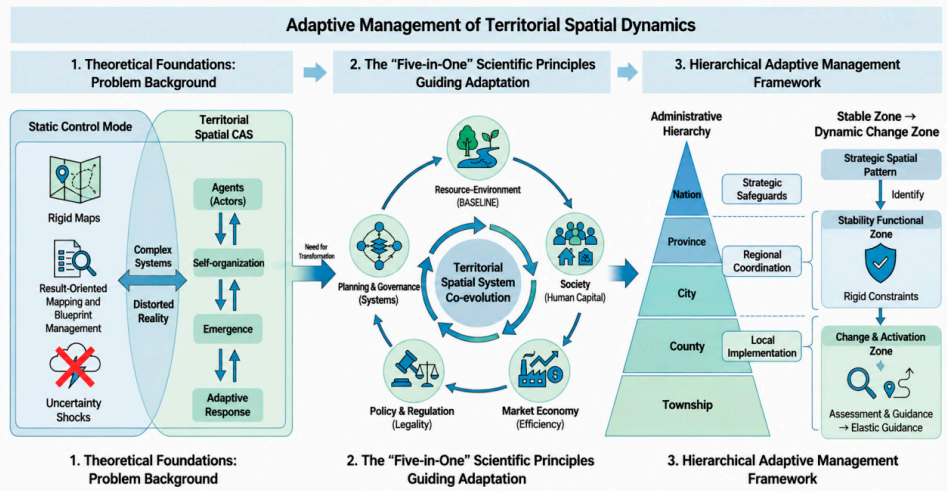


**Figure 1.** Theoretical framework integrating Complex Adaptive System (CAS) theory with the "Five-in-One" evaluation criterion for territorial spatial adaptive governance.

## 3. Current Dilemmas and Transformation Demands

Starting from the practical context of China's territorial spatial governance, this section sorts out the achievements and inherent limitations of the current patch-based management model and demonstrates the realistic necessity of paradigm transformation, so as to provide practical support for the subsequent theoretical framework construction.

### *3.1. Outcomes and Preliminary System of the Multi-Plan Integration Reform*

China's territorial spatial planning reform of multi-plan integration has consolidated previous major functional zoning, land-use planning, and urban–rural planning, yielding remarkable achievements in top-level institutional design. Its core contributions are summarized as follows: (1) A unified planning system is established. The delineation of three control lines—including ecological protection redlines, permanent basic farmland, and urban development boundaries—has realized preliminary bottom-line regulation of nation-

ally strategic spatial resources [34]; (2) The dual assessment (resource and environmental carrying capacity assessment plus territorial spatial development suitability assessment) are anchored as scientific foundations, significantly enhancing the rationality of planning decisions [35,36]; (3) A nationwide unified digital platform of one-map territorial spatial planning is constructed to underpin digital spatial governance [37].

In terms of implementation tools, the patch-based management paradigm grounded in the Third National Land Survey data has played an irreplaceable role in the initial stage of reform. On the one hand, it ensures strong administrative penetration and enforcement. Relying on unified national base maps and standardized management rules, it has rapidly built a quantifiable and evaluable governance system across the country, providing strong support for safeguarding national food security and ecological security boundaries. On the other hand, it guarantees high technical objectivity and accuracy. With modern surveying and mapping technologies, it records precise geographic information of each spatial patch, which underpins the objectivity of spatial governance and provides reliable data support for planning formulation, implementation supervision, and law enforcement.

The established system provides a robust macroscopic framework for guiding the future development and protection patterns of territorial space.

### *3.2. Inherent Limitations of Patch-Based Management*

In the initial stage of territorial spatial reform, the patch-based management paradigm is predominantly based on the Third National Land Survey data, which exercises strict oversight of spatial changes through top-down target allocation and compliance checks regarding land-use categories. This method offers prominent strength. First, it ensures robust penetrability and enforcement. In the early phase of the multi-plan integration reform, patch-based management has rapidly constructed a nationwide quantifiable and evaluable governance system through unified national data basemaps and standardized management criteria [38], offering solid support for safeguarding national food security and ecological security boundaries. Second, it guarantees high technical objectivity and accuracy. Grounded in modern surveying and mapping technologies, patch-based management stores precise geographic information regarding the location, area, and boundary of each spatial patch. Such technical features underpin the objectivity of spatial governance practices and provide reliable data support for planning formulation, implementation, supervision, and law enforcement, represented by satellite remote sensing inspection. Accordingly, this paradigm has substantially advanced the standardization of territorial spatial management [39].

Arguably, this initial reform model has played a vital role in rapidly establishing a unified nationwide planning order, curbing unregulated spatial development, and securing fundamental ecological and developmental boundaries. However, as reform has deepened, its inherent limitations have become increasingly apparent, as shown in Table 1.

Rigid locking and insufficient adaptability results in static land-use designations that cannot adapt to changing market conditions, technological innovation, and diversified social demands. Rooted in complex adaptive system (CAS) theory, the logic of adaptive iteration and multi-agent learning offers a targeted theoretical pathway to address this rigidity. Facing legitimate land demands, local governments either are constrained by cumbersome approval procedures and quota shortages into over-restrictive regulation or resort to frequent fragmented ad hoc revisions that undermine planning authority.

Technical simplification in patch-based management amid complicated governance tends to reduce multifaceted spatial issues concerning land tenure, rural livelihoods, community interests, and industrial ecology into standalone land-use compliance checks. This gives rise to legally compliant yet substantively unreasonable outcomes. For in-

stance, off-site farmland reclamation implemented to meet cultivated land requisition–compensation balance may satisfy formal spatial rules but proves ecologically and economically unsustainable.

**Table 1.** Dual Effects of Patch-based Management.

| Dimension | Historical Contributions and Positive Effects | Current Challenges and Limitations |
| --- | --- | --- |
| Governance Efficiency | High efficiency and robust implementation penetration: rapidly unifies nationwide planning standards and constructs a quantifiable, evaluable regulatory system that effectively curbs disorderly land development. | Insufficient flexibility and adaptability: static patch designation fails to keep pace with market shifts and diversified local demands, easily resulting in over-restrictive regulation. |
| Governance Logic | High technical accuracy and objectivity: supported by the Third National Land Survey dataset, it delivers quantifiable evidence for law enforcement and reduces discretionary ambiguity in administration. | Oversimplification against complicated governance realities: complex socioeconomic concerns (livelihood security, land tenure, etc.) are reduced to land-use compliance checks, triggering legally compliant yet practically unreasonable outcomes. |
| Central–local Relations | Safeguard national strategic bottom lines: enables full implementation of state-set redlines for cultivated land and ecological protection. | Ambiguous division of administrative authority: the highly centralized top-down mechanism constrains context-specific local innovation and institutional autonomy, thereby impairing comprehensive governance performance. |
| Interdepartment Coordination | Unified foundational spatial dataset: offers consistent technical benchmarks to advance multi-plan integration. | Emerging interdepartmental barriers: inconsistent patch datasets among planning, forestry, and agricultural departments lead to unmatched spatial patches and raise extra coordination costs. |

Ambiguity in central–local administrative powers means that the centralized top-down delivery mechanism facilitates the enforcement of national strategies but constrains local governments' discretionary autonomy and context-specific innovation. Universal preoccupation with patch compliance triggers scale mismatch: national strategic objectives and grassroots practical concerns are governed under identical regulatory logic, thereby undermining overall governance efficiency.

### *3.3. Transformation Demand: Shifting from Patch-Based Management to Hierarchical Dynamic Adaptive Management*

The aforementioned dilemmas suggest that China's territorial spatial planning has entered a new stage of in-depth reform, marked by a core paradigm shift from static patch-based management to hierarchical dynamic adaptive management. This transformation involves three key dimensions: (1) Governance structure: a transition from one-way top-down implementation to tiered collaborative management with well-defined powers and responsibilities; (2) Planning philosophy: a departure from the pursuit of a fixed final blueprint toward an adaptive system characterized by continuous learning and iterative adjustment; (3) Management approach: a replacement of uniform, one-size-fits-most regulation with targeted, differentiated policies for diverse spatial units. On this basis, the following sections of this study construct the corresponding theoretical framework accordingly.

## 4. Logical Framework for Hierarchical Governance

As the core institutional output of this study, this section constructs a hierarchically organized governance framework tailored to China's five-tier administrative system (national–provincial–municipal–county–township), which is indispensable for the efficient implementation of adaptive management. Centered on the tight coupling of spatial scales and administrative mandates and guided by the principle of matching administrative power to jurisdictional tier, the framework further clarifies the differentiated positioning, roles, and responsibilities of each administrative level in dynamic adaptive governance.

### *4.1. Theoretical Basis for Scale Effect and Administrative Power Allocation*

Scale dependence of spatial issues underpins hierarchical governance. Macro-scale agendas, including national ecological security and transboundary watershed management, differ substantially from micro-scale affairs such as community regeneration and site-specific land-use conversion in driving factors, spatial coverage, and governance logics. The adoption of a uniform regulatory approach across all scales inevitably results in scale mismatch. Fiscal federalism from public economics prescribes that administrative responsibilities should be allocated following the benefit–area principle, which stipulates that governmental jurisdiction should correspond to the geographic scope of public service benefits. Extended to spatial governance, this principle dictates that higher-level governments dominate governance over strategic, nationwide, and highly externality-prone spatial issues, while local governments are delegated greater decision-making power for site-specific, locally oriented and market-sensitive spatial matters.

### *4.2. Differentiated Positioning and Priorities of Adaptive Management Across Five Administrative Levels*

Following the above rationale, a robust hierarchical governance system eliminates uniform and repetitive dynamic revisions across tiers, thereby realizing role-specific responsibility and complementary coordination, as shown in Figure 2. Under the guidance of the principle matching planning mandates with administrative tiers, the planning system abandons simplistic content scaling or quota decomposition between superior and subordinate governments. High-level plans (national and provincial) establish strategic frameworks, stabilize territorial spatial patterns, and delineate regional functional zoning. In contrast, lower-tier plans (prefectural, county, and township-level) are empowered with substantial autonomy within these frameworks to optimize local spatial layouts, facilitate project implementation, and flexibly adapt to dynamic local demands, as shown in Table 2.

National level—Strategic security and pattern stabilization. Core mandate: safeguard national sovereignty, security, and developmental interests and formulate nationwide spatial strategies and rigid regulatory rules. Adaptive management focus: long-cycle strategic revisions. Centered on macro driving factors such as global climate change, geopolitics, and demographic transitions, authorities conduct prudent assessment and framework optimization of core stabilizing systems covering ecological security, cultivated land protection, and major infrastructure every 10–15 years. Such adaptation relies on overall framework refinement rather than fine-scale adjustment of site-specific spatial details.

Provincial level—Regional integration and cross-jurisdictional coordination. Core mandate: translate national strategies into local practices and mediate cross-city major affairs within provincial boundaries. Adaptive management focus: medium-cycle coordinated balancing. Targeting regional disparity and resource competition, provinces adaptively reallocate key production factors through cross-municipal ecological compensation, coordinated industrial specialization, and provincial-level infrastructure optimization.

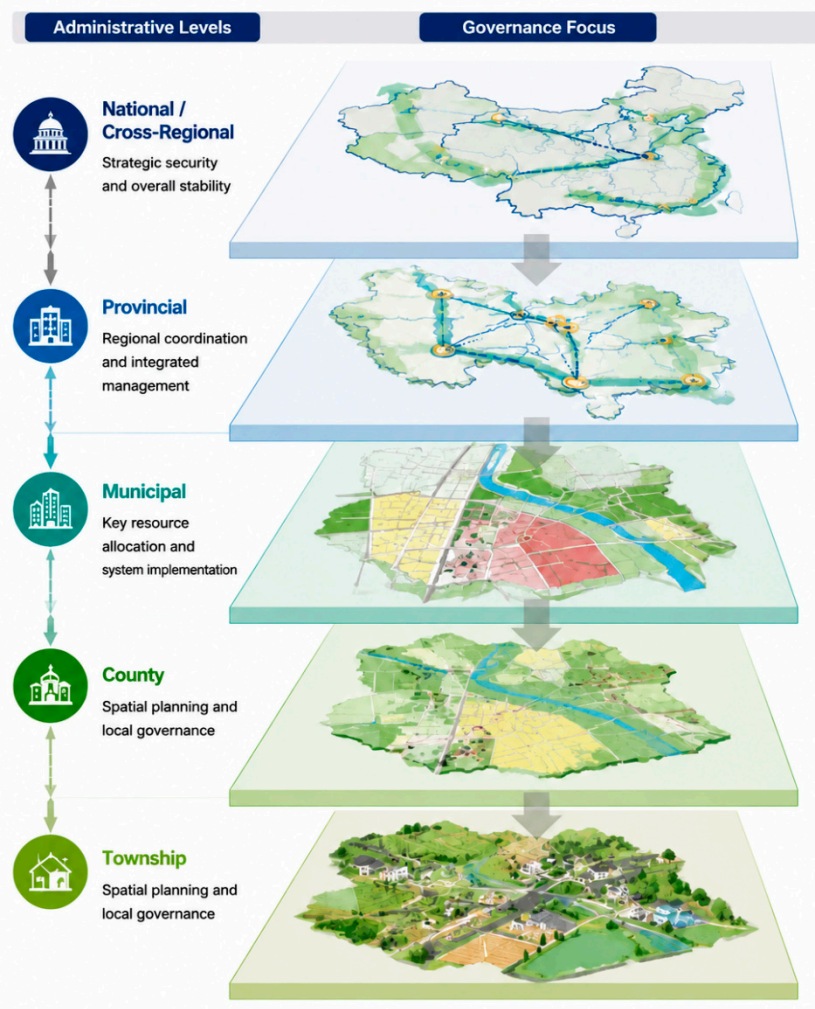


**Figure 2.** Hierarchical governance framework illustrating differentiated power orientations and core responsibilities across five administrative levels in territorial spatial management.

Municipal level—Factor allocation and implementation coordination. Core mandate: primary implementer responsible for allocating key developmental resources such as land, capital, and environmental capacity. Adaptive management focus: short-cycle, market-oriented responses. This is the core governance layer for change-prone zones. Within provincial regulatory boundaries, cities carry out annual project-oriented adjustments to satisfy market-derived industrial land demand and public service expansion triggered by population mobility, as illustrated by flexible annual industrial land supply and the rational layout of educational and medical facilities.

County and township levels—On-site implementation and grassroots governance. Core mandate: final executor for detailed planning approval, land-use permission, project landing, and stakeholder negotiation. Adaptive management focus: real-time, demand-led minor tweaks with the finest granularity and highest adjustment frequency. Adaptation manifests in flexible implementation for individual projects and respect for village autonomy. For instance, bottom-up routine planning maintenance may be launched to facilitate the development of characteristic rural industries, provided that such practices comply with upper-level planning and bottom-line constraints. Micro-level iterative learning and fine adjustments serve as the linchpin enabling the overall adaptive management system to operate flexibly.

**Table 2.** Five-tier Hierarchical Planning Governance System Based on Administrative Power Allocation.

| Planning Tier | Core Administrative Mandate | Key Governance Priorities |
| --- | --- | --- |
| National and Inter-provincial Regions | Strategic security and national spatial pattern stabilization | ① National ecological security patterns (e.g., national ecological shelter patterns of Three Zones and Four Belts);<br>② National food security layout (e.g., agricultural strategic framework of Seven Zones and Twenty-Three Belts);<br>③ Layout of national critical infrastructure networks such as comprehensive three-dimensional transportation system;<br>④ Overarching spatial guidance for major strategic regions including Beijing–Tianjin–Hebei, Yangtze River Delta, and Guangdong–Hong Kong–Macao Greater Bay Area. |
| Provincial | Regional overall planning and comprehensive coordination | ① Provincial key ecosystems such as rivers and lakes, as well as regional ecological corridors;<br>② Cross-municipal corridors for large-scale transportation, energy, and water conservancy infrastructure;<br>③ Provincial urban system and industrial division layout;<br>④ Provincial nature reserve system. |
| Municipal | Factor allocation and integrated implementation | ① Delimitation and administration of urban development boundaries, permanent basic farmland and ecological protection redline;<br>② Annual quota allocation of newly added construction land;<br>③ Spatial arrangement of municipal major public service and infrastructure land;<br>④ Demarcation of control lines for historical and cultural preservation. |
| County/ Township | On-site spatial implementation and grassroots governance | Refine municipal quotas and layout requirements into site-specific land-use zoning and control rules in line with local realities, covering rural residential arrangement, industrial project settlement, infrastructure construction, and issues closely related to villagers' interests. |

## 5. Methodological Framework for Dynamic Adaptive Management

As the core technical output of this study, built on the aforementioned hierarchical governance structure, this section constructs an operable methodological framework for dynamic adaptive management anchored in the delineation of stable and change-prone spatial zones. Underpinned by the Five-in-One evaluation criterion, it forms a complete implementable path by covering the dimensions of spatial unit identification, multi-scale zoning, and differentiated spatial regulation, as illustrated in Figure 3.

### *5.1. Spatial Unit Identification: Stable Zones and Change-Prone Zones*

Classifying territorial space into two functional categories—stable zones (rigidly protected areas with fixed core functions) and change-prone zones (flexibly guided areas with dynamic adjustment space)—lays the prerequisite for differentiated spatial governance.

Stable zones denote areas whose dominant functions remain fundamentally unchanged over an extended period (one full planning cycle or longer). Serving as the core stabilizers of territorial development and protection patterns, such zones possess three intrinsic attributes: (1) Functional persistence: core spaces such as key water conservation areas and high-quality permanent basic farmland carry long-term, irreplaceable ecological and productive values that cannot be easily replaced by other land uses. (2) Structural inertia: once a stable spatial configuration is established, large-scale restructuring would incur substantial economic and institutional costs**, and in most cases cause irreversible damage to local ecosystems. (3) System resilience: drawing on the concept of robustness from ecological resilience theory, these spatial systems can absorb small-scale ex-

ternal disturbances and maintain their core structural and functional integrity without fundamental transformation**.

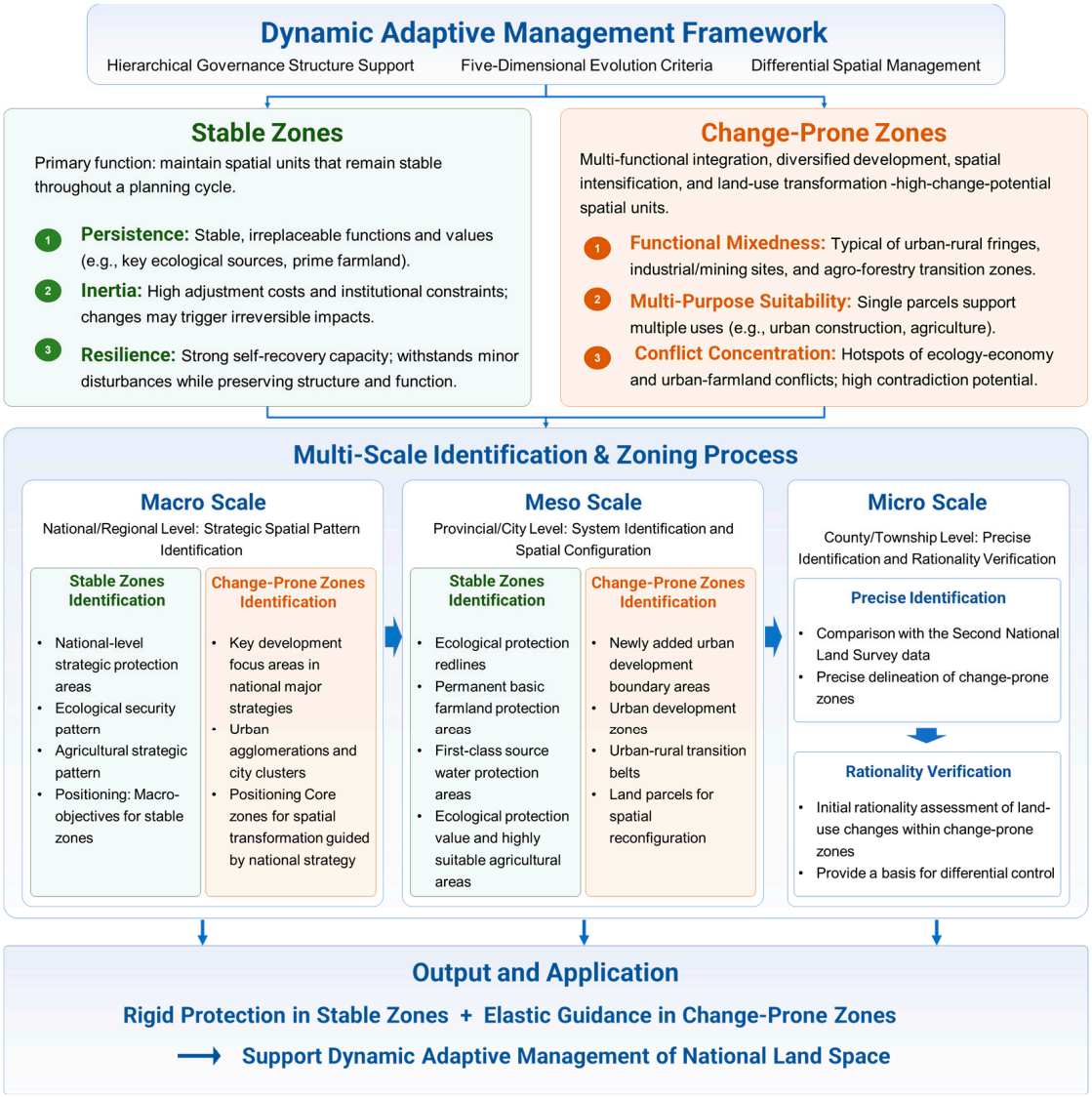


**Figure 3.** Multi-Scale Technical identification framework for stable zones and change-prone zones across macro, meso, and micro spatial levels.

Change-prone zones denote areas with mixed multifunction, diversified developmental prospects, intensive spatial conflicts, and strong potential for land-use transition. Their characteristics are summarized as follows: (1) Mixed functionality: Typically located at the transition interface of multiple land uses, including urban–rural fringes, abandoned industrial and mining land, and agroforest ecotones. (2) Multi-purpose suitability: A single land parcel is eligible for multiple development alternatives based on dual evaluation outputs, including urban construction and agricultural cultivation, thereby triggering intense competition over land-use allocation. (3) Concentrated conflicts: These regions witness clustered contradictions between ecological conservation and economic expansion, urban sprawl, and cultivated land preservation, as well as disputes over incremental versus stock land, government–market relations, and conflicting demands among diverse stakeholders.

To operationalize this conceptual classification, the identification of stable zones and change-prone zones follows a hierarchical spatial identification approach. Specifically, the framework determines zone types by integrating strategic spatial patterns, dual evaluation

results, ecological and agricultural suitability assessments, and historical land-use transition data across different spatial levels. Macro-scale identification focuses on strategic territorial patterns, meso-scale identification emphasizes systematic functional zoning and spatial conflicts, and micro-scale identification verifies specific land-use transitions at the parcel level.

### *5.2. Multi-Scale Zoning of Stable Zones and Change-Prone Zones*

#### 5.2.1. Macro-Scale Identification of Strategic Spatial Patterns

At both national and regional levels, stable and change-prone zones forming the backbone of territorial space are delineated from a strategic perspective. Macro stable zones mainly consist of state-level strategically protected territories specified in the National Territorial Spatial Planning Outline, including the national ecological security framework of Three Zones and Four Belts and the agricultural strategic layout of Seven Zones and Twenty-Three Belts. As the fundamental cornerstone of national ecological security and food security, these territories are designated as macro-level absolute stable zones. In contrast, change-prone zones correspond to key development areas outlined under national major development strategies, particularly major urban agglomerations and metropolitan areas within the Two Horizontal and Three Vertical urbanization layout. Serving as the primary carriers of future population aggregation and economic activities, these territories function as core regions for state-guided orderly spatial transformation.

#### 5.2.2. Meso-Scale Systematic Identification and Spatial Arrangement

At the regional level, systematic identification and layout of stable zones and change-prone zones are conducted. At provincial and municipal levels, refined systematic zoning relies on dual-evaluation outcomes and historical land-use transition datasets. Specifically, ecological protection redlines, permanent basic farmland protection zones, primary water source conservation areas, and territories with extremely high ecological conservation value or agricultural suitability are classified as stable zones. In comparison, newly added construction land within urban development boundaries, suburban development zones, and urban–rural transition belts are defined as change-prone zones, whose scale and spatial distribution undergo systematic optimization.

#### 5.2.3. Micro-Scale Precise Identification and Rationality Verification

The precise delineation of two types of zones and rationality judgment of land-use transitions within change-prone zones are primarily undertaken at the county and township levels. By comparing datasets from the Second and Third National Land Surveys, each altered land parcel can be pinpointed. Beyond zoning classification, this tier focuses on conducting preliminary rationality assessments of potential land-use conversions across change-prone zones.

### *5.3. Criterion-Based Adaptive Guidance and Differentiated Regulation*

Differentiated adaptive governance constitutes the core follow-up after spatial zoning and forms a closed-loop management mechanism. This dynamic closed-loop mechanism comprises three interconnected stages: monitoring, assessment, and guidance.

Strict rigid protection and bottom-line constraints are applied to stable zones. The management focuses on preservation, ensuring structural integrity and undisturbed dominant functions. This is achieved through stringent land-use control and negative list management. For absolute stable zones including core areas of ecological redlines and permanent basic farmland, all development inconsistent with dominant functions is prohibited in principle. For relatively stable zones, such as ordinary ecological spaces, limited compatible

activities (e.g., eco-tourism and conservation tillage) are permitted, provided that the core functions are not impaired.

Flexible steering and adaptive optimization apply to change-prone zones. The core of management is 'steering'—guiding their evolution toward a better direction through adaptive strategies, thereby enhancing spatial value and resilience. 1. Monitoring: Remote sensing, big data, and internet-of-things technologies enable periodic or real-time tracking of land-use dynamics across change-prone zones. 2. Assessment: Detected spatial changes are comprehensively evaluated against the Five-in-One criterion system to judge their rationality. For instance, spontaneously formed industrial clusters may conform to market economic demands but violate environmental protection constraints. 3. Guidance: Targeted adaptive governance measures are formulated based on comprehensive assessment outcomes. Rational changes aligned with industrial upgrading and public service improvement are legally recognized and incentivized through streamlined approval, priority land quota allocation, and support for infrastructure construction. Irrational conversions involving illegal land occupation, ecological degradation, and severe negative externalities are curbed and rectified through law enforcement, land consolidation, and ecological restoration. Meanwhile, alternative policy incentives can drive territorial functional transformation, such as shifting from secondary to tertiary industries.

## 6. Discussion

### *6.1. Theoretical Contributions*

Against the prominent mismatch between rigid blueprint planning and dynamic territorial realities in China's spatial governance, this study establishes an integrated theoretical framework, elaborates hierarchical governance logic, and proposes a technical roadmap for tiered dynamic adaptive management, aiming to enhance planning efficiency and modernize territorial governance capacity. This work complements and extends the global literature on adaptive spatial governance, which has largely been developed in Western polycentric contexts, by exploring adaptive management in a hierarchical administrative system. Its theoretical innovations are summarized in three dimensions.

The first is the construction of an integrated theoretical framework. This research systematically integrates CAS theory and adaptive management into China's unique multi-level administrative system within a unified analytical framework, providing a novel theoretical perspective for the ongoing transformation of China's territorial spatial governance.

The second is the clarification of value benchmarks for adaptive management. Existing literature generally describes ideal governance outcomes in ambiguous terms, lacking clear orientation for targeted adaptive adjustment. While the five individual dimensions are conventional considerations in spatial planning, the proposed Five-in-One criterion system innovatively integrates them into a standardized unified evaluation framework tailored for territorial adaptive governance and couples it with hierarchical governance logic and differentiated zoning regulation, establishing operable multi-dimensional benchmarks for judging rational spatial transitions. It transforms adaptive management from ad hoc contingency adjustments to proactive value-oriented governance, thereby enhancing its scientific rationality and legitimacy as a public policy instrument.

The third is the concretization of spatially implementable approaches. The zoning approach that distinguishes stable zones from change-prone zones translates the abstract connotations of planning rigidity and flexibility into visually explicit and practically enforceable spatial policies. It provides a coordinated rigid–flexible solution to the longstanding dilemma between ecological protection and socioeconomic development in planning practice.

### *6.2. Research Limitations*

Despite the systematic theoretical construction, three major limitations remain in this study:

First is insufficient empirical verification of the proposed framework. The current framework is derived from theoretical deduction and practical abstraction; its practicability, effectiveness, and implementation obstacles require further verification via empirical case studies.

Second are difficulties in quantification and the practical application of evaluation criteria. Although comprehensive, the Five-in-One criterion encounters tangible practical barriers, such as weight assignment for diverse indicators and trade-off settlement amid conflicting evaluation dimensions. These processes require sophisticated model simulation and multi-stakeholder negotiation, thereby posing substantial challenges to on-the-ground implementation.

Third is insufficient elaboration of bottom-up governance mechanisms. Although the proposed framework reserves flexible spatial adjustment space for local contexts, its overall institutional design remains dominated by top-down governance logic. This study fails to systematically elaborate on approaches to expand public participation, stimulate market innovation, and accommodate complex grassroots social networks and informal institutions.

Fourth, this study does not elaborate the quantitative operational methods for zoning. As a theoretical framework study, this paper focuses on the logical system and classification criteria of stable and change-prone zones. The quantitative algorithms and empirical validation of zoning methods will be addressed in our follow-up research.

## 7. Conclusions

Against the fundamental tension between rigid planning blueprints and dynamic territorial realities, this study systematically constructs a theoretical and methodological framework for hierarchical dynamic adaptive management of territorial space. The core conclusions are summarized below.

First, paradigm transformation emerges as a promising development trend. Based on the CAS theory, this study reveals that territorial spatial governance may benefit from a fundamental paradigm shift from static blueprint-oriented control to dynamic adaptive management. The core objective of spatial planning is no longer to formulate a fixed ultimate layout but to establish a governance system capable of guiding, regulating, and understanding the continuous evolution of territorial spatial systems.

Second, hierarchical governance provides institutional guarantees. A tiered management framework with clarified power and responsibility boundaries, which aligns with China's five-tier administrative system, lays an essential institutional foundation for adaptive territorial governance. By defining differentiated roles for each administrative tier in strategic security maintenance, regional coordination, and grassroots implementation, this framework ensures the rigid delivery of national strategic intentions while reserving sufficient flexibility for local governments to respond to contextual changes in a targeted manner.

Third, differentiated regulation constitutes a practical operational pathway. The zoning and classified governance of stable zones and change-prone zones deliver an effective approach to balance planning rigidity and flexibility. Strict protection is enforced for stable zones that carry core ecological, agricultural, and strategic spatial values, while flexible, evidence-based guidance is implemented for dynamically evolving change-prone zones, in accordance with the proposed Five-in-One scientific criterion. This integrated rigid–flexible mechanism provides an innovative practical solution to reconcile conservation and development in territorial governance.

In conclusion, this study provides a theoretically rigorous and practically feasible potential solution framework for advancing the modernization of China's territorial spatial governance system and governance capacity. The proposed framework is expected to guide the territorial system toward more resilient, sustainable, and high-quality development. Its practical applicability and implementation effect need to be further verified and improved through empirical case studies and methodological refinement in follow-up research.

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