

Policies for Sponge City Transformation in China's Old Urban Areas and Analysis of Construction and Development Dynamics

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Abstract: After a period of conceptual introduction, pilot exploration, and demonstration and promotion, the sponge transformation of old urban areas in my country has entered a phase of nationwide implementation. With the continuous introduction of supportive policies from national and local governments, the institutional framework for sponge transformation in my country's old urban areas has gradually improved, but implementation still faces certain bottlenecks. This article systematically reviews policy documents and construction data, analyzes the policies and practices supporting this transformation, and offers targeted recommendations. The study finds a positive correlation between the intensity of policy support and the effectiveness of transformation in different regions, with Tianjin, Inner Mongolia, and Jilin making rapid progress, while Tibet and Ningxia lag behind. Financial and credit support accounts for the highest proportion (24.53%), reflecting a common bottleneck for transformation across regions. Project operation and maintenance support accounts for the lowest proportion (3.46%), primarily concentrated in northern China, indicating that insufficient post-project operation and maintenance is a prominent shortcoming. Current bottlenecks include an incomplete policy system, a significant funding gap, an inadequate third-party evaluation mechanism, and insufficient internal motivation among transformation entities. Recommendations include improving the policy and standard support system, developing diversified financing mechanisms, and establishing a full-cycle management system for transformation to facilitate the high-quality development of sponge transformation in old urban areas.

1. Introduction

With rapid urbanization, older urban areas are experiencing aging infrastructure, weak drainage systems, a prevalence of combined rainwater and sewage systems, insufficient green space, and a high proportion of impervious surfaces. These issues have led to frequent urban flooding, increased water pollution, wasted rainwater resources, and degraded water ecosystems, severely restricting urban drainage capacity and improving the quality of the ecological environment.

Faced with increasingly severe challenges to the urban water environment, the concept of sponge cities emerged^[1]. In December 2013, General Secretary Xi Jinping first proposed at the Central Urbanization Work Conference to "build sponge cities with natural storage, natural infiltration, and natural purification," providing top-level guidance for my country's urban water management reform. Through systematic measures such as "infiltration, retention, storage, purification, use, and discharge," sponge city construction can achieve on-site absorption and resource utilization of urban rainwater, thereby enhancing the city's resilience to extreme climate and hydrological events.

In this context, as the key and difficult areas for urban spatial renewal, the sponge transformation of old

urban areas has become the key grasp and core content of sponge city construction. In this regard, the country has continuously strengthened top-level design and policy guidance. In 2025, the "Opinions of the General Office of the State Council on Continuously Promoting Urban Renewal Action" once again emphasized that "the construction of sponge cities in old urban areas should be promoted in an orderly manner to create a livable urban environment" ^[2], and promote the in-depth development of related work. However, the current policy framework still has significant limitations at the maintenance mechanism level, specifically manifested in: the definition of the responsible parties is vague, and there is a lack of clear division of specific responsibilities among community property, residents and relevant government departments in the maintenance work after the renovation is completed; the funding guarantee mechanism is imperfect, the source of maintenance funds is unstable, and there is excessive reliance on fiscal appropriations and a lack of diversified fundraising channels, resulting in a shortage of funds for the long-term maintenance of sponge facilities; maintenance standards and specifications are lacking. At present, only 29% of provincial administrative regions have issued maintenance policies, making it difficult to effectively supervise and evaluate the quality and effectiveness of maintenance work. These problems

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seriously affect the long-term benefits and sustainability of sponge transformation of old communities.

By 2025, my country's sponge city development has gradually moved from pilot projects to a systematic, comprehensive, and high-quality implementation phase, with significant success in many cities. These achievements demonstrate the enormous environmental, social, and sustainable benefits of the sponge city concept in the renovation of older urban areas. However, sponge city renovation in older urban areas also faces multiple challenges, including limited spatial resources, insufficient funding, inadequate management and maintenance mechanisms, and inadequate third-party evaluation mechanisms. These challenges have resulted in suboptimal results for some projects and a lack of public awareness of the benefits. To this end, this article reviews the relevant national and provincial-level policy frameworks for sponge city renovation, analyzes the progress of construction in different regions, and identifies the current institutional and technical bottlenecks hindering its implementation. Based on these findings, it proposes targeted policy optimization recommendations and support measures, aiming to provide theoretical reference and practical support for scientific decision-making and efficient implementation of sponge city renovation in older urban areas across my country.

2. Analysis of policy support for sponge city construction in old urban areas in my country

2.1. National-level policies

The policy support for sponge city construction in old urban areas in my country can be divided into the following stages^[3]:

Policy embryonic stage. Before 2013, urban stormwater management in my country was mainly based on traditional drainage systems, lacking a systematic urban water management concept^[4]. During this period, some cities began to explore the application of low-impact development (LID) stormwater systems in urban construction^[5], but a national policy system had not yet been formed.

Policy launch phase. In 2013, the Central Urbanization Work Conference first proposed the concept of "building a sponge city with natural accumulation, natural infiltration and natural purification", marking the official introduction of the concept of sponge city construction^[6].

In 2014, the "Technical Guidelines for Sponge City Construction – Low Impact Development Rainwater System Construction (Trial)" provided technical guidance for sponge city construction^[7].

In 2015, the "Guiding Opinions on Promoting Sponge City Construction"^[8] clearly stated that by 2030, more than 80% of urban built-up areas would meet the target requirements^[9]. This document clearly identified

the renovation of old urban areas as one of the key areas for sponge city construction for the first time.

Main features: The concept of sponge city has been initially introduced and a national policy framework has been initially established, but the specific policies and measures for the sponge transformation of old urban areas are still not clear enough.

Pilot promotion stage. In 2016, the "Interim Provisions on the Preparation of Sponge City Special Plans" standardized the preparation of sponge city special plans.

In 2018, the "Sponge City Construction Evaluation Standard" (GB/T 51345-2018) provided a standard basis for the evaluation of sponge city construction effects^[10].

Main features: Policies at the national level have been gradually refined, pilot projects for sponge city construction have been launched in an all-round way, and sponge transformation of old urban areas has begun to be explored in pilot cities, but policy coverage and implementation efforts are still limited.

Comprehensive promotion stage. In 2020, the "Guiding Opinions on Comprehensively Promoting the Renovation of Old Urban Communities" incorporated the concept of sponge city construction into the renovation of old urban areas^[11].

In 2021, the "Notice on Carrying out Systematic and Comprehensive Promotion of Sponge City Construction Demonstration Work" provided central government subsidy funds to support the sponge transformation of old urban areas^[12].

Main features: Sponge city construction policies have been further improved and pilot experiences have been promoted, but the systematicness and coordination of policies still need to be improved.

Deepening and improvement stage. In 2022, the "Notice on Further Clarifying the Requirements for Sponge City Construction" prioritized the construction of projects in old urban areas with prominent shortcomings^[13].

In 2023, the central government issued the "Notice on Carrying out the Third Batch of Systematized and Comprehensive Sponge City Construction Demonstration Work during the 14th Five-Year Plan Period", promoting sponge city construction through a "competitive selection + fixed-quota subsidy" mechanism.

In 2023, the "Notice on Solidly Promoting the Renovation of Old Urban Communities" clearly required old urban areas to improve drainage facilities in combination with the sponge city concept.

In 2025, the "Opinions on Continuously Promoting Urban Renewal" clearly proposed to promote the completion of sponge transformation in old urban areas, protect and restore urban wetlands, and consolidate the results of urban black and odorous water body treatment^[14].

Main features: The policy system for sponge city construction has been further improved, the sponge transformation of old urban areas has been incorporated into the important contents of urban renewal and new urbanization construction, and the systematicness and

coordination of policies have been significantly enhanced.

2.2. Local level policies

The "Opinions on Continuously Promoting Urban Renewal Action" and the "Regulations on Water Conservation" issued by the General Office of the State Council are important documents for coordinating urban renewal and sponge city construction at the national level^[15]. First, the document fully implements the preferential tax policies such as the "three exemptions and three reductions" of corporate income tax, urban land use tax, urban infrastructure supporting fees, and education fee surcharge for sponge transformation projects, and builds a basic policy guarantee framework; second, it requires local governments to strengthen differentiated incentives, support sponge transformation

in land use indicators, approval processes and other links, and form a resource factor allocation pattern; at the same time, it broadens financing channels, supports financing through urban renewal special bonds, REITs and other means, guides financial institutions to develop special products such as "sponge loans", and increases credit supply under the premise of controllable risks. Finally, a policy support system with coordinated efforts of fiscal and tax incentives, land guarantees, and financial support has been established.

Under the guidance of national policies, local governments, based on their local realities, have actively implemented policy innovations to promote the transformation of older urban areas into sponge cities. To date, all 30 provincial-level administrative regions across China have refined their support measures based on national policies. The main details are shown in Table 1.

Table 1. Support policies for sponge transformation of old urban areas in provincial administrative regions.

Classification	Project	su	Bt	Ti	H	S	Inner	Li	J	Heil	Sh	Ji	Zh	A	F	Ji	Sh	H	H	H	Gu	G	H	Ch	Si	G	Y	T	Sh	G	Qi	Ni						
		ot	in	ji	b	n	Mon	ao	il	ong	gh	gs	an	h	ia	gx	do	n	b	a	don	ng	na	qin	ua	zh	na	ou	n	et	i	u	i	a				
Land security	Prioritize ensuring the land use quota for transformation projects	27		√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√		
	Sponge facilities are permitted	6	√	√	√		√					√	√																									
Financial support	Establish a special fund	26		√	√		√		√	√	√	√	√	√	√	√	√	√	√	√	√		√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	
	Financing allowed "Sponge loan"	28	√	√	√	√	√	√	√	√		√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	
Fiscal policy	Loan discount	23	√	√	√	√	√	√	√	√			√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	
	Renovation tax exemptions	1																√																				
Technical and standard support	Central financial subsidies	2	√						√																													
	Compile local technical guidelines	30	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
Approval and management support	Establish a technical service platform	29	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
	Approval green channel	3	√	√								√																										
Public engagement	Interdepartmental collaborative mechanism	28	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
	Selection of model transformation projects	27		√		√		√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
Operations support	Establish an incentive mechanism for residents to participate	18	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√		√			√			√									
	Operation and maintenance fund subsidies	19		√			√	√	√	√	√	√	√	√	√	√	√	√	√	√	√			√		√	√	√	√	√	√	√	√	√	√	√	√	√
Retrofit assessment	Pilot operation and maintenance of entrusted institutions	9	√	√	√	√	√	√			√					√											√											
	Formulate evaluation methods	2	√	√																																		
Total	Establish an evaluation mechanism	19				√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√			√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
		21				√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√			√	√	√	√	√	√	√	√	√	√	√	√	√	√
Total		31	8	11	13	1	1	14	9	1	12	12	9	12	1	1	9	12	1	1	1	10	7	9	9	10	11	12	7	11	1	10	9					

As shown in Table 1, provincial policies focused on 18 support projects across eight categories, including land and space security, financial and credit support. Six of these projects, including prioritizing land use quotas, allowing financing, supporting central government subsidies, compiling local renovation technical guidelines, establishing a green channel for renovation project approvals, and implementing a multi-departmental collaborative working mechanism, received support from over 85% of provinces, becoming universal policies. Meanwhile, projects such as subsidies for sponge facility operation and maintenance, pilot programs for entrusting professional institutions with operation and maintenance, and establishing technical service platforms were primarily implemented in northern provinces, reflecting regional differences.

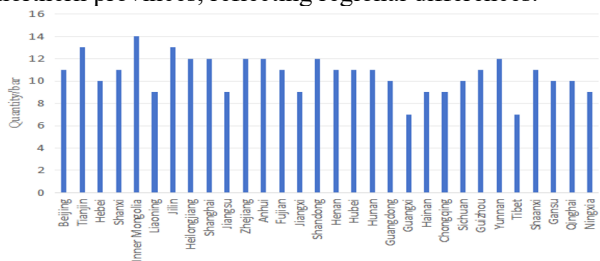


Fig. 1. Provincial administrative regions and their policy items.

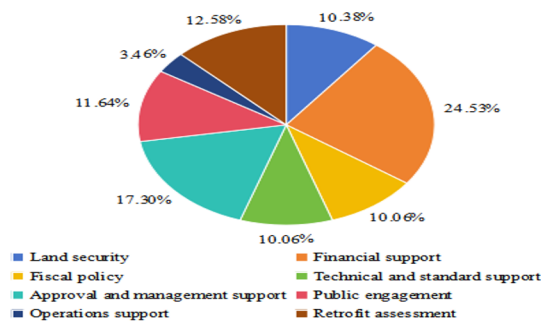


Fig. 2. Policy proportion distribution.

Fig 1 shows the number of policies per province, covering 18 projects, and a total of 318 policies across 31 provinces. Fig 1 shows the distribution of policies by province, and Fig 2 shows the policy percentage. Fig 1 shows that northern provinces such as Tianjin, Inner Mongolia, and Jilin have a relatively high number of policies (over 12 each), covering the entire supply chain, including land, fiscal and taxation, finance, technology, and assessment. Western provinces such as Gansu and Ningxia focus on technology, financial subsidies, approval support, and incentives for public participation (accounting for over 60%), reflecting the current situation of insufficient renovation funding and weak technical reserves. Fig 2 shows that financial and credit support accounts for the highest proportion (24.53%), reflecting the common bottleneck of renovation across the country. Project operation and maintenance support accounts for only 3.46%, and this is primarily concentrated in northern China, indicating that insufficient post-project operation and maintenance remains a prominent shortcoming in the sponge

renovation of old residential communities across the country.

2.3. Analysis of the characteristics of supporting policies

By reviewing the policy evolution at the national and local levels, the following characteristics can be summarized, as shown in Fig. 3.

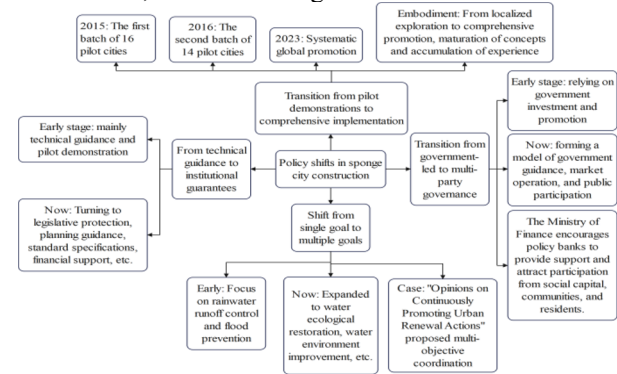


Fig. 3. Characteristics of support policies.

3. Construction status of sponge transformation in old urban areas

As urbanization accelerates, sponge-enhancing urban renewal in older urban areas has become a key measure for enhancing urban resilience. This chapter systematically analyzes the status and development path of sponge-enhancing urban renewal in my country, focusing on three key dimensions: funding gaps, technological innovation, and comprehensive benefits.

3.1. Analysis of funding gap for sponge city transformation in old urban areas

Causes of funding gaps under the policy framework.

The division of responsibilities between the central and local governments. According to the "Notice on Carrying out Urban Renewal Demonstration Work" issued by the Ministry of Finance in 2024, sponge city construction will implement a funding mechanism based on "central guidance and local participation." The central government will provide support through special subsidies and awards to demonstration cities (for example, the 2024 subsidy standard for demonstration cities will be 800 million yuan per city in the eastern region, 1 billion yuan in the central region, and 1.2 billion yuan in the western region and municipalities), but local governments will bear the primary responsibility. This "central government provides a small portion of the funding, while local governments contribute the majority" model has resulted in significant financial pressure on local governments.

Differences in renovation standards and costs. The costs of sponge renovation vary significantly across different city tiers. First-tier cities generally have higher renovation costs than small and medium-sized cities due to land scarcity and complex underground pipeline

networks. Third- and fourth-tier cities rely primarily on central government subsidies and local fiscal budgets for funding.

Financing channels are limited. Currently, the main source of funding is still fiscal funds, with low participation of social capital.

Funding gap estimation. The core estimation formula is: Gap = Total Project Investment - (Central Subsidy + Local Fiscal Support + Social Capital Investment + Other Financing). Based on this formula and policy data, the funding gap for sponge renovation in old urban areas across different city tiers is shown in Table 2.

Table 2. Analysis of funding gaps in sponge transformation of old urban areas in different levels of cities.

City level	Project Type	Unit transformation cost	Main financial sources	Funding gap ratio	Main reasons for the gap
First-tier cities	Mainly systematic projects: underground pipeline network upgrades, rainwater gardens, intelligent monitoring systems, etc.	120 million to 250 million yuan per square kilometer	Local fiscal dominance (60%-80%) + special bonds + REITs	10%-30%	Land and demolition costs; underground pipeline relocation; high-standard design
New first-tier/second-tier cities	The main focus is on local area renovation: community rainwater collection, permeable paving, and small-scale storage facilities.	80 million to 150 million yuan per square kilometer	Central government subsidies (30%-40%) + local matching funds + a small amount of PPP	30%-50%	Fiscal reliance on transfer payments; low PPP implementation rate; hidden costs not covered
Third-tier and below cities	Low-cost measures are mainly: green belt transformation, drainage ditch repair, and simple water storage tanks.	30 million to 60 million yuan per square kilometer	Central transfer payments (80%+)	50%-70%	Weak local finances; insufficient technical capabilities; and lack of social capital.

3.2. Technological innovation

The technical adaptability of sponge transformation in old urban areas directly determines the effectiveness and sustainability of the transformation. Due to the common characteristics of old urban areas such as cramped space, complex pipe networks, and diverse geological conditions, it is necessary to achieve the organic

integration of the six major functions of "infiltration, retention, storage, purification, use, and drainage" through refined technical solutions^[16]. In view of the severe limitation of spatial resources in old urban areas, adaptive technical strategies for space-constrained communities should be designed, as shown in Table 3. The flow chart of the technical solution for sponge transformation in old urban areas is shown in Fig 4.

Table 3. Adaptive Technology Strategies for Space-Constrained Communities.

Technical Strategy	Core measures	Applicable Scenarios	Maintenance requirements	Core Advantages
Vertical composite technology	Thin permeable pavement ($\leq 3\text{cm}$); roof downspout disconnection + elevated flower beds; vertical greening + facade water storage	Roads/squares, building exterior walls, garage roofs	Low (quarterly inspection)	Breaking through the limitations of plane space and adapting to old building structures
Micro-facility integration	Modular permeable paving; pocket rain garden ($\leq 10\text{m}^2$); integrated grass ditch and drainage ditch	Corners between houses, road edges, and activity areas	Medium (monthly desilting)	Efficient use of fragmented space, minimal disturbance to residents
Digital collaboration	GIS spatial suitability analysis; BIM lightweight construction simulation; IoT real-time monitoring	Areas with complex underground pipelines and high-density residential areas	High (system operation and maintenance)	Reduce transformation risks and achieve dynamic optimization
Community Resilient Governance	Resident participatory design; EOD feedback and financing; phased renovation plan	Communities with tight funding and difficult coordination	Sustained community mobilization	Alleviate funding and collaboration difficulties, and promote long-term governance and operational guarantees

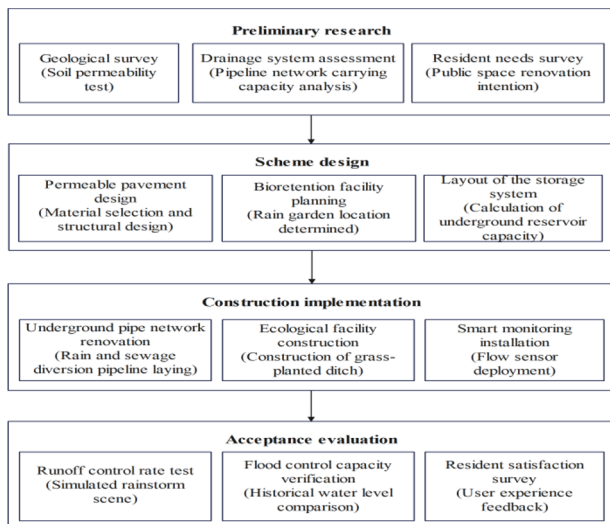


Fig. 4. Flowchart of the technical solution for sponge transformation of old urban areas.

3.3. Comprehensive Benefit Assessment

Sponge-enhancing urban renewal isn't just about engineering; it's about systematic transformation, reshaping the urban ecosystem and improving quality of life. Comprehensive benefit assessments should be holistic, focusing on key areas such as quantified environmental benefits, economic and social value, and sustainability performance. Their value and development potential should be measured through concrete results, as shown in Fig 5.

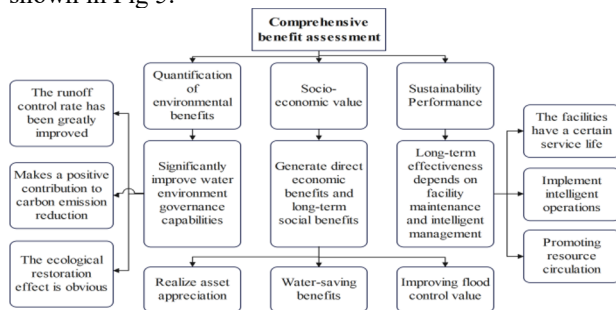


Fig.5. Comprehensive benefit evaluation of sponge transformation in old urban areas.

4. Problems and suggestions for sponge transformation of old urban areas

4.1. Problems of sponge transformation in old urban areas

Although the sponge city transformation of old urban areas in my country has achieved certain phased results under the active promotion of national and local policies, there are still several constraints in the actual promotion process.

The policy framework is still imperfect. Currently, my country's sponge urban renewal policies are still primarily based on macro-guidance, lacking detailed,

operational regulations and unified evaluation criteria. Regional implementation is limited by regional differences and insufficient resources, resulting in some measures being ineffective. Furthermore, the existing policy framework is unable to effectively address the widespread funding shortages in the renovation of older urban areas.

Spatial resources are severely limited. Most older urban areas were built in the middle of the last century and feature high building density, narrow roads, and a lack of public green space. Floor area ratios generally exceed 2.0, resulting in limited space utilization. The dense crisscrossing of various municipal pipelines in underground spaces creates complex construction conditions, hindering the rational layout and construction of sponge facilities. Furthermore, the functional coordination of sponge facilities with existing buildings, roads, and green spaces presents significant challenges, significantly increasing the difficulty of planning and design.

There's a significant funding gap. Sponge city construction requires high investment and a long payback period, especially in older urban areas, which involve comprehensive infrastructure renovation. However, current financing still relies primarily on government finances, with low levels of social capital participation. Partnership models like PPP and BOT are limited in scope, making it difficult to meet the funding requirements for these renovations.

The third-party evaluation mechanism is not sound. The evaluation of sponge city transformation results lacks unified standards and professional support. Some evaluation agencies have low entry barriers, insufficient professional staff, and a lack of full oversight of the evaluation process. This can easily lead to results deviating from actual transformation effectiveness, impacting policy feedback and subsequent adjustments.

Renovation entities lack internal motivation. Some local governments and construction companies have failed to incorporate sponge renovation into their core urban renewal strategies, lacking a long-term development perspective. This has led to low enthusiasm for renovation and a lack of social participation. Furthermore, the existing evaluation and incentive system fails to fully reflect the diverse values of ecological, environmental, and social benefits, further weakening the initiative of entities promoting renovation.

4.2. Suggestions on sponge transformation of old urban areas

Improve the policy and standard support system. We should promote the establishment of a unified and systematic policy guidance system to enhance the level of policy detail and implementation guidance. At the same time, we should establish an evaluation standard system centered on quantitative indicators, strengthen dynamic supervision and cross-regional coordination, and provide clear evidence and evaluation tools for renovation projects.

Innovate space utilization models. Faced with limited spatial resources, we should explore the development of three-dimensional and micro-spaces. This includes utilizing rooftops and walls to create rooftop gardens and vertical greening, achieving "greening wherever possible"; transforming marginal and unused land into small-scale sponge facilities such as rain gardens and pocket parks; and promoting the integration of facilities and site functions, such as integrating permeable pavement with parking lots and sidewalks, and integrating sunken green spaces with leisure plazas, to improve land use efficiency.

Improve diversified financing mechanisms. The government should increase fiscal support and promote the establishment of a multi-tiered financing system. Actively guide social capital participation and promote investment and financing models such as PPP, BOT, and TOT. Explore innovative mechanisms such as rainwater resource utilization, water rights trading, and green finance to enhance the economic feasibility and attractiveness of projects.

Improve the third-party assessment and supervision system. A system for reviewing the qualifications of assessment institutions and a mechanism for reviewing assessment results should be established to strengthen oversight throughout the entire process. By establishing a government-accredited mechanism, assessment institutions will be urged to improve their professional capabilities and enhance their sense of responsibility, ensuring that assessment results are authentic, objective, and usable.

Establish a full-cycle transformation management system. Promote closed-loop management of the entire process, from early planning and construction implementation to post-operation and maintenance, and clarify transformation goals, indicator systems, and assessment mechanisms. Improve management efficiency and ensure the continued success of transformation efforts through dynamic monitoring and feedback mechanisms. Simultaneously, promote technological iteration and management optimization to reduce long-term operating costs and enhance the overall effectiveness of the transformation system.

5. Conclusion

my country's sponge-enhanced urban renewal efforts have achieved phased progress through policy guidance and practical exploration, but constraints remain in funding, incentives, and policy frameworks. Funding is crucial for the initiation and continuation of renovations, while incentives determine their implementation and the formation of a long-term mechanism. Future initiatives should prioritize systematic governance, integrating policy support, funding channels, and management systems to promote the coordinated improvement of ecological, economic, and social benefits. This will ensure that sponge-enhanced urban renewal is better integrated into urban renewal processes and contribute to the achievement of resilient cities and sustainable development goals.

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