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Balancing Density and Green Space: A Comparison of Sustainable Land Use in Copenhagen, Singapore, and Shanghai

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Abstract. Compact development has now become the dominant paradigm in sustainable urban planning around the world, yet while density keeps rising, green space has not kept up, and the imbalance between the two is still there. Most existing research focuses on a single city, or compares cases within one institutional tradition, so systematic cross-context analysis of how cities in different institutional settings balance density and green space is still lacking. This paper builds an assessment framework on four principles, namely compact and mixed-use development, green-blue infrastructure integration, equitable access, and adaptability and resilience, and uses it to compare how Copenhagen, Singapore, and Shanghai handle this tension and the institutional logic behind their performance. The comparison shows that each city has its own strengths and weaknesses across the dimensions of the four principles. The institutional rigidity that the planning system leaves to green space is a key variable in explaining differences in city performance, though the way rigidity is realized still has to fit local institutional conditions. Policy implications should be read against institutional context. Copenhagen, as a consensus-based system, needs to prevent green space from being scattered too thinly and gradually eroded. For a contract-based system such as Singapore, the more pressing gap to fill lies in public accessibility. As for Shanghai, an administrative target-based system, what needs attention is that indicators can be met while actual outcomes fall short.

Keywords: Compact development, Green space, Institutional rigidity

1. Introduction

Compact development is often treated as a way to counter urban sprawl, and many cities have folded it into their planning strategies, yet its sustainability has been questioned ever since the concept appeared [1]. Some scholars argue that sustainability belongs to a process rather than to urban form itself [2], because in the course of densification planning documents may claim to protect green space while actual practice keeps squeezing it [3], and social outcomes have been mixed [4]. Over time the debate has widened to include how green space is distributed [5] and how well cities can withstand climate shocks [6], and both are now treated as dimensions that cannot be left out when judging the sustainability of compact cities. For Chinese cities, the peculiarities of the land system

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put land development and spatial restructuring into the hands of the state [7], a point that matters especially when analyzing Shanghai. This paper builds its assessment framework around four principles, which are compact and mixed-use development, green-blue infrastructure integration, equitable access, and adaptability and resilience. In terms of theoretical grounding, Neuman's [2] discussion of form and process, Haaland and van den Bosch's [3] analysis of how densification threatens green space, Artmann et al.'s [8] treatment of the trade-off from a green infrastructure angle, Wolch et al.'s [5] distributive justice argument, and Meerow et al.'s [6] urban resilience perspective together supply the basis for these four principles. On top of this, the paper adopts "institutional rigidity" as its core explanatory concept, measuring how firmly green space protection obligations are locked into legal or administrative systems and whether these obligations can be crowded out by other development goals in specific decisions. The three cities realize this concept in different ways, and that difference helps explain why they perform differently on the four-principle assessment.

This study adopts a structured comparative case design [9]. Copenhagen corresponds to the Nordic consensus-based planning type, while the regional strategic plan, although not legally binding, has always had stable political support. Singapore belongs to the city-state development control system, and after the green space obligation was written into the legal guidelines, every development application must be carried out in accordance with the regulations. The situation in Shanghai is different. It belongs to the Chinese land state-owned and administrative goal type, and the green space indicators are directly embedded in the administrative assessment system. The four principles are operationalized into measurable indicators, including per capita green area, Green Plot Ratio, and park accessibility coverage rate, etc. The literature search is mainly conducted on China National Knowledge Infrastructure, Bing Scholar, and Google Scholar. The search terms cover compact city, green space, green infrastructure, urban resilience, sponge city, etc., and the time range covers 1996 to 2025. In terms of data sources, peer-reviewed literature from the three cities [10-12] and official planning documents jointly form the basis, including Copenhagen's Fingerplan 2019 [13], Singapore's Master Plan 2019 [14], and Shanghai's 2035 Master Plan [15].

The contributions of this paper can be read from three angles. In scope, existing work mostly centers on a single city or compares cities within one institutional tradition, while this paper brings three institutional types, namely the Nordic consensus-based system, the city-state development control system, and the Chinese state-ownership plus administrative target system, into a single assessment framework for cross-case comparison, thereby widening the institutional coverage of comparative research. In assessment, the four principles are operationalized into measurable indicators, making the evaluation criteria transparent and easier to compare across cities. In explanatory logic, the paper takes institutional rigidity as the main lens, distinguishes three forms of rigidity, namely planning consensus, statutory contract, and administrative targets, points out their differences in origin, speed, and persistence, and clarifies the boundary of transferability between policy tools and institutional prerequisites.

The paper is organized in five parts. Section 2 evaluates the three cities under the four principles. Section 3 moves to the cross-case comparison and focuses on institutional rigidity and transferability. Section 4 builds on the analysis to offer further reflection and discussion. The final section closes with the main findings, the study's limitations, and possible directions for future research.

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2. Four-principle assessment

2.1. Compact & mixed-use development

Copenhagen's compact form starts with the 1947 Finger Plan. The city grows along five radial rail corridors that fan out like fingers, and the land between them stays open as green wedges for agriculture and recreation [10]. The idea was to concentrate housing, commerce, businesses, and public institutions in finger towns where infrastructure was already in place, and later rounds of regional planning kept repeating this basic structure [13], so it is still the framework the metropolitan region has to work within. Fingerplan 2019 goes further and requires the 34 municipalities in the Capital Region to follow its provisions, principles, and area designations when they draw up their own municipal and local plans [13]. What finally emerged is a metropolitan form with a compact core, corridors running outward along the rail lines, and protected green wedges sitting in between.

Singapore keeps its city compact through statutory development control and public land management. The Urban Redevelopment Authority (URA) prepares Master Plan 2019, which turns long-term strategic planning into plot-level guidance on how land and property should be developed [14]. Public housing carries much of the weight in this high-density form. The Housing and Development Board (HDB) has delivered more than 1.25 million flats, home to around 80 percent of the resident population [16], and the new towns spread across the island are connected by a transport network of roads, rail, and buses [17].

Shanghai organizes compactness through administrative planning targets, which makes it different from the other two. According to 2024 data, the seven central districts of Huangpu, Xuhui, Changning, Jing'an, Putuo, Hongkou, and Yangpu hold about 6.35 million permanent residents on roughly 289 square kilometers, an average density of about 21,900 people per square kilometer and well above the citywide figure of about 3,900 [18]. The Shanghai 2035 Master Plan defines [15] the central city as the area inside the outer ring road, plans for about 664 square kilometers and 11 million people, and requires new towns to stay above 12,000 people per square kilometer. The 15-minute community life circle asks neighborhoods to provide education, medical care, and elderly care within walking distance [19]. The compactness logic here is that walkability shapes how space is organized, residence, employment, and public services end up close together, and population size in turn supports the provision of facilities, so compactness works down to the community scale.

Looking at the three cities side by side, the institutional logic behind compactness differs in each case. In Copenhagen, what binds is a consensus built at the regional planning level. The Finger Plan itself has no legal form, and its force comes from being reaffirmed again and again through successive regional plans. Singapore relies on statutory development control, with density and greening requirements written into plot-level statutory guidelines that development applications cannot bypass. Shanghai's leverage lies in administrative targets, since indicators for density, services, and green space all enter the master plan and the assessment system. Consensus, contract, and administrative targets serve as the institutional pivots through which the three cities realize compactness.

2.2. Green & blue infrastructure

Copenhagen's green and blue infrastructure is organized mainly at the regional scale. The Finger Plan keeps the wedges between its fingers as green space, and these wedges run from the outskirts into the city, linking up into a network of recreational and ecological corridors [10]. On the blue

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side, the system ties into surface stormwater management. The Cloudburst Management Plan puts parks, boulevards, and detention basins along the drainage routes, so the retention facilities themselves become part of the open space [20]. Fingerplan 2019 still asks municipalities to protect the wedges, keeping this ecological framework in place [13].

Singapore works plot by plot and puts the requirements straight into regulation. Under the Green Plot Ratio, new developments have to reach a minimum leaf area index, so greening stops being an aspiration and becomes a statutory duty for developers [21]. After fifty years of systematic greening, Singapore has moved toward the City in Nature vision under the Singapore Green Plan 2030 [22], with parks, nature reserves, and park connectors all part of the expansion [12, 23].

Shanghai builds its green infrastructure through administrative targets, and the growth in scale has been fast. Between 2000 and 2020, park green area went from 4,812 to 21,981 hectares, the number of parks moved from 122 to 406, and per capita park area climbed from 2.93 to 8.84 square meters. The Thousand Parks City campaign pushed much of this growth along, and most of the new parks sit in the outer areas, which is meant to even out the spatial distribution of green space [11].

When the three cities' green and blue infrastructure is set side by side, the differences in structure and distribution become clear. Copenhagen puts green wedges and stormwater corridors into one framework at the regional level, which protects the coherence of the ecological system. Singapore presses greening requirements down to the plot scale and enforces them through the Green Plot Ratio, so delivery standards are clear and results are predictable, yet once plot boundaries multiply, green space becomes easy to fragment. Shanghai relies on administrative targets to push rapid growth in total volume, with new parks concentrated in the peripheral areas. The three paths correspond to regional structure, plot-level rules, and aggregate targets, so the integration of green and blue infrastructure ends up taking different forms.

2.3. Equitable access

Copenhagen's green wedges are mainly agricultural and recreational space. The Finger Plan lines each finger with good transport, so residents of the compact city can get out to open landscapes quickly. Urbanization pressure has not fallen evenly on the wedges, though. As neighboring municipalities expanded, the narrow inner section of the Hjortespring wedge mostly disappeared, and green space access could no longer be assured equally across the region [10].

Singapore shows how good-looking supply indicators can hide accessibility gaps. The government plans to build 500 kilometers of park connectors by 2030, with every household within a ten-minute walk of a park [23]. The Green Plot Ratio, though, only counts the total leaf area on a plot and says nothing about how much of it the public can actually enter [21]. Private green space lost to densification is usually not replaced by new public green space either [3]. A lot of sky greenery works well ecologically, but what the public can actually use stays limited.

Shanghai's case shows how aggregate indicators can overstate accessibility. The overestimation means that a static model based on current population distribution returns higher park accessibility results than a dynamic model based on future population projections. Cen and Xiao [11] found that a static per capita park area model overestimates park accessibility by about 40 percent, and among the spatial units in urban Shanghai defined at the residents' committee level, roughly 71 percent were overestimated by the static model while 7 percent were underestimated. The overestimated areas concentrate in the transition belt between the inner and outer ring roads where population is still growing, which reflects a mismatch between current park supply and future demand that cannot be evenly reconciled [11].

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Taken together, the three cases show that the difficulty of equitable access lies not in whether total green space is sufficient, but in the fact that totals cannot reflect how much green space residents actually get. Copenhagen's wedges are open to the public, yet they disappear locally under urbanization pressure, leaving uneven access within the region. Singapore's green volume numbers look strong, but the indicator follows leaf area rather than public accessibility, so sky greenery does not easily translate into green space that residents can use in daily life. Shanghai's supply has grown quickly, while static indicators overstate accessibility. Equity problems take different shapes in the three cities, and identifying them calls for attention to each city's indicator design and spatial structure.

2.4. Adaptability & resilience

Damage from the 2011 cloudburst in Copenhagen came close to one billion euros, and the city answered within a year by issuing the Cloudburst Management Plan. The plan brings parks, boulevards, and detention basins into surface stormwater management, so the city no longer depends on underground pipes alone [20]. It also reflects the same consensus-based planning culture behind the Finger Plan, which lets the city adjust land use quickly after a major shock.

Urban resilience is explicitly listed as one of the five pillars of the Singapore Green Plan 2030 [22]. PUB, Singapore's national water agency, reports that close to SGD 2 billion has been invested in drainage improvement works over the past decade to cope with more intense weather events [24]. PUB has also kept upgrading drainage infrastructure to ease inland flash floods, while long-term coastal protection planning is underway to address sea level rise. These investments are delivered through statutory development control, which lets drainage and greening requirements take effect quickly.

Shanghai's adaptation path runs through the national sponge city program and its local implementation. The State Council's guiding opinion requires cities to absorb and use 70 percent of annual rainfall on site [25]. Shanghai's 2024 implementation opinion then sets more concrete targets, with more than 40 percent of the built-up area required to meet sponge city standards by 2025 and more than 80 percent by 2030. The requirements also enter planning conditions and land transfer contracts, which makes flood adaptation a precondition for development [26].

The three cases show that adaptability and resilience enter urban water management through different institutional mechanisms. Copenhagen, after the 2011 cloudburst, moved from disaster response to planning adjustment within a year, and its resilience rests on a consensus-based planning culture. Singapore places resilience among the five pillars of its national green plan and builds it over the long term through sustained drainage investment and statutory development control. Shanghai treats sponge city targets as the core, writing requirements for on-site rainfall retention and the share of compliant built-up area into planning conditions and land transfer contracts, so resilience becomes a precondition for development and construction. All three cities take the water system as their point of entry, but resilience arises from event-driven rapid response in Copenhagen, institution-driven sustained investment in Singapore, and target-driven regulatory constraint in Shanghai, which again maps onto the differences in the three forms of institutional rigidity.

3. Cross-case comparison

Comparing the three cases shows that the differences among the cities are shaped, to some degree, by institutional rigidity, that is, the extent to which green space protection obligations are locked into

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institutions, as mentioned in the introduction. The three cases correspond to three different forms of rigidity.

For Copenhagen, rigidity grows out of consensus at the regional planning level. The 1947 Finger Plan was never enacted into law, yet the design of the green wedges kept being reaffirmed through successive regional plans, and by now it effectively carries binding force. Fingerplan 2019 requires the 34 municipalities in the Capital Region to follow its provisions, principles, and area designations [10, 13]. Building this kind of consensus-based rigidity is slow and takes time, but once it is established, it tends to sustain itself.

Singapore builds rigidity through statutory development contracts. The Master Plan 2019 and plot-level requirements such as the Green Plot Ratio are written into statutory guidelines and strictly enforced in every development application [14, 21]. This arrangement works fast and stays transparent, but enforcement capacity has to keep up, and green space can easily fragment at the plot scale.

Shanghai's rigidity runs on administrative targets. Sponge city and green space requirements are set through five-year plans and implementation opinions, then incorporated into planning conditions and land transfer contracts [26]. This administrative approach can pull resources together quickly, but it is exposed to shifts in priorities, and indicators may be met while actual outcomes fall short.

Table 1. Comparison of the three cities across the four principles

City	Compact and Mixed-Use Development	Green and Blue Infrastructure Integration	Equitable Access	Adaptability and Resilience
Copenhagen	Finger Plan creates rail corridors and a compact core, with green wedges protected by regional planning	Green wedge corridors combined with surface stormwater systems	Green space is publicly accessible, but wedges are eroded by expansion and unevenly distributed	Cloudburst Management Plan issued within a year of the 2011 storm, showing a quick response
Singapore	Statutory development control supports high-density HDB new towns	Green Plot Ratio makes greening a statutory obligation, supported by park connectors	Supply-side indicators are strong, but public use of sky greenery is limited	Statutory drainage investment keeps being upgraded to cope with flooding and sea level rise
Shanghai	Administrative targets and the 15-minute community life circle organize compact services	Park green area expands rapidly, with sponge city requirements included in development conditions	Aggregate indicators overstate actual accessibility, and supply and demand are mismatched	Sponge city targets enter planning conditions and land transfer contracts, advancing through institutionalization

Three observations follow from these comparisons. No city performs evenly across all four principles. The three forms of rigidity differ not only in origin but also in speed and persistence, with administrative rigidity working quickly yet depending on enforcement will, consensus rigidity building slowly but sustaining itself once formed, and contract rigidity staying fairly predictable as long as supervision continues. Transferability is constrained by land property rights, political structure, and city size, so policy tools can be borrowed, but the institutional conditions that make them work cannot simply be copied.

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4. Reflection and discussion

The real strength of institutional rigidity cannot be judged from what documents say alone. It has to be tested along four dimensions. At what level are green obligations set, in binding regulations or merely in advisory plans? Who has the power to override an obligation, what procedure has to be followed, and does it require legislative amendment? Has the obligation ever been broken in past practice? And how strict is compliance review, project-by-project approval or only aggregate oversight? Only when the four dimensions are considered together can we tell whether rigidity is a promise on paper or an institution that can actually sustain itself.

Reading the three cases through this lens, Copenhagen's Finger Plan lacks legal form but has been continually reaffirmed in regional plans, and Fingerplan 2019 requires the 34 municipalities to follow it. Breaking the plan would mean breaking a regional consensus, yet the inner narrow section of the Hjortespring wedge was still eroded by urbanization, which shows that consensus constraints are not invulnerable. Singapore's Green Plot Ratio is checked in every development application, so compliance within a single plot is not a problem, but green space easily fragments along plot boundaries. Shanghai's sponge requirements are written into land transfer contracts and planning conditions, giving clear project-level constraints, yet the strength depends on administrative assessment, and indicators can be adjusted within the five-year planning cycle, leaving a risk that meeting indicators substitutes for meeting real outcomes. Whether a form of institutional rigidity is sustainable depends less on whether it is written into law and more on who can break it, how much breaking it costs, and whether assessment indicators are tied to real green space outcomes.

5. Conclusion

Drawing on the four-principle framework for sustainable urban land governance, this paper assesses how Copenhagen, Singapore, and Shanghai balance density and green space. The assessment shows that no city performs best on all four principles. Institutional rigidity offers a lens for explaining differences among cities, and this perspective adds something to compact city theory. Existing research has argued that sustainability is a property of process rather than form, and the findings here suggest that institutional rigidity is one of the factors affecting the sustainability of that process, since cities that alike pursue density and green volume end up with different results because of how green obligations are realized. Transferability is also constrained by institutional conditions such as land property rights, political structure, and city size. Tools can be borrowed, but the institutional conditions that make them effective cannot be moved directly. For a consensus-based system such as Copenhagen, the way forward is to prevent green space from being eroded through fragmentation and to anchor regional consensus in binding municipal arrangements. Singapore's contract-based system needs to add public accessibility requirements on top of green volume. Shanghai's administrative target-based system should guard against fulfilling indicators while ignoring actual outcomes. Before transferring experience, a city needs to assess whether its own land property rights, political structure, and city size fit the theory in question.

This study has limits that are worth acknowledging. The four principles did not get the same quality of data. Shanghai's accessibility can be measured with population-weighted estimates, Singapore is judged mainly through its 2030 policy targets, and Copenhagen has no official accessibility statistics, so the analysis there has to lean on planning evidence. Comparing cities at this level also flattens differences that exist at the neighborhood scale. Since the sources are literature and policy documents rather than fieldwork or stakeholder interviews, the study mostly captures planning intention instead of implementation outcome. Future work could take the same

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framework to more cities, test it in other institutional settings, and watch how institutional rigidity shifts over time.

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