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Planning Compact City in Rapidly Growing Cities—An Estimation of the Effects of New-Type Urbanization Planning in Hangzhou City

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Abstract: The Chinese New-type Urbanization (NTU) Plan indicated a major shift in planning towards compact development. This study developed an integrated framework to estimate the effectiveness of planning in promoting compact development in rapidly growing cities. We analyzed the coherence and conformance of planning, as well as the development outcome from a multi-dimensional perspective of compactness. Spatial data of both private and public development projects and big data of POI were employed for analysis in the case of Hangzhou. The findings indicate that land development efficiency and intensive urban functions at the local scale were significantly promoted after NTU planning's initiation. However, the planning was inefficient in leading a more centralized development at the city scale. This could be attributed to the inability of the planning to resolve conflicts between growth pressure and compact goals, which is reflected in the incoherent control between the master and local plans. The inefficiency is further underlined by the insufficient connection between city-wide and subject plans, as well as the permanent planning of the Urban Development Boundary without specific tools. Particularly, planning performed weaker in controlling public projects due to dual-track planning institution. These conclusions suggest the urgency of enacting a planning system that dynamically links plans of different scales and functions as a crucial element for implementing compact development in rapidly growing areas.

Keywords: new-type urbanization; planning effects; compact development; rapidly growing; Hangzhou

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1. Introduction

There is a growing interest in compact city planning as a promising vision to combat urban sprawl [1–4]. It has been suggested that a sustainable city is also a compact city [5]. The vision has been mainly formed by the idea of a densely developed core of European cities [6]. Even though there is no clear or generally accepted definitions of compact city, some aspects, such as concentrated, dense development with mix uses that intensify land efficiency and proximity of services, are commonly used dimensions to describe the "compact city" or "compact development" [7]. Compact development has been adopted as a guiding concept in the planning documents of various cities across the world. However, the practices of compact city planning were mostly implemented and discussed in the context of developed areas experiencing post-growth urban dispersion or even urban shrinking [8–11]. Nevertheless, the excessive supply of cheap suburban land and urban sprawl often increases fiscal stress in less-developed regions, which implies the need for efficient planning control in promoting compact development [12].

Chinese cities have undergone a high-speed urbanization since the economic reform in 1978. The evidence suggests that the national urbanization rate has risen from 17.9% in

1978 to 53.7% in 2013. This trend has brought conflicts in low-efficiency and consumptive land use, unreasonable urban structure and size, "urban diseases" such as transport congestion, environmental damages, and so forth in large cities. For instance, during 2000–2012, the urban built-up area has increased 76.4%, while at the same time the increase rate in urban population was 50.5%. Thus, in 2014, the Central Committee of the Communist Party of China (CPC) and the State Council of China jointly released the National New-type Urbanization Plan (NUP, 2014–2020). The plan indicated that China has entered the period of economic transition, which meant that the upgrade and facilitated modernization of the socialist country needs to transform from traditional extensive urbanization toward a new-type urbanization (NTU) focused on high quality development. As one prospect of the sustainable development, the compact city model is especially appealing. Therefore, one of the main targets of NTU is the promotion of compact and efficient urban growth characterized by intensive and mixed land use, as well as transit-oriented development.

The NTU has been frequently cited in official reports of local governments, and efforts have been made to apply the compact development strategy into plans. For example, in 2014, the Ministry of Housing and Construction and the Ministry of Land Resources jointly selected 14 cities to conduct the experimental planning of urban development boundary (UDB) to control excessive urban expansion. The implementation of NTU has drawn broad interest as an indication of the transformation of urban policies and planning in China [13]. However, the effects and outcomes of NTU planning are controversial. Although improvements were made in balancing urbanization at the national scale, the land-centered urbanization is still ongoing. Even some new development modes vigorously carried out by local governments under the title of NTU are actually land urbanization [14]. These new modes of NTU may unintentionally provide excuses for land expropriation, evidenced by uncurbed increment of land sale revenue. It is becoming clear that urban expansion is likely to continue regardless of NTU, which calls for profound planning reforms [15]. Deng revealed that NTU had a positive impact on the sustainability of land use, but the current level of land use efficiency in most cities is far behind NTU targets—evidenced by the frequent urban sprawl [16]. Moreover, the compactness of urban development and intensity of land use show an increasing trend from the aspects of investment density and economic output per land, but the coordination of development is basically unchanged [17]. Moreover, in general, land eco-efficiency has increased during the NTU period; however, the effects are distinctively different due to varied development strategies of NTU adopted by local cities [18]. This points to the necessity of rational investigation of the effects of NTU planning implemented at an intra-urban scale to reveal specific planning issues.

Even though a consensus has been reached that verifying planning outcomes can contribute to the accountability of public institutions and should guide improvements in plans and practices [19], little is known about whether NTU planning has achieved the spatial goals set in the NUP, such as compact development, and the evaluation of performance remains rather undetermined. Moreover, studies that attempted to preliminarily assess NUP outcomes were either qualitative descriptions of the progress and achievements of the plan from a general view of urbanization at the national/regional scale [14,15], or developed indicators to quantify NTU and its implementation [20,21]. For instance, Deng (2021) developed a system of proxy indices to incorporate NTU policies into a regression model, such as the proportion of urban population, construction land per capita, etc. [16] Even though conceiving the compact city in terms of a process rather than form holds more promise for sustainable development [1], the associations between the planning practice of compact development and spatial form is barely explored, and a theoretical framework to comprehensively estimate the effective of urban planning is almost absent.

This study aims to bridge this gap and provide evidence on the performance of NTU planning from the spatial dimension. The research questions are:

(1) How effective is the NTU planning in guiding and regulating development in rapidly growing areas?
(2) Does NTU achieve the objective of compact development? Or is the urban development under the NTU planning regulation more intensive and compact?
(3) What are the main obstacles in achieving compact development with NTU planning? How to improve the performance?

To address these questions, our study develops a framework for evaluating the effectiveness of NTU planning from the perspective of compact development. The focus is on the interaction of plans during the planning process that affects urban development forms. The results reveal critical issues in the implementation and performance of NTU planning and shed light on possible improvements to achieve the goal of compact development. Evaluating the effects of urban planning in promoting compact development in rapidly growing cities of emerging regions can provide hints for building an effective planning system that supports the sustainable urban development of such areas.

2. Theoretical Framework

It is widely accepted that spatial planning influences land use pattern and urban form. However, conceptualizing the role of planning in guiding urban development is quite challenging [22] and the evaluation of the effects of plans is rather ignored or overlooked [21]. Quantitative research that estimates the impacts of urban policies or planning on development is often performed with regression models that use urban planning or governance as a single indicator [23–26]. Another group of studies estimates potential effects of planning or land use policies by simulating urban development under different planning scenarios [27,28]. Nevertheless, this simplification of the planning factor can hardly explain the complex relationships during the implementation of planning nor can reveal critical issues that are insightful for political decisions. On the other side, much of the qualitative assessment of the effects of urban planning are usually historical narratives of developments and the role of urban planning in this process [29,30], which are relatively subjective in the evaluation criteria and sketchy in the assessment of planning outcomes.

There are two general directions of evaluation in planning: (1) plan evaluation that focuses on the plan's quality and its outcomes and (2) the evaluation of planning practices and processes. Accordingly, performance- and conformance-based approaches are the two main models of post-plan evaluation [31]. In general, there are two criteria for estimating the conformance of planning: (1) the degree to which outcomes on the ground conform to planning goals and (2) the extent to which implementation instruments support planning goals [32,33]. The conformance studies are often GIS-based comparisons of planned and actual urban development, where the goal is to identify discrepancy between the real and the planned land use [34–37]. Others focus on the effectiveness of a specific planning tool, such as green belts or growth boundary, by checking if the real development corresponds to the aims of planning policy [38,39]. Usually, a matching rate would be used to indicate this conformance [40]. Still, quantitative estimations are rare, especially for strategic and large-scaled plans. The focus is often on the process performance and plan utilization, i.e., if the planning concepts are influential in local programs and policy decisions [41], or by evaluating the partnership and coherence during the planning [42].

Although research on the planning practice and its impacts on urban development are equally necessary [39], only a small number of studies attempt to address both. The exceptions are Laurian et al. (2010), who used a triangulated approach to integrate the evaluation of plan coherence in the plan implementation and observe data-driven outcomes (known as plan-outcome-evaluation or POE methodology) [14], and Oliveira and Pinho (2009, 2010b) that developed a Plan-Process-Results (PPR) approach to evaluate the implementation and outcomes of plans by using a checklist procedure [43,44]. Attributing outcomes to plans is difficult when external factors are considered. However, a "soft"

comparison of outcomes and planning goals and logical reasoning to identify linkages could be conducted in such a case [45,46]. Associations between plans and outcomes or between intended goals and actual implementation also can be ascertained through methods using discriminating indicators [47], or tracking performance over time to establish the covariation of programs and outcomes [48]. In addition, Hersperger et al. (2018) stress that planning evaluation should make use of spatially explicit tools to assess whether land changes have occurred, as well as to determine their spatial distribution [22]. Therefore, combining a qualitative analysis of planning practice with a temporal comparison of explicit indicators of development outcomes could contribute to a detailed clarification of planning effects capable of revealing critical issues for political decision-making.

The planning system in China is theoretically hierarchical, but there have been cases where multiple plans interact with each other at different levels of the system [49]. Local plans that directly regulate development projects are drawn by three different departments—the Urban Planning Bureau, the Bureau of Land and Resources, and the Development and Reform Commission. The city's spatial plans—Master Plan (MP) and Detailed Control Plan (DCP)—are mainly prepared by the Urban Planning Bureau. Development permits are granted by the Urban Planning Bureau for both private and public developments. The Land and Resource Bureau is responsible for drafting Master Land Use Plans, the primary focus of which is to designate farmland conservation zones and to control the supply of land for construction. At the same time, five-year economic and social plans are made by the Development and Reform Commission to guide the entire development of the city.

At the end of 2013, a report of the Sixth Plenary Session of the 16th CPC municipal committee pointed out the need for a revision of Hangzhou city's plans to promote an urban system of a "compact city". Since then, "establishing the ideology of a compact city and smart growth" and "facilitating urban intensification based on urban renewal" have been frequently mentioned in the municipal government work reports and various action plans of Hangzhou. Under guidance of the municipal NTU strategies, a multi-level and diverse planning system of NTU was established (Figure 1). For the general plans, in the spatial MP, land use master plans, district plans, and DCP, a permitted/conditional building area is designated to control urban expansion. In the Hangzhou's MP of 2001–2020, which was revised in 2014, and in the district plans afterwards, urban renewal and designated urban redevelopment areas were highlighted to serve as a main focus for densifying.

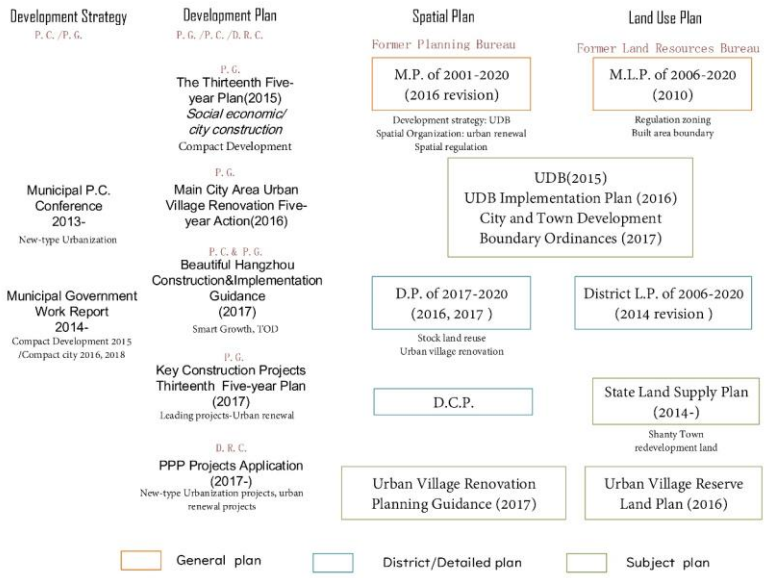


Figure 1. The NTU planning system in Hangzhou. (P.C.: Municipal CPC Party Committee; P.G.: Municipal people's government; D.R.C.: Development Reform Committee; M.P.: Master Plan; D.P.:

District Plan; M.L.P.: Master Land use Plan; UDB: Urban Development Boundary; D.C.P.: Detailed Control Plan).

For the subject plans, Hangzhou announced an Urban Development Boundary (UDB) plan in 2015. The development boundary was drawn to protect existing green land and farmland conservation areas outlined in MPs and Land Use Plans. All development outside the boundary was strictly prohibited to contain extensive urban expansion, while urban intensification inside the boundary was intended to be promoted. On the other hand, Urban Village Renovation Guidance Plan and Urban Village Reserve Land Plan were compiled to promote planning of diverse service facilities for the functional intensification in renovation areas. Moreover, since 2014, the annual Land Plan largely increased the supply for shanty house area renewal and low-efficient stock land redevelopment, which provided resource support for urban redevelopment and land use densification. In sum, the control of urban expansion was mainly pursued through general plans and planning of UDB, while the intensification was promoted by subject plans for urban renewal.

This study developed a coherence–conformance-effects framework to comprehensively evaluate the effectiveness of NTU planning practice in Hangzhou city. The evaluation focused on the perspective of compact development. We first checked the vertical consistency between different levels of urban planning in the plan-implementation process, including relationships between the MP and district plans, the MP and subject plans, and the MP and DCPs, as well as the consistency between the Master Land Use Plan and District Land Use Plans. Further, we analyzed the horizontal coordination between plans of different functions, specifically, the coherence of planning goals and development regulations, the coordination of economic and social plans, and the rationality of Master Plans and Master Land Use Plans. Secondly, the conformance of planning was evaluated by comparing plans with actual development. At last, the effects of planning on compact urban development were estimated by quantitatively comparing the compactness of urban development before and after the implementation of NTU planning.

3. Materials and Methods

3.1. Study Area

Hangzhou is a regional central city on the Yangzi River Delta—the most economically strong area of China. As the capital of Zhejiang Province and a center for digital economy, Hangzhou underwent striking population growth and urban area expansion during the past decade. The city's population has reached 11.93 million in 2020, with a national top-level population increment index of 55.57% compared to 2010, while the increase rate of construction was 61.46% in the last decade. Thus, among Chinese cities undergoing dramatic growth in recent years, Hangzhou is the most outstanding one. Moreover, as discussed above, in 2014 Hangzhou was selected as an experimental city to conduct the UDB planning and the municipal government has consecutively set "compact city" as the main development target in social-economic plans, under the guidance of which a relatively mature NTU planning system has been constructed in the city.

The registered urban population of the city in 2020 was 5.68 million, while the city's urban built-up area was 666.18 km^2. In this study, we focused only on the main urban area of approximately 3334 km^2, where most of the population and urban development is clustered.

3.2. Plan Evaluation–Coherence and Conformance

Based on the theoretical framework, at first, a variety of plans implemented under the NTU were reviewed. The coherence of planning goals between different functional plans was analyzed by document scrutinizing. Development boundaries of the planning maps were digitalized in GIS so that the consistency of development regulations between plans could be verified.

In the land market of China, urban land is state-owned, while rural land is collectively owned by villagers. Only local governments have the right to transfer rural to urban land and lease that land to developers in case of profit-use projects or public projects designated on administratively allocated land (public facilities or public/resettlement houses). Thus, the second step was to obtain records of leased and administratively allocated land from www.Landchina.com for the analysis of the distribution of actual urban development. The dataset includes information on the project name, period of development, location, FAR, and function of the developed land. A total of 2620 development projects were recorded in the main urban area of Hangzhou between 2010 and 2020. Projects with industrial use are not included in this number because those projects are mostly clustered in the industrial zone and leased by negotiation. One thousand six hundred and seventy-seven of the total projects located in the main urban area were developed on leased land for profit (residential or commercial use), and another nine hundred and forty-three were developed on administratively allocated land by public institutions.

Subsequently, the comparison between distribution of development projects and planned areas was conducted via spatial overlay functions in GIS to estimate the conformance of developments to urban planning.

3.3. Measurement of Compact Development

As one prospect of sustainable development, the compact city is especially appealing for urban planning under NTU. Based on previous research, generally accepted characteristics of the compact urban form could be found in the contained urban expansion, higher density or intensive development, mix land use, and so forth [7]. While previous studies often used statistical parameters such as population density, built-up density, etc., for assessing compactness [50], this study primarily focused on indicators that reflect development patterns and practical urban function. Thus, by combining the general understanding of compact development and the explanation of compact development in the NUP—intensive development and efficient land use—in this study, we developed multi-scale indicators to estimate the compactness of developments.

1. Centralization

The original vision of compact city was a contained city with clear boundary between urban and rural areas [6]. Thus, the concentration of developments inside the urban area, especially the agglomeration in the central urban area, is widely accepted as the main feature of a compact city. Thus, the centralization in this study was estimated based on whether the development project was carried out in the central urban area designated by the MP, including sub centers. If that was true, the value for that development would be 1; otherwise, it would be 0.

2. Land efficiency

Density is the most common interpretation of a compact city [51]. Median-high density of built form could be achieved by efficient land use, where land parcels are densely occupied by buildings rather than partially built or left idle. Thus, efficient land use is one of the important indicators to measure compact development pattern. The land efficiency in this study was estimated according to the renewal aspect of the project in three levels: if the project was a redevelopment carried out on low-efficient urban stock land (urban vacant land, previously urban construction land, urban villages, etc.), the indicator value obtained would be 2; if the project was carried out in a rural village, the value would be 1; and if the project was carried out on natural or farmland, the value would be 0. To this end, the land use condition before the development was checked through historical satellite images with Google Earth Pro.

3. Functional intensity

The compact city is also envisioned as a vibrant city that provides a diversity of facilities [7,52]. In the compact city, transit needs would be largely reduced by allocation of

plentiful services nearby housing. This means that the compact city is not only physically intensified by density of built, but also functionally intensified by varied and sufficient service facilities of good accessibility. Thus, functional intensity could be more representative of a compact city. In this study, the intensity of urban function was investigated through the density and diversity of service facilities in the local area.

Facility Density (FDE) was measured as the number of total facilities per area in Equation (1), while the Facility Diversity (FDI) was measured by the Shannon–Weiner index in Equation (2):

$$\mathrm{FDE} = \frac{f_m}{A} \tag{1}$$

$$FDI_j = -\sum_{i=1}^{m} \left(\frac{f_i}{f_m} \times \ln \frac{f_i}{f_m}\right) \tag{2}$$

where f_i stands for the number of facilities of type i (car service, financial service, restaurants, shops and markets, medical service, daily service, culture and educations, sports and entertainments, toilets and newsstand) and f_m is the total number of facilities of total m types. *A* stands for the area of the study zone. Big data of Points of interest (POI) from Amap navigation were used for counting service facilities.

Finally, a one-way analysis of variation (ANOVA) was employed to investigate the variations of compactness of urban development in different planning periods to identify if the NTU planning promoted more compact development. The time span of the data is from 2010 to 2020. According to the planning transformation of Hangzhou and considering the time-lag of planning effects, we divided the observations into three periods for comparison: prior NTU period (2010–2013), transit period (2014–2016) during which most of the NTU plans were initiated, and NTU period (2017–2020). The research design is shown in Figure 2.

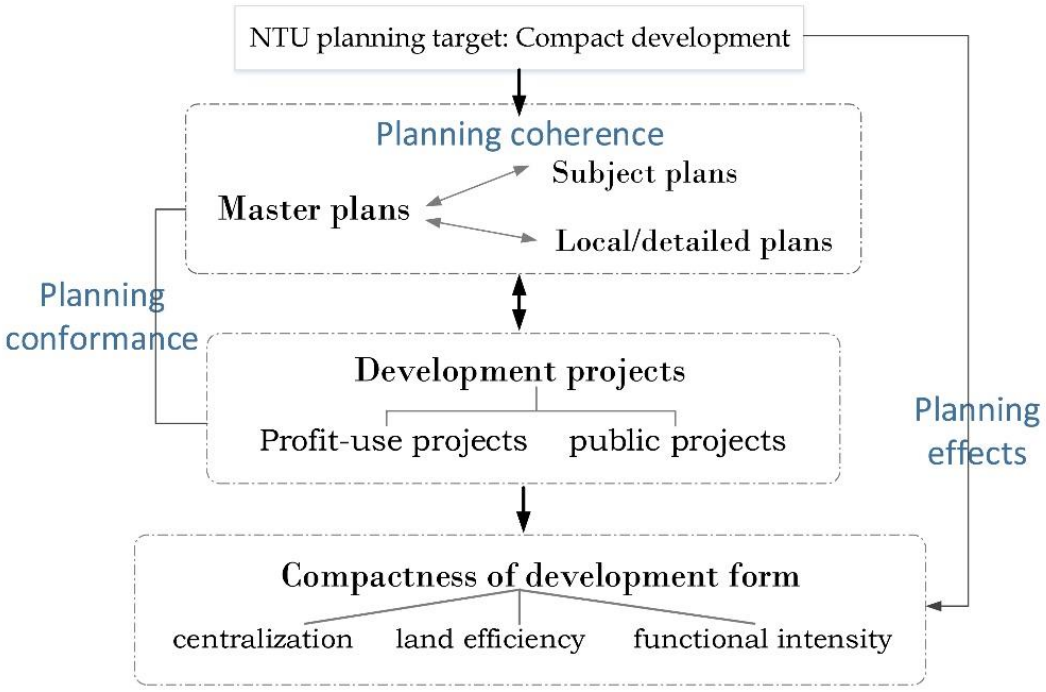
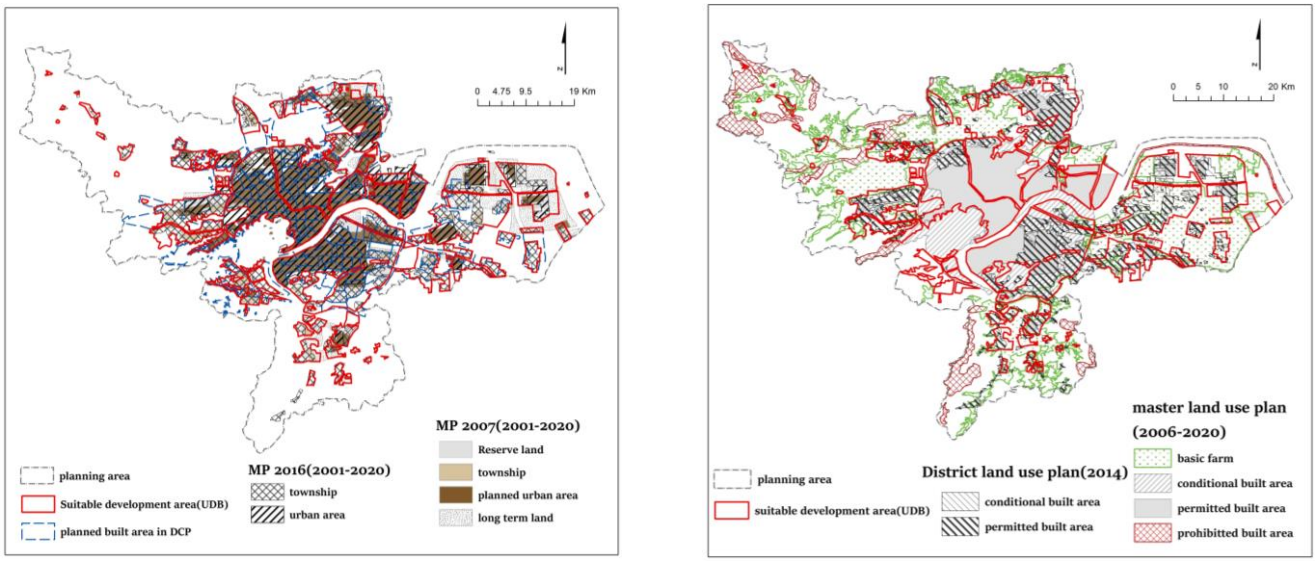


Figure 2. Research design.

4. Results

4.1. Coherence of Planning

Figure 3 reveals planned areas in the 2007 and 2016 MPs, the UDB (2015) and planned development area in the DCP. The planned urban area was just slightly expanded in the 2016 MP compared to 2007. However, the planned township area was significantly enlarged to accommodate outward development. Most of the planned area of the DCP was contained in the UDB, yet the planned area of several new DCP was beyond the city-level planning boundaries. Meanwhile, parts of the township in the MP were not covered by the DCP (Figure 3a). Considering land use plans, we found that permitted and conditional development areas of the original Master Land Use Plan were significantly enlarged in the revised District Land Use Plans (2014) of the two peripheral districts, even encroaching onthe planned basic farmland (Figure 3b). Therefore, the vertical coherence of NTU′s planning control was insufficient since control lines were constantly expanded and the target of compact development was overlooked.

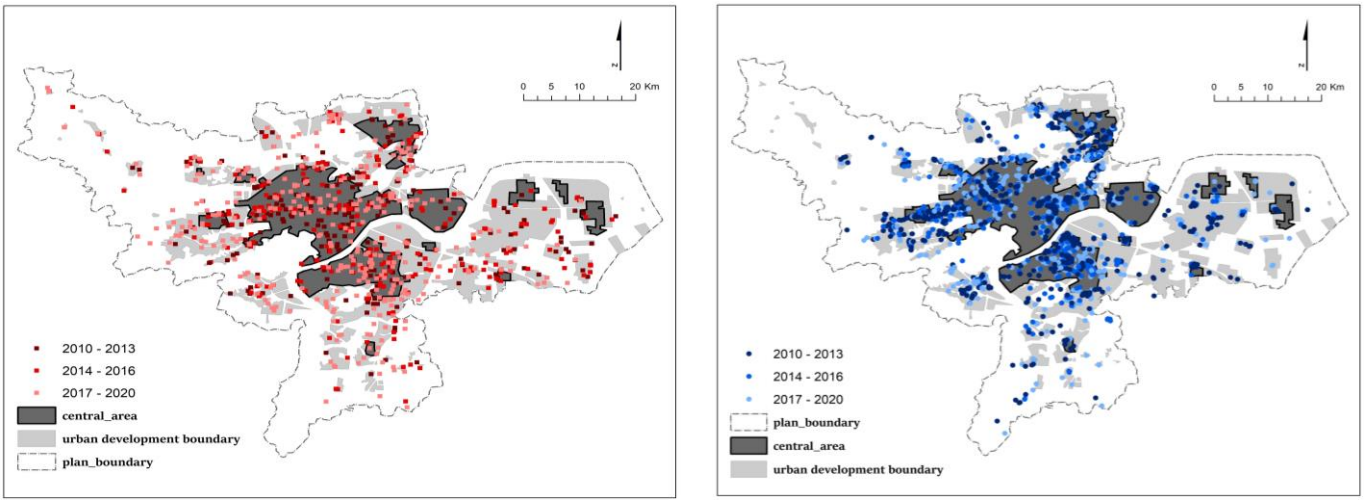


(**a**) (**b**)

Figure 3. (**a**) The spatial plans of Hangzhou; (**b**) the land use plans of Hangzhou.

4.2. Planning Conformance

The distribution of development projects for profit are shown in Figure 4a and public projects in Figure 4b. Only half of the projects (53.50%) developed before the implementation of the revised MP of 2001–2020 occupied leased land contained in the planned urban area (Table 1). This inconformity was largely alleviated during the implementation period of the revised MP (2016–2020). It can be observed that projects carried out in the planned township area increased significantly. Furthermore, the predominant part of the profit-use projects was confined by the UDB (92.61%), while the matching rate was lower for the control of DCP. This might be due to the piecemeal and slower progress of enforcing the DCP. In terms of conformance with land use plans, it was revealed that a total of 30.47% of the profit use projects were outside the area of the Master Land Use Plan of 2010. However, in the revised District Land Use Plans of 2014 the conformance rate increased to 94.95%. It seems that the NTU planning was effective in development control. However, it is because these new or revised plans generally expanded planning boundaries that deviated from compact development goals. For example, 150 profit-use projects were carried out on land planned as basic farmland in the MLUP. One hundred and seven of these projects were later included in the revised DLUPs. Notably, public-use projects initiated by local governments are more likely to deviate from the urban planning than profit-use projects (Table 2).



(**a**) (**b**)

Figure 4. The distribution of development projects of Hangzhou (2010–2020) (**a**) Profit-use projects; (**b**) public projects.

Table 1. Conformance between the urban planning and projects on leased land.

	Planned			**Unplanned**
	urban area	township area	Reserved and long-term area	Outside the planned area
MP 2007 (2010–2015)	534 53.50%	69 6.91%	140 14.03%	255 25.51%
MP 2016 (2016–2020)	403 59.35%	231 34.02%		45 6.63%
UDB		Suitable development area 1553 92.61%		Outside the boundary 124 7.39%
DCP		planned area 1409 84.02%		Outside the planned area 268 15.98%
Master Land-use plan (2010–2020)	Permitted building area 754 44.96%	Conditional building area 412 24.57%	Basic farm 150 8.94%	Outside the planned area 361 21.53%
District Land-use plans (2014–2020)	Permitted building area 409 79.42%	Conditional building area 80 15.53%		unplanned 26 5.05%

Table 2. Conformance between the urban planning and projects on administratively allocated land.

	Planned			**Unplanned**
	urban area	township area	Reserved and long-term area	Outside the planned area
MP 2007 (2010–2015)	232 50.43%	32 6.96%	59 12.83%	137 29.78%
MP 2016	192	148		143

(2016–2020)	39.75%	30.64%		29.61%	
UDB		Suitable development area		Outside the boundary	
		790		153	
		83.78%		16.22%	
DCP		Planned area		outside	
		720		223	
		76.35%		23.65%	
Master	Permitted building area	Conditional building area	Basic farm	Prohibited building area	Outside the planned area
Land-use plan (2010–2020)	392	206	164	2	179
	41.57%	21.85%	17.39%	0.21%	18.98%
District Land-use plans (2014–2020)	Permitted building area		Conditional building area	unplanned	
	277		49	124	
	61.56%		19.89%	27.56%	

4.3. Compactness of Urban Development

4.3.1. Centralization

The variation of centralization of developments in different planning periods is illustrated in Table 3. The test results of ANOVA demonstrated that the centralization of profit-use projects was not improved during the transition and NTU periods. Moreover, for the public projects, even a trend of decentralization was observed in the significantly higher mean value of centralization in prior-NTU period compared to the transition and NTU periods. The variation of centralization between transition and NTU periods was not significant.

Table 3. Multiple comparisons of centralization of development projects between different periods.

	Profit-Use Projects			**Public Projects**		
	Prior-NTU Period	**Transit Period**	**NTU Period**	**Prior NTU Period**	**Transit Period**	**NTU Period**
	2010–2013	2014–2016	2017-2020	2010-2013	2014-2016	2017-2020
Obs.	743	368	566	298	263	381
mean	0.561	0.576	0.553	0.5302	0.422	0.407
2010–2013 [1]		−0.0149	0.0082		0.108 *	0.123 *
2014–2016			0.0231			0.0152
ANOVA [2]		0.242			5.715 **	
homogeneity test of variance [3]		0.955			3.820 *	

[1]: ** Robust multiple comparisons (Tamhane's T2) significance level at at 0.05 or less and * for significance level at 0.1 or less; [2]: Robust test of equality of means if it is a heterogeneity of variance (Welch); [3]: Levene Statistic.

4.3.2. Land Efficiency

Table 4 reports the variation of land efficiency of the development projects in different planning periods. The land efficiency of profit-use projects was significantly strengthened in the NTU period compared to the prior-NTU and transition periods, while the variation of land efficiency was not significant between prior-NTU and transition period. Thus, more projects were allocated to former low-efficient land than to the green sites under the NTU planning. A similar trend could also be observed for the public projects, which indicates the densifying of the land development is developing.

Table 4. Multiple comparisons of land efficiency between different periods.

	Profit-Use Projects			Public Projects		
	Prior NTU Period	**Transit Period**	**After NTU Period**	**Prior NTU Period**	**Transit Period**	**After NTU Period**
	2010–2013	2014–2016	2017–2020	2010–2013	2014–2016	2017–2020
Obs.	743	368	566	298	263	381
mean	0.607	0.715	0.910	0.789	0.734	0.961
2010–2013 [1]		−0.108	−0.303 *		0.055	−0.172 *
2014–2016			−0.195 *			−0.227 *
ANOVA [2]		18.711 ***			11.103 ***	
homogeneity test of variance [3]		24.742 ***			16.359 ***	

[1]: *** Robust Multiple comparisons (Tamhane's T2) significance level at 0.01 or less, and * for significance level at 0.1 or less; [2]: Robust test of equality of means if it is a heterogeneity of variance (Welch); [3]: Levene Statistic.

4.3.3. Functional Intensity

In this section, we analyzed the variations of functional intensity between 2015 and 2020—the POI data before 2014 was insufficient due to technology deficiencies. We focused on the 500- and 800-m buffer area of redevelopment projects that were completed or under implementation during 2015–2020 and were designated the major area in the Urban Village Renovation Planning Guidance. The objective was to estimate if the urban renewal contributed to the improvement of functional intensity of neighborhoods during the NTU period.

The results of the FDE variation test between 2015 and 2020 showed that the density of facility in 500 buffer area of renovation projects decreased, but FDE increased in the 800 m buffer. However, in general, the increment or decrement were not significant, which indicates that the promotion effects of renovation projects in functional density were weak.

Nevertheless, the diversity of service facilities (FDI) was increased significantly in both buffer areas during the same period (Table 5). The result indicates that the functional diversity and mixed use in and around renovation projects were promoted by the subject plans of urban renewal. This is probably due to the focus of renovation planning guidance on the supply of sufficient facilities for the residents living in these local areas.

Table 5. Variation of functional intensity of surrounding areas of main urban village renovations between 2015 and 2020.

		500 m Buffer Area		800 m Buffer Area	
		2015	**2020**	**2015**	**2020**
FDE	Obs.	58	58	58	58
	Mean (N/km^2)	575.950	563.519	518.039	542.431
	anova [1]	0.016		0.093	
	homogeneity test of variance [2]	0.498		1.866	
FDI	Obs.	58	58	58	58
	mean	1.554	1.669	1.643	1.752
	anova [1]	5.840 **		10.919 **	
	homogeneity test of variance [2]	0.007		3.049 *	

[1]: Robust test of equality of means if it is a heterogeneity of variance (Welch), ** for significance level at 0.05 or less and * for significance level at 0.1 or less; [2]: Levene Statistic.

The results demonstrate that the urban renewal did not trigger more dense investment into surrounding areas, but the living convenience was improved due to more balanced distribution of services and strengthened mix-use urban functions. There are two probable reasons for this fact: (1) from the results of centralization analysis, we now know that more concentrated and denser developments were not promoted at the city scale as a consequence of under-performance of general plans; and (2) the absence of interaction between the subject plans and city-wide plans also did not promote densification. For example, a major area designated in the Urban Village Renovation Planning Guidance was not incorporated as a target area in any master plan or district plan. The DCPs also did not prioritize planning conditions for these areas.

5. Discussion

The NTU planning targets in Hangzhou were generally coordinated and centered on municipal strategies of compact development. The main undertakings were intensive developments based on reuse of low-efficient stock land, urban renewal, as well as strict control of urban expansions. However, it was found that regulations of different plans are not consistent since planning boundaries were still subject to constant enlargements. The culture of frequent plan revisions to cope with rising development demands, noticed broadly in the literature of Chinese urban planning, seems to persist in the NTU planning period. For a rapidly growing city such as Hangzhou, the competition for inward migration and mega-projects is overwhelming. The planning seems caught in the dilemma to accommodate a great amount of new development while keeping planning control goals set by the NTU.

A considerable amount of development is still outside the original plans; however, plans after the NTU performed better in planning conformance. The interesting finding is that public projects initiated by local governments were more likely to breach planning boundaries. This points to the deficiency of planning institutions, where the dual-track planning permission system requires projects on administratively allocated land to be first reviewed by a development committee in charge of social-economic development and afterwards a planning permit is issued. In this sense, spatial plans only serve economic plans—a legacy of the former planned economy. Thus, the need to strengthen the coordination between economic and spatial planning is implied. However, the current focus is more on coordination between the spatial plan and the land use plan. Therefore, the low conformance of NTU planning is mainly the consequence of incoherent planning.

From the aspects of development outcomes, we found no clear evidence to indicate that development was transitioning to be more concentrated during the NTU period. Public developments even presented a decentralized pattern. The lack of planning conformance has led to a less centralized form. Many of the public projects were schools, resettlement houses, and community centers for rural villagers whose land was expropriated. This indicates that cheaper rural outskirts are rapidly trending towards urban development since public projects are triggers for private investments. NTU plans should not only focus on the control of development boundaries but find appropriate policies to drag inward development and promote more concentrated urban form inside the planning area. We draw a parallel with the compact city policies of Melbourne 2030, where the lack of specific mechanism to direct development into the targeted activity center was criticized as a key reason for its failure [53].

On the other side, land efficiency was improved in the NTU period for both profit and public projects. This shows that the implementation of subject plans for land consolidation and urban redevelopments was efficient. The improvement of functional diversity is likely a direct outcome of urban village renovation plans with detailed designs. The fact that denser function was not gained further signifies the failure of plans in promoting centralized development at a broader scale. This is probably since renewal plans are not linked with general plans. For instance, the floor area ratio or development intensity for

these renewal areas are not designated with higher priority in MPs or DCP, nor incentives are provided.

Finally, the effects of NTU planning in promoting compact development in Hangzhou are fragmented. The NTU planning is generally effective in improving land efficiency and intensifying urban functions at the local area. Yet, NTU planning is still weak in promoting concentrated urban development at the city scale. From the streamlined analysis of relationships between the coherence, conformance, and effects of planning, we claim that the reason behind this ineffectiveness could be found initially in the inconsistent planning controls under pressure for rapid development. Secondly, there is a general lack of coordination between the economic and planning departments. Thirdly, subject plans are usually developed apart from city-wide plans and are not incorporated into general plans later. Thus, the effect of compacting is limited to local areas.

In addition, Urban Growth Boundary (UGB) or Green Belt is a common planning tool for growth management. However, as revealed by Siedentop et al. (2016) [39], UGB may be efficient in preserving open space, but its effects are limited in urban structure due to low degree of compactness. This conclusion is confirmed in Hangzhou. The concept of China's UDB was always viewed as a static control line, which does not differ much from the traditional planning lines with a single physical function. The permanent drawing of a large-scale UDB in Hangzhou seems to have resulted in a fragmented or leapfrog development inside the boundary, similarly as the UGB resulted in a patchwork development of Tokyo´s suburbs [54]. Instead, a timely and sequential revision of the UDB seems necessary to achieve more compact development. As argued by Boyle and Mohamed (2007) [55], growth management of strong power is constituted by mandatory comprehensive planning and an auxiliary policy. More innovative planning tools, such as fiscal incentives and FAR bonuses, public-private cooperation for projects carried out in target areas, as well as development fees on projects in peripheral dispersed areas, could be options to assist the UDB.

6. Conclusions

New-type Urbanization has been the central development strategy in China since 2014. Compact development was stated as one of the principal goals of NTU. The research question tackled in this study is whether the NTU planning of China was effective in promoting compact development in rapidly growing cities and what might be critical problems in this planning system. An analysis framework was developed by integrating an estimation of coherence of planning, conformance of planning with development outcomes, and actual development forms. Multi-dimensional indicators of compact development—centralization, land development efficiency and functional intensity were employed for evaluating the ´compactness´ in the case of Hangzhou.

We concluded that urban functional diversity and land development efficiency at the local scale were indeed promoted during the NTU planning period. This could be attributed to the well-implemented subject plans for urban renewal. However, the urban planning is still weak in directing more concentrated and dense urban development form at the city scale. The reasons for this underperformance could be found in insufficient coherence between plans from different levels—seen in the enlargements of the master plan´s urban area in district plans and DCPs—the inadequate coordination between economic and spatial plans reflected in the low conformance of public projects to the planed area, the patchwork of plans, and the absence of planning tools to support the UDB.

The compact development still faces great challenges, especially in rapidly growing cities. The competition for investments creates a dilemma between accommodating a great amount of new development while keeping the compact development goals. Central planning mainly targets expansion control and balanced development, while local governments pay more attention to economic growth based on urban land exploitation. Consen-

sus between central and local states should be reached before seeking an efficient development mode. On the other hand, the function of planning in development guidance and regulation should be strengthened. This stresses the importance of a coordinated planning system that dynamically links different plans and different departments to achieve the desired goal of compact development. For example, the Ministry of Natural Resources of China was established in 2018 to uniformly exercise all responsibilities of land use and spatial planning, and to promote the multiple-plan integration. This program's effects in planning coordination could be measured in further studies. Moreover, public participation in the planning and bottom-up plan-making based on coordinating demands from different stakeholders may improve the coherence of planning.

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