Typologies of Rapid Urbanization in Developing Asian Countries: A Study of Shanghai’s Rapid Urbanization and Subsequent Strategies

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Abstract. Over the last several decades developing countries, especially in Asia, have undergone large scale rapid urbanization, impacting their developmental patterns. Compounded with increased economic prosperity and social mobility attracting individuals and companies, to urban centres, has led to severe administrative challenges that can negatively affect the citizens, nation, and environment. In efforts to mitigate those adverse side effects cities have instituted, or citizens naturally adopted, a variety of strategies to address those issues. These strategies result in the typologies of rapid urbanization that are most prevalent in developing Asian cities. By focusing on Asian and Chinese cities, using shanghai as a test case, this research proposes several major typological categories associated with rapidly urbanizing areas. Shanghai’s rapid urbanization has been shaped by seven main typologies of urban growth and expansion, since the implementation of China’s economic growth policies and its resurgence as an influential global city. Spatial typological patterns of urban growth in Shanghai are analyzed to explain how the economic prosperity and social mobility have been managed. Typological adaptations learned from the historical urban expansion provide the subsequent strategies for future sustainable development in a rapidly urbanizing area.

1. Introduction

Presently, 55% of the world’s population (4.14 billion) lives in urbanized areas. [1,2] According to a study conducted by the United Nations the urban population will increase by 13%, to a total of 68% by 2050, approximately adding 2.5 billion people in urbanized areas, from both migration and population growth [1]. The majority of this growth is occurring in rapidly developing countries primarily located in Africa and Asia. India, China, and Nigeria are the three nations projected to contribute the most to global urbanization by adding a total of 857 million people by
2050, 34.3% of all expected growth. A trend, expected to continue, which overwhelmingly affects the developing world – specifically in Asia and Africa. Studying countries that have already undergone the majority of their rapid urbanization can offer insights and typological developments that occurred during its process. The lessons learned can provide a means of addressing and offsetting the negative effects of urbanization and rapid development. As urbanized areas account for 70% of CO₂ and 60 - 80% of energy consumption according to 2012 estimates, a figure expected to increase [3,4]. The building sector, in terms of construction and maintenance role in global energy consumption should not be underestimated – especially in developing countries.

China’s rapid urbanization, an ongoing process since the 1970s, has caused their urban population to surge from 13%, in 1950, to an estimated 60.3% by 2030. [5] China’s herculean rapid urbanization effort serves as an excellent case study for which current and future efforts can be examined against. The entire nation has undergone dramatic changes over the last decades, reaffirming the historical role that the eastern cities and coast have had. Hefei, Yangzhou, Shenzhen, Chengdu, and Shanghai have all grown into cities containing more than five million people [2]. However, out of all these cities, Shanghai has experienced the most dramatic effects of rapid urbanization, which can act as a microcosm of its effects. For this purpose, China, specifically Shanghai, will serve as a case for studying the proposed typologies of rapid urbanization that occurred and is continuing in developing Asian countries.

2. Background

China is the most recent large scale Asian nation to undergo rapid urbanization and has begun to slow down as the majority of the population now lives in urbanized areas. Large scale rapid development is predicted to have occurred between the 1950s until 2030, given the rise from 13% to 68%, a total growth of 55% over mostly 40 years [1]. Though urban areas are still intensifying, and new urbanized areas being constructed the rate of this process has slowed when compared to the growth rates experienced during the 1980s–2010s [6]. Currently China accounts for 21.9% percent of total primary energy consumption, in 2012, and 27% of this comes from the building sector [6,7]. Energy consumption including construction and operation phases of the building sector contributes to 6% of global energy consumption which is directly affected by rapid urbanization [8]. While other Asian countries are just beginning this process, or at their height of urbanization growth rates, China provides an illustrative test case for how these other nations development may unfold.

Historically, China’s development patterns can be roughly segmented into four district general categorizations: Traditional City, Hybrid City (Colonial), Socialist City, and Global City (Rapid Development) [9,10]. Traditional City pertains to the traditional methods of development which constitute the cultural forms, ideas, and planned settlements that dominated and governed Chinese urban and rural development [11]. Forms, tied to the Rites of Zhou (1100-256 BC), although morphed and updated, continue to have an effect on modern planning and layouts [12]. Hybrid City (1860 – present) meshes the ideas of architecture and planning in western methods with traditional Chinese forms [10]. Shanghai is an example of a small traditional village that was transformed by colonial powers and ideas mixing, or forcing out, traditional Chinese forms [13]. Socialist City (1950 – 1980) shifted towards the soviet methods of viewing cities as a means of production and began the first stage of rapid housing development – Xincun “Worker Village” [10,14]. These villages were built quickly, designed to maximize residents and shelve environmental and material sustainability, as evident by Shanghai’s redevelopment plan [15]. Global City (1990 – present) following China’s economic growth policies saw the rapid expansion of numerous cities and boom of the national economy [10].

Many developing countries share these trends, as former colonial nations themselves, which have meshed traditional forms with those of western colonial powers. While these historic forms inevitably reverberate in the expression of rapid urbanization that radically transformed China from the 1970s onwards, the sheer force of rapid development overshadows their effects. Identifying the types of typologies standard to this context requires understanding the context of
rapid development, specific to China; the use of GIS methods; and types of building and urban typologies.

Developing these urban typologies may aid in mapping carbon emissions and in comparison, or conjunction, with local climate zones (LCZ). Previous work done in Shanghai has shown the potential benefit of using abstraction for the purposes of modeling carbon and energy usage, rather than individual building modeling. [16] This work seeks to build upon this understanding and develop a potential alternative, or conjoined, method of classifying space in urban areas.

2.1. Rapid Development - Shanghai

Starting in 1978 China, under Deng Xiaoping, initiated a set of economic growth policies with the aim of re-engaging with global markets and revitalizing its economy. Leading to a 40 years long period of rapid urbanization and economic growth that has flourished in China. Initially, contained to a few cities (Shenzhen, Zhuhai, Shantou, and Xiamen) these Special Economic Zones (SEZ) proved overwhelmingly successful, as evident by Shenzhen’s growth rate averaging 40% from 1981 until 1993. A total of 31% above the national average for the same time period [17]. Soon the SEZs were expanded nationally and other cities experienced similar development in terms of growth and challenges.

Nations undergoing the process of global/rapid development experience a number of benefits as a direct result or indirect results of the process. The early stages to later stages of rapid urbanization are characterized by the construction and development of new and old urban centers. Construction on this scale aids in creating jobs and economic opportunities for those who are underserved or stagnated under previous economic models, the rural poor are often the most affected by this. A large concentration of workers further boosts the economy due to the agglomeration of resources and manpower [18]. Shanghai’s economic and built area soared following the enactment of China’s economic growth policies, going from Chinese Yuan ¥31.189 GDP by income to ¥3,100 nearly a 100-fold increase [19]. Beyond direct economic and built considerations urbanization has been connected to bettering of sanitation infrastructure and services [18]. Between the mid-1900s and the present, and rapid urbanization cities, have reworked and installed sanitation services designed to combat historical dumping.

While rapid development confers certain benefits, it is not without consequences or drawbacks that must be considered and actively minimized. Building energy consumption has been rapidly increasing, keeping pace with urbanization, as filling the housing need in urban areas takes precedence over building energy efficiency. China has enacted policies designed to curb energy consumption, however research has noted that the strategy of setting a target of 50% may not lead to the best results and may misunderstand the relationship between energy consumption and energy efficiency and only targets new buildings post-enactment [20,21]. A further report examined this issue noted a combination of effort must be adopted to combat this issue, business as usual, would result in residential energy consumption increasing by nearly 25% (by about 670 Million TCE: tons of coal equivalent; 1 TCE = 29.39 GJ) of advanced strategies (by about 425 Million TCE) by 2024 [22]. Quickly erected structures in the massed copy development style that is ubiquitous in Chinese development, and in developing countries, often are developed cheaply and en masse. These structures, often made from the 1950s on and prior to energy standards, have lower energy performance characters when compared to that of buildings of similar sizes, needs, and locations as their developed nation counterparts. As the desire for increased thermal comfort increases, alongside upward mobility, the energy demand of buildings will rise quickly given the current building stock. Rapid development is also connected to worsen social, health, and environmental conditions. Poorer communities are often most negatively affected by this pattern and densification of these people into neglected areas – rural migrant villages and urban villages [23].

2.2. GIS Study Methods

China’s publicly available Geographical Information System (GIS) data is minimal or restricted due to political restriction. To circumvent this, Open Street Maps data, retrieved via R-Scripting,
is used for visual and data analysis purposes for specific regions that exemplify specific typologies \cite{24}. Relying on Open Street Maps for shapefile collection present two key problems: (1) large amounts of old buildings and less popular destinations were not created and (2) small sections, less than 2km from center points, could be extracted at once. Given these restrictions, sites and typologies were chosen first based on manual visual inspections to act as a pool of potential candidate sites. For these selected sites, GIS is used to compare a mixture of visual analysis techniques (manual) and spatial analysis of formal and land use characteristics (automated and manual). Land uses characteristics are manually coded based on ground truthing and through applying previously developed random forest land use maps \cite{16}. Visual qualitative analysis, using site pictures and visits, were used to augment and provide corrections for the lack of readily available GIS information (fig. 1).

![GIS Study Method](image)

**Figure 1: GIS Study Method**

Once all sites had been selected and properly coded with land uses and assessed based on manual visual qualitative analysis, they were clustered based on like characteristics. This process was then repeated several times till final typologies, from the selected samples, were decided upon which best matched the known on the ground conditions and the available data. Primarily this was implemented by manual visual analysis supplemented and aided by automated clustering.

### 2.3. Typologies - Shanghai

Four core elements are used to construct most typologies in so far as the built environment is concerned: Form, Structure, Context, and Use. Form pertains to outward physical expression of a building; façade construction, height, window to wall ratio, and shape/form. Structure examines the interior construction and components of a building; structure, number of floors, and thermal insulation. Context refers to adjacent objects or exterior influencing on a building, physical or social aspects; cultural forms, nearby amenities, environment, and transportation. Use catalogs how people directly interact with the building; land use, occupancy rates, and length of use. While directly applied to buildings these can be simplified and expanded to encompass larger scale urban forms, blocks, superblocks, and administrative districts. Urban typologies, for this paper, are subdivided into two categories: Building Forms and Urban Forms.

#### 2.3.1. Building Forms

Due to the quantity and macro level scale of the analysis-built forms are abstracted from their detailed characteristics: specific land use, physical structure, built form, and built year. Instead, each of the primary four characteristics is transformed into a categorization tool with subdivisions interior to it for all buildings. Form measures the size of buildings split into four categories: Small, 0 - 200m$^2$; Medium, 200 – 1,000m$^2$; Large, 1,000 – 9,000m$^2$; and Macro, +9,000m$^2$. Structure gauges the granularity of the building clusters: Finer, tightly packed with little, or no, space between buildings (Pingdeli); Fine, tightly packed buildings with space
between buildings (Anshanxincun); Coarse, separated buildings with considerable space between buildings (Huiyuanfang); and Coarser, sparse development patterns (Shenhong). Context is used to determine the age and development period of the building: Historical, Hybrid (Colonial), Socialist, and Contemporary (Global City/Rapid Development). Use ties land use to buildings; Residential, Commercial, Office, Mixed, and Other.

2.3.2. Urban Forms. Building forms are then aggregated together based upon like characteristics to develop urban form typologies. Quan (2015) identified several specific built forms that tied land use, built form, and structure together [25] (fig. 2). While his study examined residential and commercial pairings, Shanghai has 11 rough land use categorizations [16]. Our study joins the data sets in identifying and studying the typologies of rapid development.

Figure 2: Shanghai Built Forms (Residential) adapted from [24]

3. Typologies of Rapid Urbanization – Shanghai
Shanghai over the last two decades has undergone dramatic shifts rapidly expanding and experiencing different typologies of development. Initially doubling in population from 1953 to 1990 to nearly double again by 2016. 40% of the total population though is internal long-term migrants that have moved to the city, often in urban villages and poorer areas. This trend is not unique to Shanghai as most Chinese cities have experienced similar growth patterns, with long-term rural migrants making up the majority of urban population growth [26]. Shanghai’s latest growth plans focus on combating the effects of earlier rapid urbanization through focusing on urban regeneration and controlling land uses [15]. Shanghai’s progression from the 1980s until now has employed a total of seven proposed typologies connected with rapid urbanization: (1) Urban Regeneration, (2) Informal Expansion, (3) Degradation, (4) Densification, (5) Sprawl, (6) Economic Development, and (7) New Town/City Model (fig. 3).

Figure 3: All Figure Grounds of Rapid Development Typologies – Shanghai
The seven typologies are created out of the four forms, based on groupings, and have benefits and disadvantages ascribed to them (table 1). Urban Regeneration does not often change the physical form of the building, relying on material and interior structural changes. This is often used in later stages of rapid urbanization once immediate needs have been met. Informal Expansion indicates that citizens take it upon themselves to improve or modify space in place of city and governmental changes. In China, internal migrants or poorer citizens moving into older historical areas are most affected by this typology. Degradation occurs when the informal expansion is halted; actively stopped, without aid; or informal expansion lasts too long it can lead to areas worsening. Services are often underprovided and disproportionally affect the poor and internal migrant communities. Densification refers to the process by which the city, or developers, redevelops often older areas using contemporary building patterns – global style architecture. Urban Sprawl appears as economic prosperity increases the needs of the wealth and new middle classes drive the creation of sprawl that are less dense and further away. Economic Development means densification and agglomeration of economic ventures into a single area – akin to transit orientated development. New Town Model can be designed as large-scale communities that are not often set into an existing population center. These developments have proved difficult in the past, often attempting to create large scale communities from non-organic processes.

| Typologies          | Urban Regeneration | Informal Expansion | Degradation | Densification | Urban Sprawl | Economic Development | New Town Model |
|---------------------|--------------------|--------------------|-------------|---------------|--------------|----------------------|----------------|
| Form                | Any                | Small              | Small       | Medium - Large| Small - Medium| Large                | Macro          |
| Structure           | Any                | Finer              | Finer       | Fine - Coarse | Coarse       | Coarse - Coarser     | Finer - Coarser |
| Context             | All                | Historic - Hybrid  | Socialist - Hybrid | Hybrid - Contemporary | Contemporary | Hybrid - Contemporary | Hybrid - Contemporary |
| Use                 | Mixed              | Residential - Mixed| Residential | All            | Residential - Commercial | Commercial | All          |
| Benefits            | Increases energy efficiency of existing building stock | Designed to fit the needs of the local residents | None | Lends itself well to clustering and improving energy performance | Provides a higher quality of life and more personal space | Concentrates shopping, retail and offices together | Shifts development away from overly crowded areas |
| Disadvantages       | Can be resource and materially intensive | Unregulated and can lead to energy and safety issues | Creates strain on all resources of the existing city | Densification can lead to strain on systems and inefficiencies | Less dense and energy efficient form of development | Too much density can strain energy and transit systems | Can quickly lead to empty towns and unliveable environments |

4. Economic Development Case Studies

Given the exploratory nature of this study, each of the seven proposed typologies is too complex of an issue to immediately explore. A comparison between two Economic Development models examines the shared elements and differences in their executions: Wujiaochang and Xiantiandi.

4.1. Wujiaochang

Located in Yangpu district, Wujiaochang is developed as the largest transit orientated development in the city and serves as the main hub for future plans. Focused around commercial and office space development, the area is isolated from the surrounding styles and uses, choosing to focus inward and not interface with them. Several major roads directly feed into the site congesting the surrounding roads, over centralization. Directly connected to a metro line the development boosts a high percentage of commuters and pedestrians, however, few use this as a drop off for the metro, more as a destination. Resulting in the area being disconnected from the surroundings, not engaging with the city, and adopting a globalist developmental model (fig. 4).
4.2. Xiantiandi

By contrast, Xiantiandi is created out of restoration and redevelopment of old stone-gated historical structures – Shikumen. Mixing the cultural trends and historic architecture with the needs of the developing economy. Designed as a pedestrian-driven development the strain on transportation systems are lessened and a more dispersed model of construction was employed. Xiantiandi not only addresses its surrounding context but acts in a symbiotic manner blending and bettering the area. However, this style of development is newer, and the development of this sub typology often occurs only after the main pushes to meet immediate needs have been met. It serves as a reaction of globalized trends seeking to blend them with local and cultural ideas, as opposed to mass acceptance of outside cultural influences (fig. 5).

![Figure 4: Wujiaochang Figure Ground](image1)

![Figure 5: Xiantiandi Figure Ground](image2)

5. Conclusions

Many Asian countries are currently, or about to, going through periods of rapid development. Set to increase the total urban population by as much as 2.5 billion people, with urban developments already consuming 60–80% of electrical energy and account for 70% of all greenhouse gas emissions. China, which has already gone through this process, shows the effects rapid urbanization can have and the forms it can take. Studying these forms can provide insights on how other countries may develop and the challenges they face. Shanghai serves as an exemplary case to study the seven proposed typologies of rapid urbanization that occur in Asian countries: (1) Urban Regeneration, (2) Informal Expansion, (3) Degradation, (4) Densification, (5) Sprawl, (6) Economic Development, and (7) New Town/City Model. This study is an initial overview and exploration as later studies will expand the clustering methods to better identify the characteristics of rapid urbanization while performing energy analysis and carbon mapping to see how each one contributes or alienates the roles cities have on climate change.

References

[1] United Nations. (16 May, 2018). 2018 Revision of World Urbanization Prospects. Retrieved from https://population.un.org/wup/

[2] The World Bank Group. (2018). 2017 Population. Retrieved from https://data.worldbank.org/indicator/SP.POP.TOTL

[3] GEA. (2012). Global energy assessment - toward a sustainable future. Cambridge UK: Cambridge University Press. doi:10.1017/CBO9780511793677

[4] United Nations. (8 July 2016). Chapter XXVII Environment, 7. d Paris Agreement. United Nations Treaty Collection. Retrieved from https://treaties.un.org/doc/Treaties/2016/02/20160215%2006-03%20PM/Ch_XXVII-7-d.pdf

[5] Vassigh, A., & vom Hove, T. (2012, August 7). Urban population growth between 1950 and 2030. Retrieved from City Mayor: http://www.citymayors.com/statistics/

[6] Yang, X., Wei, Q. P., & Jiang, Y. (2007). Study on statistical method for building energy
consumption. Building Energy Efficiency, 35, 7-10.

[7] Lin, B., & Liu, H. (January 2015). China's building energy efficiency and urbanization. Energy and Buildings. 86, 356-365.

[8] Long, D. W. (2005). Building energy consumption proportion and building energy saving target. Energy of China, 27, 23-27.

[9] Smith, M. E. (2007). Form and Meaning in the Earliest Cities: A New Approach to Ancient Urban Planning. Journal of Planning History, 6(1), 3-47. doi:10.1177/1538513206293713

[10] Hahn, Thomas. 2006. China Urban Planning materials

[11] Steinhardt, N. S. (1990). Chinese Imperial City Planning. University of Hawaii Press.

[12] Whitehand, J.W.R. and Gu, Kai. (2006). Research on Chinese urban form: retrospect and prospect. Progress in Human Geography 30(3), 2006, pp. 337–355.

[13] Lovell, J. (2015). The Opium War: drugs, dreams and the making of China. New York, NY: The Overlook Press.

[14] Ma, L. J. (2002). Urban Transformation in China, 1949 – 2000: A Review and Research Agenda. Environment and Planning A, 34(9), 1545-1569. doi:10.1068/a34192

[15] Shanghai Urban Planning and Land Resource Administration Bureau. (January 2018). Shanghai Master Plan 2017-2035: Striving for the excellent global city. Shanghai.

[16] Wu, Y., Sharifi, A., Yang, P., Borjign, H., Murakami, D., & Yamagata, Y. (2018). Mapping building carbon emissions within local climate zones in shanghai. Energy Procedia 152, 815-822.

[17] Chapter 4: The Performance of Special Economic Zones". Special Economic Zones and the Economic Transition in China. World Scientific Publishing Co Pte Ltd. pp. 67–108. ISBN 978-9810237905.

[18] Spence, M., Annez, P. C., Buckley, R. M., Arnott, R., Duranton, G., Jaffee, D. M., . . . Venables, A. J. (2009). Urbanization and Growth. (M. Spence, P. C. Annez, & R. M. Buckley, Eds.) The World Bank. doi:10.1596/978-0-8213-7573-0

[19] National Bureau of Statistics. (2018). China GDP: by Income: Shanghai. CEIC. Retrieved from www.ceicdata.com

[20] Xu, X., Anadon, L. D., & Lee, H. (April 2016). Increasing Residential Building Energy Efficiency in China. Harvard Kennedy School, United States of America.

[21] Palanivel, T. (06 September 2017). Rapid urbanisation: opportunities and challenges to improve the well-being of societies. United Nation Development Programme.

[22] Da, Y., Tianzhen, H., Cheng, L., Qi, C., Jingjing, A., & Shan, H. (September, 2017). A Thorough Assessment of China’s Standard for Energy Consumption of Buildings. Lawrence Berkeley National Laboratory.

[23] National Bureau of Statistics of China. (April 28, 2011). Sixth National Population Census of the People's Republic of China. People's Republic of China.

[24] OpenStreetMap contributors. (2019, January 23). Retrieved from OpenStreetMap: https://www.openstreetmap.org/

[25] Quan, S. J., Wu, J., Wang, Y., Shi, Z., Yang, T., & Yang, P. P.-j. (2016). Urban Form and Building Energy Performance in Shanghai Neighborhoods. Energy Procedia 88, 126-132.

[26] Gong, P., Liang, S., Carlton, E. J., Jiang, Q., Wu, J., Wang, L., & Remais, J. V. (3-9 March 2012). Urbanization and Health in China. Lancet, 379, 843-852.