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Daniel Safarik will present this paper in his presentation **"Megacities: Setting the Scene"** in Session 2B: *Megacities – Setting the Scene,* Monday 17 October at 11:15 a.m

The rise of the megacity presents unprecedented opportunities to understand the human urbanization phenomenon, and to observe the effects of multi-core, polycentric cities growing together to effectively become one. This paper establishes the criteria for defining such megacities, discusses their characteristics and locations, and assesses the impact they are having and will have on tall buildings, urban development, transportation, infrastructure, and quality of life.

Note: Please also refer to the Tall Buildings in Numbers study on pages 52 and 53

Introduction

Anyone concerned with the development of human civilization in the 21st Century will likely have heard the term "megacity." It is – as it should be – increasingly prevalent in both mainstream and academic discussions of the great trends of our time: urbanization, rising technological and physical connectivity, increasingly polarized extremes of wealth and poverty, environmental degradation, and climate change. It is a subject as large and far-reaching as its name implies. This introduction sets the scene on how megacities and the built environment are growing together, and examines the implications for those who plan, design, develop, and operate tall buildings and urban infrastructure.

What is a Megacity?

In order to rationalize the data CTBUH collects – predominantly on skyscrapers and large urban developments – with that collected by other organizations, first a definition that reflects a distillation of the prominent literature on the subject should be set forth:

A megacity is an urban agglomeration with a total population of 10 million people or greater, consisting of a continuous built-up area that encompasses one or more city centers and suburban areas, economically and functionally linked to those centers.

A megacity is typically, though not always, polycentric, with multiple nodes of concentrated urban activity and high-density development, rather than being centered around one large primary central business district (CBD). Indeed, a telltale sign of a megacity, and an indicator of its polycentric nature, is the tendency of residents and urban planners alike to refer to more than one "CBD." Even if there is a consensus about the location of the "center of town," development and transportation patterns strongly suggest otherwise; it should be thought of as an interwoven web, rather than a series of concentric zones.

The polycentric pattern is often the result of established urban centers traditionally separated by distance and their own identities eventually merging together through a continuous spread of urban and suburban development. A key aspect of the megacity is that these linkages of urbanity fuse the agglomeration together, not only physically, but also economically, functionally, and often, culturally.

In a megacity, the extent of urban development spread will not be described by a single radius or a compact, circular shape; in other words, it is asymmetrical and polymorphic. This is due to a variety of factors, including but not limited to; uneven development patterns, geographic obstacles, transport corridors, and political boundaries. While green spaces and "undeveloped" land may separate urban centers, this does not necessarily indicate that there is a definitive economic, cultural or political division between cities and their relationship within a megacity. In other words, there may be considerable amounts of open space contained within a megacity (see Figure 1). Open spaces could be the result of geological features such as mountains and bodies of water, military installations or protected greenbelts. Meanwhile, "leapfrog" development has a tendency to create long,

narrow strands of development along transportation routes, which then fill in perpendicularly to those corridors over time.

For the purposes of the 45 megacities noted in this study (see Table 1), it should be clearly noted that the cited population, area, and density figures are the result of existing political boundaries which can dilute density numbers, because they may encompass open spaces and adjacent hinterlands potentially available for future development lying beyond highly built-up areas. For example, if a district, county, prefecture or other political jurisdiction adjoins a heavily built-up area, and a distinctly dense tendril of urban land penetrates into what is otherwise a rural political unit, along a watercourse, highway or railway, the entire surrounding political unit is typically counted in area and population figures. Thus, the "Los Angeles" megacity in this study extends all the way through open desert to the Colorado River and the border with Arizona, because the political entity of Riverside County, California – heavily urbanized in the west and sparsely populated in the east – is included.

In step with the theme and site of the CTBUH 2016 Conference, the primary benchmark for a megacity in this study is the Pearl River Delta region of southern China, the world's largest megacity (see Figures 2 and 3). Drawing a line around the boundaries of the Pearl River Delta's urban centers would encompass a span of up to 367 kilometers from southwest to northeast (that is, from the southwestern-

Figure 2. Example of undeveloped space comprised of mountains and farms within the urbanized area.
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Figure 2. The Pearl River Delta megacity boundaries. Source: www.citypopulation.de

Figure 3. The Pearl River Delta megacities (from left to right): Hong Kong, Guangzhou, and Shenzhen.

Rank *by pop.*	Megacity	Country	Combined Population	Area *(sq. km)*	Density *(ppl/sq. km)*	# of 200 m+ Buildings	Cities & Administrative Areas Within
1	Pearl River Delta	China	64,899,778	56,217	1,154	220	Dongguan, Foshan, Guangzhou, Hong Kong, Huizhou, Jiangmen, Macau, Shenzhen, Zhaoqing, Zhongshan, and Zuhai
2	Shanghai-Changzhou	China	50,302,212	28,010	1,796	90	Changzhou, Jiaxing, Shanghai, Suzhou, and Wuxi
3	Tokyo (Kanto Region)	Japan	42,797,000	32,424	1,320	29	Prefectures of Chiba, Gunma, Ibaraki, Kanagawa, Saitama, Tochigi, and Tokyo
4	Beijing-Tianjin	China	40,594,839	34,588	1,174	50	Beijing, Langfang, and Tianjin
5	Delhi	India	34,397,873	15,562	2,210	3	Delhi, Nodia, Gurgaon, Ghaziabad, Rohtak, and Meerut
6	New York-Philadelphia	USA	30,907,175	54,880	563	96	Atlantic City, Jersey City, New Haven, New York, Philadelphia, Trenton, and Wilmington
7	Chongqing	China	30,165,500	82,403	366	46	Chongqing Province
8	Sao Paulo	Brazil	29,740,692	23,556	1,263	0	Baixada Santista, Campinas, Santos, Sao Jose dos Campos, Sao Paulo, and Sorocaba
9	Jakarta	Indonesia	28,424,717	6,438	4,415	46	Bekasi, Bogor, Depak, Jakarta, and Tangerang
10	Mumbai	India	26,136,721	17,313	1,510	38	Districts of Mumbai, Mumbai Suburban, Pulghar & Raigad, Thane
11	Seoul-Incheon	South Korea	25,524,572	11,807	2,162	39	Gyeonggi Province, Incheon, and Seoul
12	Manila	Philippines	25,169,197	8,113	3,102	30	Provinces of Bulacan, Cavite, Leguna, Rizal, and the National Capitol Region
13	Dhaka	Bangladesh	24,952,038	9,353	2,668	0	Districts of Dhaka, Gazipur, Munshiganj, Mymensingh, and Narayanganj within Dhaka Division.
14	Karachi	Pakistan	23,500,000	3,527	6,663	1	Karachi Administrative District
15	Mexico City	Mexico	23,492,352	11,317	2,076	6	Metropolitain areas of Mexico City, Tianguistenco, Toluca, Tula, and the municipality of Tepeji del Río de Ocampo
16	Cairo	Egypt	21,455,656	6,649	3,227	0	Al Qalyubia, Cairo, and Giza Governorate
17	Hangzhou-Ningbo	China	21,218,301	34,936	607	24	Hangzhou, Ningbo, Shaoxing
18	Osaka	Japan	20,750,000	27,351	759	6	Prefectures of Hyogo, Kyoto, Osaka, Nara, Shiga, and Wakayama; including the cities of Hemeji, Izumisano, and Kobe
19	Kolkata	India	20,608,327	18,885	1,091	1	Districts of Hooghly, Howrah, Kolkata, North 24 Parganas, Parganas, and South 24
20	Lahore	Pakistan	20,530,000	12,631	1,625	0	Districts of Gujranwala, Kasur, Lahore, and Sheikhupura
21	Moscow	Russia	19,002,220	33,262	571	19	Moscow City and the more urbanized portions of the Moscow Oblast
22	Los Angeles	USA	18,679,763	87,944	212	13	Long Beach, Los Angeles, Oxnard, and Riverside
23	Ho Chi Minh	Vietnam	18,051,200	23,724	761	7	Ho Chi Minh City and Provinces of Ba Ria-Vung Tau, Binh Duong, Dong Nai, Long An, Tay Ninh, and Tien Giang
24	Bangkok	Thailand	17,718,258	21,028	843	20	Provinces of Bangkok, Chachoengsao, Chon Buri, Nakhon Patham, Nonthaburi, Pathum Thani, Rayong, Samout Prakan, and Samut Sakhon
25	Chengdu	China	17,663,383	18,115	975	24	Chengdu, Deyang
26	Xiamen	China	16,469,863	25,792	639	20	Quanzhou, Xiamen, Zhangzhou
27	Istanbul	Turkey	16,437,489	8,808	1,866	7	Istanbul and Kocaeli provinces, including the districts of Gebze and Izmit
28	Tehran	Iran	15,450,000	18,814	821	0	Provinces of Alborz and Tehran, including the cities of Eslamshahr, Karaj, and Varamin
29	Buenos Aires	Argentina	15,333,035	11,134	1,377	1	Greater Buenos Aires and La Plata Metropolitan Areas
30	London	United Kingdom	14,031,830	12,091	1,161	8	London and the districts of Essex, Hertfordshire, Kent, and Surrey
31	Shantou	China	13,943,141	10,660	1,308	0	Chaozhou, Jieyang, and Shantou
32	Johannesburg-Pretoria	South Africa	13,937,500	22,017	633	1	Gautang Province (including Johannesburg, Midrand, and Pretoria) and the municipality of Madibeng
33	Bangalore	India	13,093,168	13,139	1,297	0	Districts of Bangalore, Krishnagiri Districts, and Ramanagara
34	Kinshasa-Brazzaville	Democratic Republic of Congo-Republic of Congo	13,271,392	10,229	997	0	Brazzaville and Kinshasa
35	Rhine-Ruhr	Germany	12,695,656	14,160	640	0	Bonn, Colonge, Duisburg, Dusseldorf, Essen, Mönchengladbach, and Wuppertal
36	Chicago-Milwaukee	USA	11,970,050	37,324	1,154	31	Chicago, Kankakee, Michigan City, Milwuakee, Naperville, and Shaumburg
37	Lagos	Nigeria	12,864,745	20,107	1,749	0	Lagos State, Ogun State
38	Rio de Janeiro	Brazil	12,678,779	7,249	1,537	0	Belford Roxo, Dudue de Caxias, Nova Iguacu, Rio de Janeiro and San Goncalo
39	Chennai	India	12,373,088	8,052	705	0	Districts of Chennai, Kancheepuram Districts, and Thiruvallur
40	Hyderabad	India	12,273,352	17409	1,005	0	Districts of Hyderabad, Medak, and Rangareddy
41	Paris	France	12,073,914	12,011	321	2	Departments of Essonne, Paris, Seine-Saint-Denis, Seine-et-Marne, Val-de-Marne, Val-d'Oise, and Yvelines
42	Nagoya	Japan	11,321,000	21,567	525	4	Prefectures of Aichi, Gifu, Mie; including the cities of Nagoya, Toyohashi, and Tsu
43	Wuhan	China	10,834,056	10,088	1,074	29	Ezhou and Wuhan
44	Taipei	Taiwan	10,280,569	5,209	1,974	6	Hsinchu, Keelung, New Taipei City, Taipei, and Taoyuan
45	Shenyang	China	10,244,261	24,132	425	41	Fushun and Shenyang

Africa Asia Europe North America South America

Total Combined Population: 958,258,662; 13% of global population
Total Combined Area (sq km): 990,025; 0.66% of global land surface area
Total Number of 200 m+ Buildings: 958; 55% of world's 200 m+ buildings

Table 1. List of 45 megacities ranked by population (see Population and Area Sources, page 39)

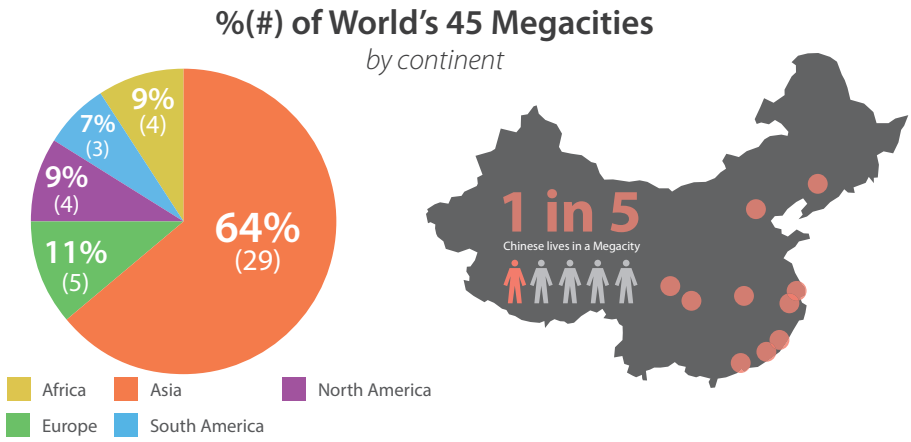

Figure 4. Percentage of megacities in each continent and location of China's 10 megacities.
Note: There are no megacities in the continents of Australia and Antarctica.

most corner of Jiangmen to the northeastern-most corner of Huizhou) and 331 kilometers from northwest to southeast (that is, from the northwestern-most corner of Zhaoqing to the southeastern-most corner of Hong Kong).

This boundary would give an area of 56,217 square kilometers, which would actually rank it 127th on the list of country areas around the world, just below Croatia, and above Costa Rica, Denmark, and Israel, for size. But it also would be the 12th largest country in terms of gross domestic product (GDP), lying between South Korea and Australia on the GDP per capita scale. Thus, as we can see, the Pearl River Delta megacity is comparable to numerous countries in terms of physical size, and far greater than many in terms of attributable economic output.

While many studies consider the Pearl River Delta and Hong Kong to be separate urban entities, due to Hong Kong's special administrative status within the People's Republic of China, this study includes Hong Kong, as all indicators point to the former British colony becoming more integrated with mainland China, and more to the point, with its immediate neighbors. The fact that it is currently a Special Administrative Region with a quasi-national boundary, a different political system, different currency – and, not insignificantly, left-hand driving – acutely underscores one central quandary of the megacity: the economic and functional realities of these cities are often several steps ahead of their political realities.

Estimates of the Pearl River Delta's population vary. The estimated current population for the Pearl River Delta, including Hong Kong, is 64.9 million. This would make it the 22nd-largest country in the world by population, just below the United Kingdom and just above France (Nations Online 2016).

The Pearl River Delta encompasses an urbanized area spreading into a total of 11 different municipalities whose administrative divisions define the overall boundary of the megacity (see Figure 3). Using this criterion, the second largest megacity would be Shanghai-Changzhou, which also includes the adjacent cities of Suzhou, Wuxi, and Jiaxing for a total population of approximately 50.3 million. The third largest megacity is Tokyo, but under this study's parameters, "Tokyo" should be considered as the larger Kanto Region, which encompasses neighboring prefecture-level political divisions, ballooning the population to about 42.8 million. The methodology of this study attempts to normalize data collection across cities that vary greatly in terms of topography, organization, and available information. As much previous study and literature has noted, it is unwise to assume that metropolitan planning models that work in one country, region, or even in a single city, will necessarily work in the next. The patterns of urbanization and densification are substantially different in different parts of the world. But as a means of identifying significant trends and issues, all megacities have something to teach each other, and our urbanizing world at large.

Where are Megacities?

Of the 45 megacities identified in this research (see Figure 4 and Tall Buildings in Numbers, page 52), 29 (64%) are in Asia, and 10 are in China alone (22%). Another six are in India. Europe has five (11%), North America and Africa have four (9% each), and South America has three (7%).

There is no evidence that a megacity, purely based on size, is inherently ungovernable; for example, Tokyo is one of the best-run and most thoroughly-integrated urban areas anywhere, of any size (Angel 2012) – but it's also an outlier in almost every category. The much more typical scenario – found in a dozen or so megacities near the Equator – sees some of the bleakest poverty, deepest corruption, most daunting environmental circumstances, and most chaotic daily life on the planet.

Based on the United Nations Human Development Index (HDI) figures for 2015, 11

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> “Mumbai is the world’s 11th-biggest megacity in terms of population, and has 38 buildings of 200 meters or higher, while Dhaka is 13th-biggest, and has none.”

megacities are in the top quartile (or “Very High” HDI), including those in Germany, the United States, and Japan; 18 are in the second quartile or “High” category, including those in Russia, Brazil, and China; 12 are in “developing” countries with “medium” HDI scores, including Indonesia, the Philippines, and India; and four are in “undeveloped” countries, including Pakistan, Nigeria, and the Democratic Republic of the Congo (UNDP 2015) (see Table 2).

Bearing in mind that 16 of the 45 megacities are in underdeveloped or developing countries, consider this:

“Of the global urban population of 730 million in 1950, 300 million (42%) lived in developing countries. By 2010, with a global urban population of 3.5 billion, 2.6 billion (73%) lived in developing countries. In 2050, the figures will be 7.3 billion, 5.2 billion and 83%, respectively. In other words, the urban population of developing countries will grow 15 times as much as in developed countries” (Angel 2012).

In addition to the predominance of urban population growth in developing countries, a substantial portion of the largest megacities are doubly affected by their location. Put another way, the fastest-growing places are those in the most vulnerable positions geographically, with respect to natural disasters:

HDI Rank	HDI Value	Quartile	Country	Megacities
5	0.916	1-Very High	Germany	Rhine-Ruhr
8	0.915	1-Very High	USA	New York-Philadelphia
8	0.915	1-Very High	USA	Los Angeles
8	0.915	1-Very High	USA	Chicago-Milwaukee
14	0.907	1-Very High	UK	London
17	0.898	1-Very High	South Korea	Seoul-Incheon
20	0.891	1-Very High	Japan	Tokyo (Kanto)
20	0.891	1-Very High	Japan	Osaka
20	0.891	1-Very High	Japan	Nagoya
22	0.888	1-Very High	France	Paris
40	0.836	1-Very High	Argentina	Buenos Aires
50	0.798	2-High	Russia	Moscow
69	0.766	2-High	Iran	Tehran
72	0.761	2-High	Turkey	Istanbul
74	0.756	2-High	Mexico	Mexico City
75	0.755	2-High	Brazil	Rio de Janeiro
75	0.755	2-High	Brazil	Sao Paulo
90	0.727	2-High	China	Pearl River Delta
90	0.727	2-High	China	Shanghai-Changzhou
90	0.727	2-High	China	Beijing-Tianjin
90	0.727	2-High	China	Chongqing
90	0.727	2-High	China	Hangzhou-Ningbo
90	0.727	2-High	China	Chengdu
90	0.727	2-High	China	Xiamen
90	0.727	2-High	China	Shantou
90	0.727	2-High	China	Wuhan
90	0.727	2-High	China	Shenyang
90	0.727	2-High	Taiwan	Taipei
93	0.726	2-High	Thailand	Bangkok
108	0.69	3-Medium	Egypt	Cairo
110	0.684	3-Medium	Indonesia	Jakarta
115	0.675	3-Medium	Philippines	Manila
116	0.666	3-Medium	South Africa	Johannesburg-Pretoria
116	0.666	3-Medium	Vietnam	Ho Chi Minh City
130	0.609	3-Medium	India	Delhi
130	0.609	3-Medium	India	Mumbai
130	0.609	3-Medium	India	Kolkata
130	0.609	3-Medium	India	Bangalore
130	0.609	3-Medium	India	Chennai
130	0.609	3-Medium	India	Hyderabad
142	0.57	3-Medium	Bangladesh	Dhaka
147	0.538	4-Low	Pakistan	Karachi
147	0.538	4-Low	Pakistan	Lahore
152	0.514	4-Low	Nigeria	Lagos
176	0.433	4-Low	DR Congo	Kinshasha

Table 2. List of 45 megacities ranked by country’s Human Development Index (HDI). Source: United Nations 2015

"A ranking of world cities by size of population vulnerable to a range of natural disasters found that the six most vulnerable urban areas in the world were in East Asia." (World Bank 2015). "Today, more than 1.5 billion of Asia's 4 billion people live within 100 kilometers of the Indian or Pacific oceans, where rising sea levels could overwhelm existing coastal barriers. Mankind's voluntary concentration into a dense, coastal civilization is certainly efficient, but it may not be very wise" (Khanna 2016).

It is already well-acknowledged that coastal defenses must be a part of any long-range plan for most of the megacities of the world; the experience of New York City during Hurricane Sandy in 2012 – with billions of dollars of damage and disruption, and from which recovery continues to this day – underscored this. Practitioners in the tall-building community have already begun to respond to this issue.

How are Megacities Growing?

In general, urban land cover – the amount of built-up area – has been increasing faster than urban population. The variance in settlement patterns contributes greatly to this. The global average density across all 45 megacities in this study is 963 people per square kilometer, a number that is highly skewed by the patterns of urbanization in the two nations with the greatest influence over urban planning worldwide, which are also the world's two largest economies – China and the United States.

For example, the urbanized area within the Shanghai municipality (not the megacity as this study has defined it) grew from 1,600 square kilometers to nearly 3,500 square kilometers from 2000 to 2010, but its population density decreased from 8,700 to 6,900 people per square kilometer during the same period. This is despite the fact that Shanghai added 29 buildings of 200 meters or greater, and 115 tall buildings of all heights during the same period (CTBUH 2015). This pattern has been repeated across China – despite its urban population having increased by more than 130 million people between 2000 and 2010, average density has remained almost constant, at 5,300 people per square kilometer, with much construction occurring in places with declining populations (World Bank 2015).

The fact that urban land coverage significantly outpaces density in the US comes as less of a surprise. Its overall average is 110 people per square kilometer. America's densest metropolitan area, the New York-Philadelphia megacity as defined in this study, has an average of only 563 people per square kilometer. Having said this, as a new generation of Americans rejects suburban living for urban lifestyles (and workplaces follow suit), and as the aging baby-boomer population downsizes its dwellings and moves into downtowns and closer to amenities, the United States is the only "highly developed" country that can expect a significant new wave of urbanization. It will add more than 100 million people to cities from 2010 to 2050, increasing its urban population by 40% (World Bank 2015).

It is significant to note the development patterns that persist in the US and China, because these are the countries where most of the urban planning "prescriptions" for the rest of the world have thus far been devised. Also, much of the design, construction, and economic power of the world is housed in, and deployed by, these countries. But both countries are outliers in terms of their spatial development, when compared to the rest of the world.

The United States is well known for having devised a particularly expansive form of auto-centric urban sprawl. Long-distance commuting patterns have created far-flung suburbs in semi-rural settings, and as a result, have created expansive metropolitan areas recognized by the US Census Bureau. This is one reason why the study includes the urbanized area of southeastern Pennsylvania, all of New Jersey, and significant portions of southwest Connecticut in the "New York – Philadelphia" megacity, an area of 54,880 square kilometers. Even more dramatically, the "Los Angeles megacity" includes substantial areas of open desert between settlements within the Los Angeles – Long Beach Combined Statistical Area (CSA), which encompasses 87,945 square kilometers – bigger than Austria and about the same size as Serbia.

China, "may also be an outlier, because its urban expansion has been accompanied by rapid economic growth, strong intervention by the central government in the urban expansion process, and massive investment in public infrastructure" (World Bank 2015). In other words, most countries do not have characteristics that would easily yield a similar or appropriate response to their localized forms of urban growth.

How Dense and Tall are Megacities?

Of the 1,731 buildings measuring 200 meters or higher, that are currently completed or under construction worldwide, 958, or 55% of these, are in the 45 megacities. Asia also claims the lion's share of 200-meter-plus buildings in megacities, with 774 (81%) of the world's 958 (see Figure 5).

In addition to being the world's largest megacity by population, with nearly 65 million people, the Pearl River Delta also has

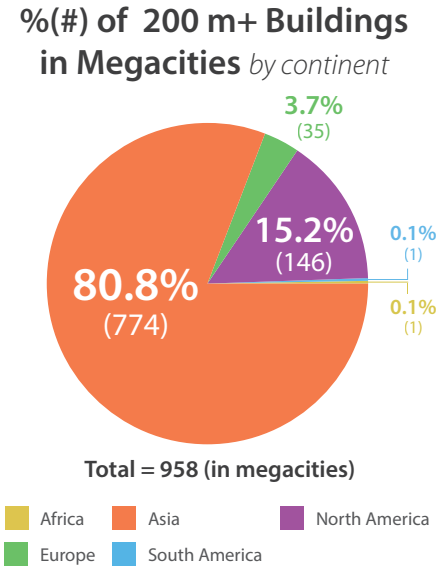

Figure 5. Percentage and number of 200 m+ buildings in megacities for each continent.

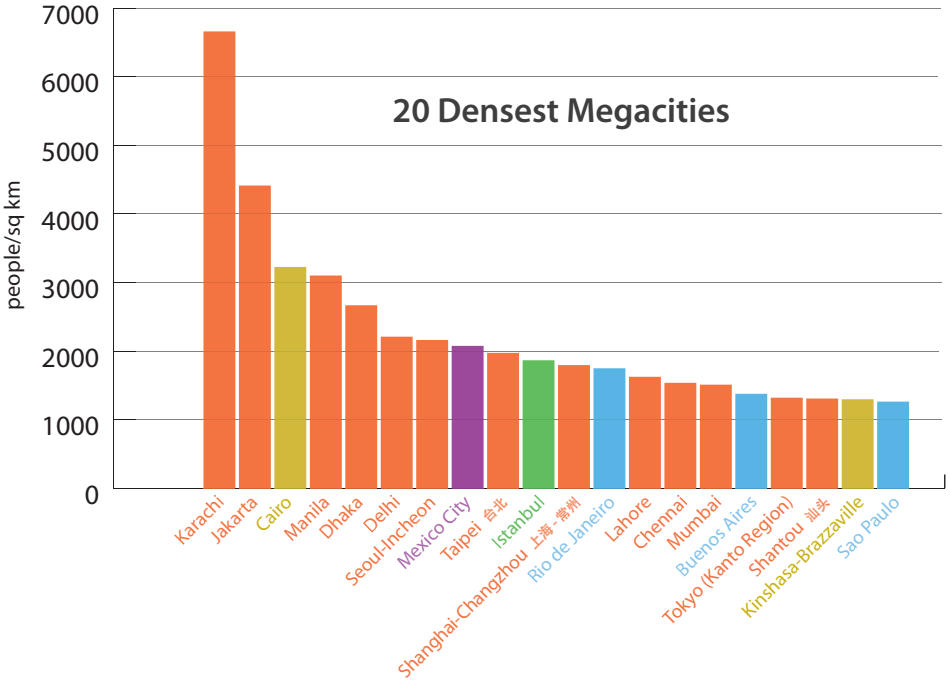

Figure 6. Population density figures shown for the 20 densest megacities are derived from an averaging of density across the entire urban agglomeration (see Population and Area Sources, page 39).

Figure 7. Karachi cityscape. © (cc-by-sa) چمرانرب یچارک

the greatest number of buildings 200-meters and taller – 220; and the highest number of 200-meter-plus tall buildings per capita – one for every 295,000 people. Nearly 30% of the 200-meter-plus buildings in the world's megacities are here. But is it the densest?

Measured as a single entity, the answer is surprising. The Pearl River Delta contains some of the densest places in the world, in particular the Kowloon area of Hong Kong, which holds up to 32,100 people per square kilometer. But, overall, its vast 56,217-square-kilometer area has an average density of 1,154 km/m^2, ranking the megacity as the 23rd-densest in this study (see Table 1).

The twenty densest megacities are shown in Figure 6, with Karachi, Pakistan being the densest on average. Karachi has an average of 6,663 people for each of its 3,527 square kilometers – but only one building of 200 meters or taller (see Figure 7).

Meanwhile, the vast informal settlements and transient populations of cities such as Mumbai and Dhaka make precise counts almost impossible, but it is generally accepted that these cities contain within them some of the most densely populated urban land on earth, in excess of 40,000 people per square kilometer in some places – and mostly in desperate urban conditions, in terms of space and infrastructure provisions. Even within this cohort – low-lying cities on the Indian subcontinent -- generalization is difficult. Mumbai is the world's 11th-biggest megacity in terms of population, and has 38 buildings of 200 meters or higher, while Dhaka is number 13, and has none (see Figures 8, 9, and 10).

In many ways, the Jakarta megacity is representative of the megacities still to come. By drawing a line around its urbanized area, from the Jakarta coastline to southern edge of Bogor, and from the Tangerang Regency boundary on the west to the Bekasi Regency boundary on the east , 28 million people fall within its orbit.

This makes Jakarta the ninth-largest megacity in this study in terms of population. Significantly, Jakarta has recently seen some of the most rapid tall-building construction outside of China. In 2015, the city saw seven buildings over 200 meters completed – the largest number of any city worldwide (CTBUH 2015). It also has a high population density, at 4,415 people per square kilometer (rank no. 2), and has forty-six 200-meter-plus buildings, ranking it no. 6 in this megacity survey. It's in a populous, economically-growing but still largely rural and poor country, with many low-lying areas susceptible to flooding. It is highly fragmented across multiple jurisdictions and travel corridors, and its infrastructure has not generally kept up with the speed of urbanization.

Cities like Jakarta, and those in less-developed conditions across South Asia and Africa, demonstrate both the enormous potential of, and the dire need for, heavy investments in transportation, infrastructure, and comprehensive regional planning.

Figure 8. Dhaka cityscape. © (cc-by-sa) Nasir Khan Saikat

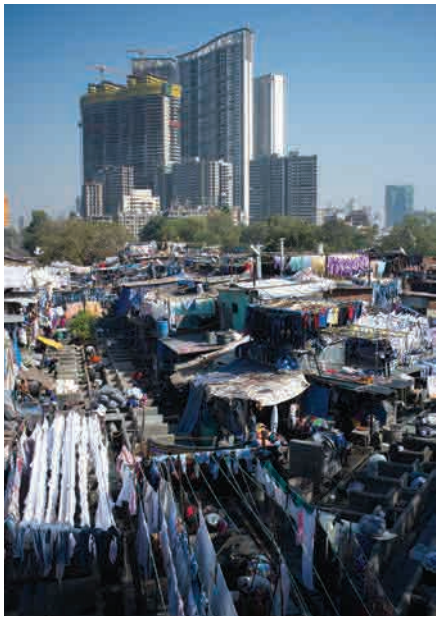

Figure 9. New tall buildings rising above a laundry district in Mumbai. © (cc-by-sa) Aleksandr Zykov

Figure 10. Mumbai cityscape. © (cc-by-sa) Vidur Malhotra

Without such improvements, the traditional, low-slung *kampungs* and the gleaming new towers alike (see Figure 11) will both be inundated by one or more vectors of a catastrophic combination: traffic, flooding, pollution, sewage, and social unrest. If they do not face total destruction, at the very least, large swaths of some megacities are at risk of becoming disconnected from their neighbors and the world.

Perhaps counterintuitively, some of the densest cities have the fewest tall buildings, and they tend to be comparatively under-developed economically and in terms of infrastructure. The majority of the world's poor are not living in tall buildings, but in low-rise, tightly packed dwellings with poor sanitation and building services. It is thus unsurprising that the default built "solution" to poverty for many cities, when the means become available, is to construct as many instances of a typology as close to the opposite of the sprawling shantytown as possible.

The result, to a large degree, has been the seemingly endless repetition of tall (though mostly sub-200-meter) modern apartment blocks, set in a "tower-in-the-park" model amidst broad roadways straight from Le Corbusier's visions. This model, devised for Europe in the 1920s but not implemented until after World War II, then repeated in America with public housing and Interstate highways in the 1950s and 1960s, and now in China, has gone virtually unchallenged for almost 100 years. Given the choice, of course, many of the urban poor would choose to live in dignity. But many believe the tower-in-the-park model isolates people and destroys the cultural integrity of their close-knit neighborhoods. The world clearly has much more densifying, vertical construction and poverty alleviation to do – the big question is, what shape will it take?

Figure 11. Newer high-rise buildings juxtaposed with the traditional, low-rise urban context of Jakarta. © (cc-by) Stefan Magdalinski

What are the Implications of Megacity Data for the Rest of the World?

Megacities comprise 13.1% of global population and occupy 0.66% of its land surface area. From this, it would be logical to infer that megacities demonstrate a high degree of sustainability with respect to land use. But their energy use, their disproportionate location along coastlines and deltas, and their population growth rates will have much wider implications than their built-up surface areas would suggest.

Even if megacities do not yet contain anything near a majority of the world's population, their strategic importance to national and global economies is difficult to overstate. The Shanghai and Pearl River Delta clusters account for less than 25% of China's population, but account for 80% of its exports (Khanna 2016). The implications of having to "move" even one of these megacities inland, or undertake massive coastal defense works, or elevate the ground plane to safety beyond new flood zones, are mind-boggling – but that is not an excuse for not thinking about the possibility.

What happens in megacities matters disproportionately to the rest of the world, which is well on its way to becoming 70% urban. Any interventions of design, planning, construction or governance in these cities will not only affect a great number of people in the first instance, but their effects will be amplified across the world due to the disproportionate significance of these cities as economic engines.

What Role Will Tall Buildings Play In Future Megacities?

The world is becoming an increasingly interdependent place. As we know only too well from revelations about greenhouse gases, climate change, and the rapid spread of viruses – both biological and technological – the choices we make in one part of the world are likely to affect many others. Nowhere is this more the case than when discussing pieces of critical infrastructure set in the world's megacities. There will not be one "template" that can be copied around the world to solve all of its problems, but that does not mean we should not think "big." This is a community that has no difficulty thinking big. The "big thinking," however, needs to extend beyond the height and style of individual buildings, and to instead think in terms of systems – tall buildings need to become part of a three-dimensional, globally-connected, and locally-vital, infrastructure. Tall buildings need to become critical infrastructure, not just users of it. Those who finance, design, and operate them, and decide where they should be built, need to think of them this way, if they are truly to be part of the solution.

Further Research

The Council on Tall Buildings and Urban Habitat intends to continue this research towards a further output; specifically, more clearly defining the actual built-up areas in each megacity, hence devising a more accurate representation of urban densities, as well as incorporating relevant economic and other data. ■

Unless otherwise noted, all image credits in this paper are to CTBUH.

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> "The world clearly has much more densifying, vertical construction and poverty alleviation to do – the big question is, what shape will it take?"

Population and Area Sources

Megacity	Source
Bangalore, Chennai, Delhi, Hyderabad, Kolkata, Mumbai	Census of India 2011
Bangkok	National Statistics Office Thailand
Beijing-Tianjin	National Bureau of Statistics of China
Buenos Aires	Instituto Nacional de Estadistica y Censos, 2016 estimates (Argentina)
Cairo	State Information Service, 2014 estimates (Egypt)
Chengdu, Hangzhou-Ningbo, Jakartar, Karachi, Pearl River Delta, Shantou, Shenyang, Tehran, Wuhan, Xiamen	www.citypopulation.de
Chicago-Milwaukee, Los Angeles, New York	US Census Bureau, 2015 estimates
Chongqing	Chongqing Municipal Statistics Bureau
Dhaka	Bangladesh Bureau of Statistics, November 2015 Population Monograph: Volume 7
Ho Chi Minh	General Statics Office of Vietnam
Istanbul	Turkish Statistical Institute, 2015 estimates
Johannesburg-Pretoria	Satistics South Africa, 2016 Community Survey
Kinshasa-Brazzaville	Centre Nationale de la Statistique et des Etudes Economiques du CONGO, 2015 estimates, Institut National de la Statistique; 2015 estimates (Democratic Republic of Congo)
Lagos	National Population Commission, Nigeria
Lahore	Punjab Bureau of Statistics, 2015 estimates
London	EuroStat Metropolitain Areas, 2014 estimates (European Union)
Manila	Phillippine Statistics Authority
Mexico City	Secreteria de Economia (Mexico)
Moscow	Russia 2010 Census
Nagoya, Osaka, Tokyo	Japan Statistics Bureau, 2014 estimates
Paris	Institut National de la Statistique et des etudes economics, 2013 census (France)
Pearl River Delta	Hong Kong Government Census and Statics Department, 2015 estimates; Statistics Bureau of Guangzhou
Rhine-Ruhr	DESTATIS Statistisches Bundesamt (Germany)
Rio de Janiero, Sao Paulo	Instituto Brasileiro de Geografia e Estatística, 2015 estimates
Seoul-Incheon	National Statistics Portal, 2016 estimates (South Korea)
Shanghai-Changzhou	Shanghai Municipal Statistics Bureau
Taipei	Taiwan National Statistics, 2010 Analysis