# The Sustainable Densities Proposition[1]

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**The Sustainable Densities Proposition states that city densities must remain within a sustainable range. If density is too low it must be allowed to increase, and if it is too high, it must be allowed to decline. The densification agenda now promoted as a general policy recommendation to be applied throughout our urban world thus needs to be examined more critically. The paper examines the range of urban densities in cities both in historical times and at present and points out that in some cities densities are too high, largely due to overcrowding, while some densities are too low and unable to sustain public transport, largely due to large-lot suburbanization.**

*The Sustainable Densities Proposition: City densities must remain within a sustainable range. If density is too low it must be allowed to increase, and if it is too high, it must be allowed to decline.*

> "What is the sense, it is frequently asked, of further densification given that densities are already high and associated with a range of problems including infrastructure overload, overcrowding, congestion, air pollution, severe health hazards, lack of public and green space and environmental degradation? The sustainability gains from further densification will be limited under conditions where densities are already high. Under these circumstances the merits of urban densification postulated for developed country cities seem far less convincing in the context of developing countries."
>
> *Rod Burgess (2000, 15)*

## 1 Introduction

When it comes to formulating policies to manage the expansion of cities ─ whether to reverse it, contain it, guide it, let it be, or encourage it ─ density matters. The denser the city, the less space will be required to accommodate its population. Compact cities can thus help protect and conserve the open countryside. They can also bring people closer together by sharing common walls, shortening travel times and the length of infrastructure networks, increasing the viability of walking, bicycling and public transport, and saving energy and reducing carbon emissions. Given that climate change is now an overriding concern, it is of paramount importance to allow and encourage densities to increase over time, if they can ensure the continued sustainability of our planet.

But that is not to say that a denser city is a better city. We cannot simply assume that urban densities are too low everywhere and must now be increased. In some cities densities are too high and therefore unsustainable for a variety of reasons: overcrowding, lack of light and air, pollution, congestion, overburdened infrastructure, and unaffordable land and housing. Many other cities have densities that are sustainable: high enough to support public transport, walking, and an urban lifestyle and to conserve energy and contain carbon emissions, yet low enough to avoid overcrowding, unaffordable housing, congestion, and overburdened urban services.

The Sustainable Densities Proposition is another version of the Goldilocks Principle: Densities should neither be too high nor too low but "just right", that is, within a tolerable or, to use a more contemporary word, sustainable range. The Goldilocks Principle itself is a version of the Confucian Doctrine of the Mean, the Buddhist Middle Way, Horace's Golden Mean, "the moral way observes the mean" of St. Thomas Aquinas, and "the right way is the mean" of Maimonides.

Average densities in the great majority of U.S. cities are too low to be sustainable and must be allowed and encouraged to increase in order to reduce the distances travelled, increase the viability of public transport, reduce carbon emissions, and thus mitigate their adverse effects on climate change.

How do present-day densities of the built-up areas in the United States and Bangladesh compare to densities in Manhattan's Tenth Ward in 1910? In the year 2000, for example, the average densities of the built-up areas of U.S. and Bangladeshi cities with 100,000 or more people were 24 and 191 persons per hectare respectively. Urban densities in Bangladesh were, on average, 8 times higher than those in the United States. In that year, the average densities in Houston and Dhaka, for example, were 20 and 555 persons per hectare respectively. The average density in Dhaka was nearly 28 times that of Houston. In 2005, the average density in Dhaka's slums, taken as a whole, was 2,220 persons per hectare. Those densities were

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actually of the same order of magnitude as those of Manhattan's Tenth Ward, its densest ward, in 1910 ─ 1,440 persons per hectare. Still, in 8.3 percent of Dhaka's densest slums ─ 409 communities packed with single-story houses like the Karail Bastee in Mahakhali ─ average densities in 2005 were higher than 3,750 persons per hectare (CUS 2005, tables 3.12 and 3.13, 40-41), or more than double that of Manhattan's Tenth Ward in 1910.

Figure 1: The Karail Bastee in Mahakhali, Dhaka, had a population density in 2005 that was more than double that of Manhattan's densest ward, the Tenth Ward, in 1910

## 2 Density and Carbon Emissions

We cannot simply assume that there is an association between urban densities and carbon emissions. We must begin by asking ourselves whether lower densities are indeed associated with higher levels of carbon emissions. A growing body of evidence suggests that this is indeed the case. A study of 46 cities, for example, found that in 1990 both the per capita energy used in transport and the per capita distance travelled decline with density (Newman and Kenworthy 1999). Higher-density cities were associated with shorter travel distances and lower energy expenditures on transport than lower-density ones. We can infer that they were also associated with lower level of carbon emissions.

Two more recent studies (Glaeser and Kahn 2009; Zheng et al. 2011) provide data for 2001 on the level of carbon dioxide emissions from all transport modes in the major cities in China and the United States using an identical methodology. I used these data, in conjunction with my own 2000 data on the average built-up area densities of these cities, to compare average emissions and average densities in 64 Chinese cities and 54 U.S. cities. The differences were striking. Average population densities in the Chinese cities studied were seven times those of the U.S. cities: 162 persons per hectare compared to 23 persons per hectare. Average annual $CO_2$ emissions from transport in the U.S. cities studied were 56 times those in Chinese cities: 12.8 tons per household compared to 0.27 tons per household. Except for these two new data sets, global data is not yet available to compare densities and carbon emissions in individual cities throughout the world, but it is possible to compare differences in densities and carbon emissions among countries.

Figure 2 illustrates the average amount of $CO_2$ emissions per capita from all sources and the average densities in cities with 100,000 people or more in 145 countries in the year 2000. The association between them is quite clear: the lower the density, the higher the level of $CO_2$ emissions per capita. The United States had an average density of 24 persons per hectare and an average annual level of 20.5 tons of $CO_2$ emissions per capita. Bangladesh had an average density of 191 persons per hectare and an average annual level of 0.2 tons of $CO_2$ emissions per capita — less than one-hundredth that of the United States.

This figure requires some further explanation. The blue dots are values for 19 selected countries. The small black dots are the values for the remaining 126 countries. (Values for countries with average densities larger than 220 persons per hectare are not shown). The ten larger yellow dots are the average values for each density decile (one-tenth of the countries studied). The vertical bars are confidence intervals for these decile averages (e.g. the average value of the first decile ─ one-tenth of the countries studied that had the lowest densities ─ is 12.2 tons per year, and we can assert with a 95 level of confidence that this

average value is somewhere between 6.5 and 18 tons per year. Generally, therefore, if two confidence intervals do not overlap, we can say with confidence that one average is significantly higher than the other. The figure demonstrates that the average emission values in the first four density deciles (cities in the lower-density ranges) are significantly higher than the average emission values for the last three density deciles (cities in the higher-density ranges). In short, country comparisons show a strong association between carbon dioxide emissions and urban population densities.

This association need not imply a causal connection between the two. Why? Households in richer countries, for example, can be expected to consume more resources than households in poorer ones. They will consume both more land and more energy per capita and can be expected to have both lower densities and higher carbon emissions. A third factor, in this case income, can be the cause of both low densities and higher $CO_2$ emissions, rather than one causing the other. Income alone, however, does not account for the differences in carbon emissions shown in figure 2. In a statistical model using both average density and income to explain the variation in carbon emissions among countries, I found that income explained only half of that variation while density explained the other half. Density appears to matter when it comes to carbon emissions. Do higher densities lead to lower carbon emissions because they require lower levels of car ownership and shorter trips? Possibly, but some will argue that the causal connection can go in the opposite direction as well. In cities with higher levels of car ownership people can opt to live in larger houses further away, thus lowering overall densities. In other words, low densities beget more cars and more cars beget lower densities.

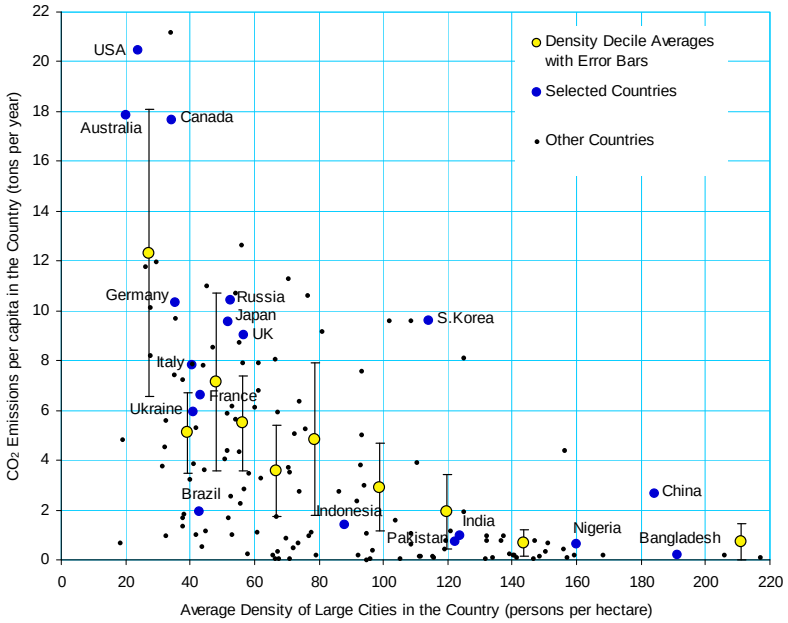


Figure 2: A comparison of average urban densities in large cities and average carbon dioxide emissions per capita from all sources in 145 countries, 2000

That said, there is good reason to believe that higher densities can indeed lead to lower carbon emissions. It has been observed that in the United States the viability of public transport, which emits far less $CO_2$ per capita, is positively associated with residential densities in the vicinity of transit stations — the higher that density, the more people use public transport (Pushkarev and Zupan 1977). Holtzclaw (1994) found that regular bus service requires a minimum density of 30 persons per hectare to be financially viable. If these contentions are correct, then a causal link can be established between densities and carbon emissions. Simply stated, other things being equal, if densities can be increased, then transit use can increase and carbon emissions can decrease.

## 3 Transit-Sustaining Densities

My colleagues and I examined the share of the total areas of U.S. cities that had "transit-sustaining" densities above 30 persons per hectare in different time periods (Angel et al. 2011). We also examined the shares of the total populations in these cities that lived at transit-sustaining densities. In 20 cities for which we had data for the period 1910-2000, we found that both shares declined substantially over time. The average share of the area of U.S. cities that was dense enough to sustain transit declined from 38 percent in 1910 to less than 4 percent in 2000, a 10-fold decline. The average share of the population that lived at transit-sustaining densities declined from 90 percent to 27 percent during that period, a 3-fold decline.

Figure 3: Los Angeles decommissioned its Pacific Railway trolleys in1956, piling them up in junkyards together with discarded World War II tanks

Examining 447 urban areas (out of a total of 453) in the United States in the year 2000, we found that almost half, 46 percent, had no population living at transit-sustaining densities; only 33 percent had more than 10 percent of their population living at transit-sustaining densities; only 13 percent had more than 20 percent of their population living at transit-sustaining densities; and only 2 percent had more than 50 percent of their populations living at these densities. The five metropolitan areas with the highest shares were San Francisco (71.4 percent), Los Angeles (67.7), State College, Pennsylvania (65.3 percent), New York City (64.7 percent), and San Jose, California (54.7 percent). In total, 27.3 percent of the U.S. urban population lived at transit-sustaining densities in the year 2000. This finding does not mean that these percentages of the population used transit, nor that transit was even available within walking distance. It only indicates the percentage of the urban population that lived at densities and could potentially sustain public transit.

It maybe that both families living at low density and relying on their cars and families living at higher densities and using public transport instead of cars may be exercising lifestyle choices by expressing cultural differences and individual aspirations. Some commentators have recently noted that cultural trends are now steering people away from low-density, car-based lifestyles ─ the proverbial American Dream ─ and toward higher-density, transit-based life styles (Calthorpe 2011). This may bode well for the United States, because several things are quite clear regarding present urban densities in most U.S. cities. They are too low to support public transport; too small a share of the population lives at densities that can sustain public transport; the country now produces an inordinate share of global $CO_2$ emissions, a share that clearly needs to be reduced to a more reasonable level that is at least on par with countries with similar per capita incomes; and higher densities may contribute to attaining that goal.

A reasonable goal for the coming decades may be to double the share of its urban population living at transit-sustaining densities, from 27.3 percent to 50 percent. This goal could be accomplished through the selective densification of parts of the urban landscape — as Curitiba, Brazil, for example, densified successfully along its main transit corridors (see photo) — but only if demand for higher-density, transit-based living is strong enough to support it.

Figure 4: In Curitiba, Brazil, dense urban development lined its five main transit corridors in 2008, serviced by frequent and efficient bus rapid transit

More people in the United States will need to vote with their feet as well as voice their political preferences for that to become a reality. And that will not be easy. Shrill reactionary voices that insist on low-density, car-dependent development as the true American Way and for which this agenda is anathema have been quick to politicize it to court suburban voters, voters that now form the majority of the U.S. electorate:

> "They want Americans to take transit and move to the inner cities. They want Americans to move to the urban core, live in tenements, [and] take light rail to their government jobs. That's their vision for America."
>
> *Representative Michele Bachmann (Murphy 2011)*

While Americans continue to debate the merits of densification, I believe that this agenda should be firmly rejected in cities that already have very high densities and need to be decongested; in cities where densities are declining but are likely to remain high enough to support public transport in coming decades; or in cities that are growing rapidly in population and need ample room for their expansion at their projected densities.

We should not forget that at the height of the Industrial Revolution and up to the beginning of the twentieth century there were genuine concerns that urban densities were too high and needed to be reduced to ensure that people had adequate living space and to bring in more light and air into their residences (see New York City Case Study below).

High densities were not unique to the industrial cities of the nineteenth and early twentieth centuries. Kowloon's Walled City ─ a small stretch of no-man's land in Hong Kong that officially remained under Chinese rule while the British governed the colony ─ was demolished in 1992. It boasted much higher densities than New York's Lower East Side in 1910 and virtually no light or air at all. At its peak density in the mid-1980s it may have housed as many as 35,000 people on some 2.5 hectares, at an average density of 13,000 people per hectare (Liauw 1998, 154), making it much denser than Hong Kong's high-rise residential districts of today and the world's highest-density urban neighbourhood ever recorded.

Figure 5: Kowloon's Walled City, Hong Kong, the densest urban neighbourhood in recent memory, before its demolition in 1992

The reduction of overcrowding in Chinese cities, through both suburbanization and redevelopment, has vastly increased floor space per person in recent decades. In Tianjin, for example, it increased from 6.5 $m^2$ in 1988 to 19.1 $m^2$ in 2000 and to 25.0 $m^2$ in 2005 (Tianjin Municipal Statistical Bureau 2006). This is welcome news, of course, and it should come as no surprise that this increase in floor area per person, coupled with the introduction of light and air into apartments, was accompanied by a corresponding decline in average densities.

There is nothing romantic about a Dhaka family of five still living in a 10 $m^2$ room with no light and air and sharing a water tap and a toilet with six or more other families. I, for one, find it disconcerting that Stuart Brand (2010), a leading environmentalist, chooses to celebrate the greenness of slums ─ their very high densities, their minimum energy and material use, and the preponderance of walking, rickshaws and shared taxis ─ while strictly avoiding any mention of overcrowding lest it interfere with his global densification message.

The Sustainable Densities Proposition seeks to broaden our perspective so we can see the entire spectrum of cities ─ from cities that are spread out at very low densities, contribute an unfairly large share of carbon emissions, and are thus unsustainable, to cities that are so dense and overcrowded they are unfit for dignified human habitation and thus unsustainable. The proposition states that no matter how sensible and noble the motives for densification may be, and despite the urgency of slowing down climate change or protecting the precious countryside, it is not the appropriate strategy for dense and overcrowded cities. On the contrary, densities in these cities need to be allowed and encouraged to decline, not to increase. This could only be done practically and economically by opening up new lands for expansion.

## Case Study: New York City

The tenements of New York City's Tenth Ward, for example, often contained 20 or more 30 $m^2$ apartments with no indoor plumbing on a 7.5 x 30–meter lot, each containing a household of 3 to 14 persons (Dolkart 2007), and many were used as a workplace as well as a residence (figure 6).

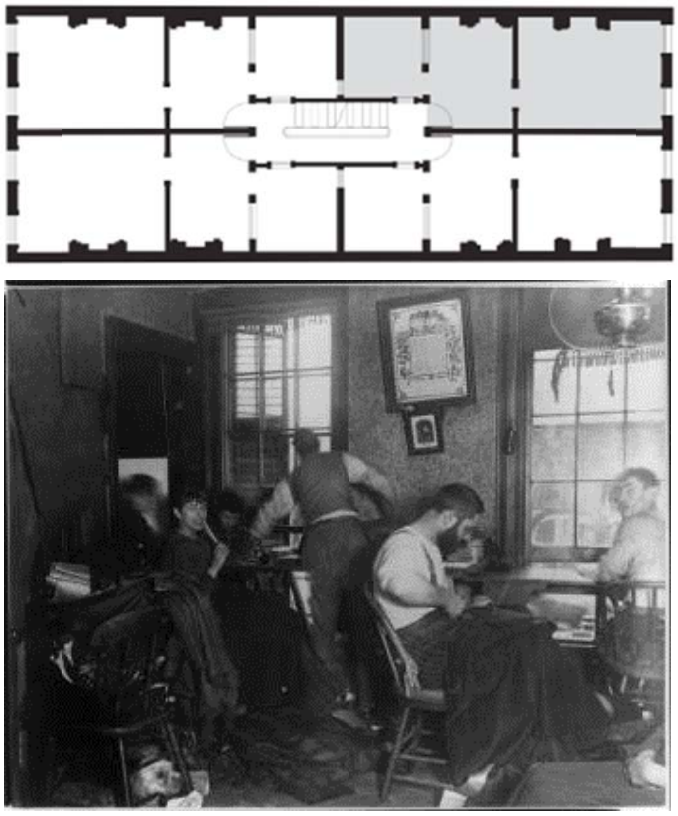

Figure 6: New York tenement floor plan (1864) and sweatshop (1889)

Politicians, reformers, and scholars were seriously concerned with living conditions in the city's crowded neighbourhoods:

> "The Tenth Ward has a population at the rate of 185,513 to the square mile [708 persons per hectare] the Seventeenth 170,006 [657 p/ha] and so on with others equally overcrowded. Portions of particular wards are even in worse condition."
>
> *(The New York Times, 3 December 1876)*

Jacob Riis, a reformist journalist and photographer credited with exposing the overcrowding and dire living conditions in the city's tenements in his book "How the Other Half Lives" was quite pessimistic about the prospects of reducing overcrowding and high densities:

> "What then are the bold facts with which we have to deal in New York?
>
> I. That we have a tremendous, ever swelling crowd of wage-earners which it is our business to house decently.
> II. That it is not housed decently.
> III. That it must be so housed here for the present, and for a long time to come, all schemes of suburban relief being at yet utopian, impracticable."
>
> *(Riis 1971 (1890), 223)*

Riis was wrong. Other social reformers sought to reduce overcrowding through decongestion policies made possible by the development of new transportation technologies from the early nineteenth century onwards. These technologies reduced the cost of movement in cities and made it possible for large numbers of people to commute over greater distances. Adna Farrin Weber (1899, 475) in his influential "The Growth of Cities in the Nineteenth Century" had it right: "The 'rise of the suburbs' it is, which furnishes the solid basis of a hope that the evils of city life, so far as they result from overcrowding, may be in large part removed."

There is no question that suburbanization did facilitate the decongestion of Manhattan's overcrowded neighbourhoods:

> "The Lower East Side contained 398,000 people in 1910, 303,000 in 1920, 182,000 in 1930, and 147,000 in 1940. To reformers who had long pressed for the depopulation of the slums, this levelling out of neighbourhoods was a welcome and much celebrated relief."
>
> *(Jackson, 1985, 185)*

Figure 7 shows census tract densities in Manhattan in 1910 and 2010. The column height displays densities in persons per hectare, not building heights, since buildings in 2010 were much higher, on average, than those of 1910, but they housed fewer people in smaller families that consumed much greater amounts of living space per person. As the figure clearly demonstrates, the high densities throughout the island and in the Lower East Side in particular were greatly reduced and overcrowding was largely alleviated as vast numbers of residents left Manhattan for the suburbs. When it comes to confronting overcrowding, we would do well to heed the advice of Weber, the detached scholar wallowing in statistics, rather than the more passionate Riis.

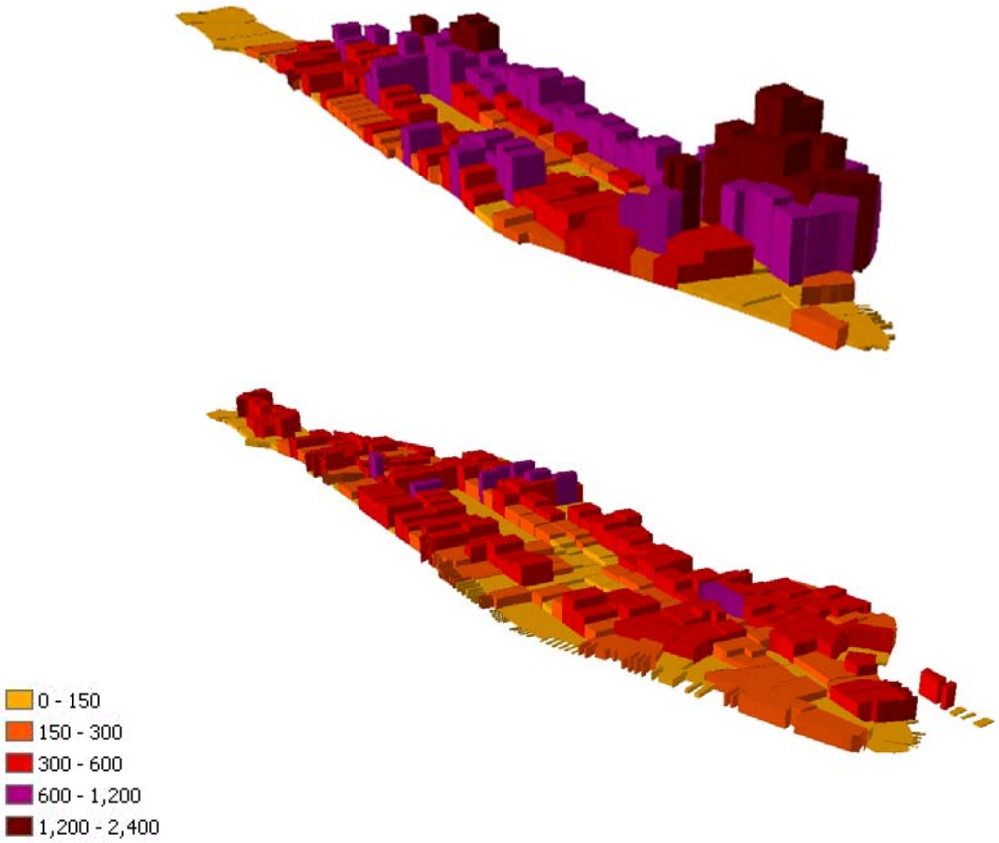


Figure 7: Census tract densities (persons per hectare) in Manhattan, New York, in 1910 (top) and in 2010 (bottom)

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