3

The Implications of Population Growth and Urbanization for Climate Change

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Introduction

It has long been common for population growth to be blamed for a range of environmental problems, but for the usually far more damaging contributions of high consumption to be downplayed (Hartmann, 1998; Satterthwaite, 2003). This misconception is now being applied to climate change. Cities, or urbanization in general, are frequently blamed for human-induced greenhouse gas (GHG) emissions and hence for climate change. The realities on both fronts are more complex. This chapter considers some of these complexities and tries to find more precise ways to allocate responsibility.[1]

Achieving More Precision in Allocating Responsibility for Climate Change

Most of the growth in the world's population is taking place in urban areas in low- and middle-income nations, and this is likely to continue (United Nations, 2008). Thus, a concern for how the growth in the world's population influences GHG emissions is largely a concern for how the growth in the urban population in low- and middle-income countries influences GHG emissions. An assessment of the contribution to climate change of urban centres or urbanization (growth in the proportion of a national population living in urban areas) or the growth in urban populations can be done either from the perspective of 'where GHGs are produced' (by assessing what proportion of GHGs emitted by human activities comes from within the boundaries of urban centres) or from the consumption perspective (assessing all the GHGs emitted as a result of the consumption and waste generation of urban populations no matter where they originated). Table 3.1 lists the most likely sources of growing GHG emissions for any city or any nation's urban population from these two perspectives.

Table 3.1: Possible Drivers of Growing Greenhouse Gas Emissions of the Urban Population in a City or in a Nation

From the perspective of where the GHGs are produced:

Sector	What drives growing greenhouse gas emissions in urban areas?	What can moderate, stop or reduce this growth?
Energy supply	Largely from fossil fuel power stations, resulting in a growth in electricity provision from high GHG-emitting sources; while many large fossil fuel power stations are located outside urban areas, the GHG emissions from the electricity used are usually allocated to these urban areas (see below).	A shift to less GHG-emitting power generation and distribution; incorporation of electricity-saving devices; an increase in the proportion of electricity generated from renewable energy sources and its integration into the grid.
Industry	Growing levels of production; growing energy intensity in what is produced; increasing importance of industries producing goods, the fabrication of which entails large GHG emissions, e.g., motor vehicles.	A shift away from heavy industries and from industry in general to the service sector; increasing energy efficiency within enterprises; capture of particular GHGs from waste streams.
Forestry and agriculture	Many urban centres have considerable agricultural output and/or forested areas, mostly because of extended boundaries that encompass rural areas; from the production perspective, GHGs generated by deforestation and agriculture are assigned to rural areas.	
Transport	Growing use of private automobiles; increases in average fuel consumption of private automobiles; increased air travel (although this may not be allocated to urban areas).	Increasing the number of trips made on foot, by bicycle, on public transport; a decrease in the use of private automobiles and/or a decrease in their average fuel consumption (including the use of automobiles using alternative fuels); ensuring that urban expansion avoids high levels of private automobile dependence.
Residential/ commercial buildings	Growth in the use of fossil fuels and/or growth in electricity use from fossil fuels for space heating and/or cooling, lighting and domestic appliances.	Cutting fossil fuel/electricity use, thus cutting GHG emissions from space heating (usually the largest user of fossil fuels in temperate climates) and lighting; much of this is relatively easy and has rapid paybacks.
Waste and wastewater	Growing volumes of solid and liquid wastes and of more energy-intensive waste.	Reducing volumes of wastes; waste management that captures GHGs.

From a consumption perspective:

Sector	What drives growing greenhouse gas emissions in urban areas?	What can moderate, stop or reduce this growth?
Energy supply	GHGs from energy supply/electricity now assigned to consumers, so GHG growth is driven by increasing energy use; consumers are also allocated the GHGs from the energy used to make and deliver the goods and services they consume.	As with the production perspective, but also a greater focus on less consumption among high consumption households; a shift to less GHG-intensive consumption.
Industry	GHGs from industries and from the production of the materials they use no longer allocated to the enterprises that produce them, but rather to the final consumers of the products; so again, GHG growth driven by increased consumption.	As in the production perspective, but with an extra concern to reduce the GHGs embedded in goods consumed by residents and to discourage consumption with high GHG emissions implications.
Forestry and agriculture	GHGs from these no longer allocated to rural areas (where they are produced), but rather to the consumers of their products (many or most in urban areas); note that most commercial agriculture has become more energy intensive; also, the high GHG implications for preferred diets among higher-income groups (including imported goods, high meat consumption, etc.).	Encouraging less fossil-fuel-intensive production and supply chains for food and forestry products; addressing the very substantial non-CO_2 GHG emissions from farming (including livestock); forestry and land-use management practices that contribute to reducing global warming.
Transport	As in the production perspective; GHG emissions from fuel use by people travelling outside the urban areas in which they live are allocated to them, including air travel; also concern for GHG emissions arising from investment in transport infrastructure.	As in the production perspective, but with a stronger focus on reducing air travel and a concern for lowering the GHG emissions implications of investments in transport infrastructure.
Residential/ commercial buildings	As in the production perspective, but with the addition of GHG emissions arising from construction and building maintenance (including the materials used to do so).	As in the production perspective, but with an added interest in reducing the CO_2 emissions embedded in building materials, fixtures and fittings.
Waste and wastewater	Large and often growing volumes of solid and liquid wastes which contribute to GHGs; these are allocated to the consumers who generate the waste, not to the waste or waste dump.	As in the production perspective, but with a new concern to reduce waste flows that arise from consumption in the city but contribute to GHGs outside its boundaries.
Public sector and governance	Conventional focus of urban governments on attracting new investment, allowing urban sprawl and heavy investment in roads, with little concern for promoting energy efficiency and low GHG emissions.	Governance that encourages and supports all the above remedies; also, a strong focus on lowering GHG emissions through better management of government-owned buildings and public infrastructure and services, including a concern for reducing GHG emissions generated in constructing infrastructure and in the delivery of services.

It is noticeable that all the drivers of the growing GHG emissions shown in Table 3.1 can occur (and often have taken place) in a national urban population or in a particular city not experiencing population growth. This is particularly the case if the consumption perspective is adopted. For instance, Greater London's population was larger in 1941 than it is today, but the total GHG emissions generated by its population's consumption are likely to have increased many times.

From the production perspective, if energy intensive production is concentrated in cities, their average GHG emissions per person will increase (unless the production is served by electricity not generated from fossil fuels). This can mean that particular cities in low- and middle-income nations with heavy industry or fossil-fuelled power stations can have very high carbon dioxide (CO_2) emissions per person. But in many nations, a considerable proportion of energy intensive production (for instance, mines and mineral processing) or fossil-fuelled electricity generation takes place in rural areas or urban areas too small to be considered cities. Rural districts with such energy-intensive production can have per capita GHG emissions that are much higher than most cities—although most city GHG emissions inventories that use the production perspective[2] use the consumption perspective with regard to electricity (wherein the emissions generated by the electricity used in the city are allocated to the city, not to the location where the electricity was generated). In addition, when comparisons for GHG emissions are made between rural and urban areas, where the high contribution of urban areas is stressed, generally, no consideration is given to emissions from agriculture and land-use changes in rural areas. The Intergovernmental Panel on Climate Change (IPCC) suggests that the latter accounts for around 31 per cent of all human-induced GHG emissions (Metz et al., 2008).

One obvious objection to using the production perspective is that a large proportion of the products of rural-based mines, forests and agriculture, as well as land-use changes, are meant to serve the production or consumption needs in urban areas. Therefore it is misleading to allocate these to rural areas (or rural populations). But the real issue here is the inappropriateness of allocating responsibility for GHG emissions to a nation as a whole (and by implication to that nation's entire population) or to urban areas in general or to particular cities (and by implication to all the urban population or to the populations of particular cities). Human-induced GHG emissions are not caused by 'people' in general, but by specific human activities by specific people or groups of people. It is not 'urban populations' in general that account for high private automobile use or high levels of air travel or high consumption lifestyles, but particular individuals or households (including many that live in rural areas). *In order for any individual or household to contribute to global warming, they have to consume the goods and services that generate GHG emissions.*

The dominant underlying cause of global warming is the consumption of goods and services that draw on resources for their fabrication, distribution (or provision), sale and use (and, for goods, disposal) resulting in the emission of GHGs. Of course, consideration also needs to be given to the (now heavily globalized) production systems that serve this (and that also do so much to encourage high consumption).

A significant proportion of the world's urban (and rural) populations have very low levels of GHG emissions because their use of fossil fuels and of the electricity generated by them—and the fossil-fuel input into the goods or services they consume—is very low, and their consumption patterns contribute little or nothing to the generation of other GHG emissions. In many low-income nations, most rural and urban households do not have electricity, and thus no household appliances that use electricity.[3] For low-income households in rural and urban areas in most of the lowest-income nations, recent Demographic and Health Surveys (DHSs) show that fuel use is still dominated by charcoal, fuelwood or organic wastes (e.g., dung). Where access to these is commercialized, as is likely in most urban centres, total fuel use among low-income populations will be low because fuel is expensive. If urban households are so constrained in their income levels that many family members are severely undernourished and can afford only one meal a day, it is unlikely that their consumption patterns are generating much GHGs. In addition, their fuel use may be largely or completely based on renewable resources, which means no net contribution to GHG emissions.[4]

Drawing on data for cooking fuel use and access to electricity for urban populations from recent DHSs,[5] among the 44 nations for which data were available, 17 had more than half of their urban populations relying primarily on non-fossil fuel for cooking. There were also 11 nations where more than half of urban households did not have access to electricity. But even when low-income households do shift to fossil-fuel-based energy sources—typically kerosene in low-income nations—their consumption levels remain low. Low-income households in Delhi that rely on kerosene typically use 25–30 litres per month (Dhingra et al., 2008), which implies CO_2 emissions per person per year of around 0.15–0.2 tonnes (very small by global standards). Low-income urban households also use transport modes that produce no GHG emissions (walking, bicycling) or low GHG emissions (buses, mini-buses and trains, mostly used to more than full capacity). To give an illustration of how low consumption levels are, in Kibera, Nairobi's largest informal settlement (with around 600,000 inhabitants), a 1998 survey found that only 18 per cent had electricity, only 7 per cent had a bicycle and only 1.5 per cent had a refrigerator; 31 per cent of all households surveyed had no radio, television or refrigerator (APHRC, 2002).

When low-income urban-dwellers do obtain electricity, the few studies available suggest that consumption levels are often very low. For instance, among low-income households in three Indian cities (Kulkarni and Krishnayya, 1994), just 32–33 kilowatt hours per month were used (1/20th to 1/40th of the average per person in most high-income nations). A very considerable number of people (both rural and urban) may have zero or negative GHG emissions per person. Included among these are many low-income urban-dwellers whose livelihoods are based on reclaiming and re-using or recycling waste. The GHG emissions 'saved' from their work equals or exceeds the GHG emissions that their consumption causes. It may also include tens of millions of small farmers able and willing to engage in sustainable agriculture and in maintaining or increasing forests on their land. Thus, perhaps up to one sixth of the world's population has incomes and consumption levels that are so low they are best not included in allocations of responsibility for GHG emissions.

The failure of more than 50 years of development to reduce the number of people living in poverty (which also means failing to reduce the number with very low and inadequate consumption levels)[6] suggests that a very considerable proportion of the world's population will continue to live in extreme poverty and, in effect, contribute very little to future GHG emissions. Of course, how income distribution changes within urban (and rural) populations has very large implications for future GHG emissions. For instance, a household in Mumbai with an income of 150,000 rupees a month (around U$3,125) is likely to contribute far more GHG emissions than a pavement-dweller household.

Thus, the much-used formula of I = P*A*T (impact relating to population, affluence and technology) should be changed to I = C*A*T when applied to global warming impacts, with C being the number of consumers, not the number of people. In addition, it is neither fair nor accurate to suggest that either population growth or urbanization necessarily causes increases in GHGs. This increase depends more on the form and levels of consumption among the growing population or among the population that moves to urban areas (the immediate cause of urbanization). For example, many urban centres in sub-Saharan Africa and low-income nations in Asia (including many with growing populations) are likely to have very low average GHG emissions per person—whether from the production perspective (they have very little or no industry and most of the population has very low fossil-fuel use within households or for transport) or the consumption perspective (with a very low proportion, or no, residents with high consumption lifestyles). This is not recognized, partly because there are no data available on their emissions, but note should be taken of the many nations whose average annual per capita CO_2 emissions are below 0.2 tonnes (i.e., less than 1/200th that of the United States or Canada). In 2005, 13 nations had average CO_2 emissions per person that were less than 0.1 tonnes. In contrast, as discussed in more detail below, there are nations with slow or no population growth and very small increases in urbanization levels where both total GHG emissions and GHG emissions per person have increased rapidly in recent decades. This would be even more the case if there were statistics for GHG emissions from a consumption perspective.

In addition, it is unfair to equate increases in GHG emissions per person among low-income populations (for example, from 0.1 to 0.5 tonnes of CO_2e per person per year[7]) with comparable GHG increases among high-income populations (for instance, from 7.1 to 7.5 tonnes per person per year). The reduction in global emissions needed to avoid dangerous climate change depends on achieving a particular global average for emissions per person—what is sometimes termed the 'fair share' level, generally set at around two tonnes of CO_2e per person. Making provision for increases in GHG emissions for those people below the 'fair share' level so that they can move out of what might be termed 'energy poverty' cannot be considered in the same light as increases in emissions from those already above the 'fair share' level.

If what is stated above is accepted, the discussion of the links between population and the causes of climate change (and, within this, the links between urbanization and the causes of climate change) is altered. Perhaps the most fundamental point is that increases in GHG emissions per person by people living below the global 'fair share' level should be treated differently from increases by people above it. Most of the nations with the most rapid growth in their national (and urban) populations have average GHG emissions per person far below the 'fair share' level.

How Much Does Population Growth Coincide with the Growth in Greenhouse Gas Emissions?

It is worth considering in more depth the extent of the association between population growth and the growth of GHG emissions. As noted, many of the nations with the most rapidly growing national and urban populations have very low levels of CO_2 emissions per person and have experienced slow growth in these emissions, while many of the nations with the slowest growing national and urban populations have the highest levels of GHG emissions per person and have had a rapid growth in CO_2 emissions per person. Between 1980 and 2005, some high-income nations had a slow growth in CO_2 emissions per person because they already had very high per capita emissions. If data were available for the consumption perspective, it is likely that they would show that high-income nations have had a much greater growth in emissions per capita, and many low- and middle-income nations have had much less.

Looking first at the nations with the highest and lowest CO_2 emissions per person, data are available for average CO_2 emissions per person for 185 nations for 1980 and 2005.[8] These can be divided into five sets of 37 nations each. All but ten of the 37 nations with the highest CO_2 emissions per person in 2005 were high-income nations (encompassing North America and much of Europe). Three small population, high-income Middle-East oil producers had the highest emissions (Kuwait, Qatar and the United Arab Emirates) and very high population growth rates (mostly from immigration). But generally, this group of high-emissions nations had very low population growth rates between 1980 and 2005 (more than half had average population growth rates of less than 1 per cent a year for this period). Of the 37 nations with the lowest CO_2 emissions per person, all were low-income nations, and most (29) were in sub-Saharan Africa; 34 had population growth rates of more than 2 per cent a year; and nine had population growth rates of more than 3 per cent a year.

Thus, when considering how CO_2 emissions per person change in relation to population growth, for the period 1980-2005, many of the nations with among the slowest population growth rates had among the fastest growth rates in CO_2 emissions, while many of the nations with among the fastest population growth rates had among the slowest increases in CO_2 emissions. The countries with low population growth and high CO_2 emissions growth are mostly high-income or upper-middle income nations, most are in Europe or Asia, and all had very considerable economic success in the period 1980-2005; the high population growth, low emissions growth countries are mostly low-income nations, most are in sub-Saharan Africa, and many had little economic success during this period. Clearly, any consideration of changes in a nation's CO_2 emissions in the last few decades cannot be separated from a consideration of economic changes that include the extent (or not) of economic growth and the sectors where this growth took place, as well as changes in incomes and how these were distributed within the national population.

For China, the very rapid growth in production (much of it for export) from 1980 to 2005 is an important contributor to its rapid growth in CO_2 emissions. This is also likely to have been the case for South Korea and perhaps for Thailand. For several nations, including Chile, New Zealand, Portugal and South Korea, it is likely that the growth in per capita income and increases in incomes (and in consumption) that benefited a large part of their national populations are important underpinnings for CO_2 emissions growth—although this is not fully represented in the CO_2 emissions figures for nations because the emissions embedded in imported goods are not taken into account. Perhaps the success of the tourist industry contributed to such emissions growth in some of the southern European nations (and perhaps Thailand); if these tourists were from other nations, within the consumption perspective, this growth would be allocated to the tourists.

For the group of nations with high population growth rates and low CO_2 emissions growth rates, almost all are low-income countries, and many are among the lowest-income nations in the world and among those that had the least economic growth between 1980 and 2005. Some are reported to have had a decline in CO_2 emissions between 1980 and 2005, for instance, Chad, the Democratic Republic of the Congo, Liberia and Zambia.

Table 3.2 compares the different world regions with regard to their share of world population growth and CO_2 emissions growth between 1980 and 2005 and between 1950 and 1980. The table highlights the fact that sub-Saharan Africa accounted for very little of the growth in CO_2 emissions for both these periods (less than 3 per cent) but for 18.5 per cent of population growth between 1980 and 2005 and 10.7 per cent between 1950 and 1980. In contrast, Northern America accounted for around 4 per cent of population growth for both periods but for 20 per cent of the growth in CO_2 emissions in 1950-1980 and 14 per cent of the growth in emissions in 1980-2005. This is despite the fact that, in 1950, CO_2 emissions per person in Northern America were already very high (much higher than in many high-income nations today). Table 3.2 also includes figures for the five nations with the largest increases in CO_2 emissions. Note that China accounted for a much larger share of the increase in CO_2 emissions than India, but with a smaller contribution to increases in population. Japan, South Korea and the United States contributed far more to increases in CO_2 emissions than they contributed to increases in population. Note, too, that China and sub-Saharan Africa accounted for similar proportions of the increase in the world's population during the period 1980-2005 (15.3 and 18.5 per cent), but China's contribution to increased CO_2 emissions was nearly 20 times that of sub-Saharan Africa.

At the risk of unnecessary repetition, it is the number of consumers (and their consumption levels) that drives increases in GHG emissions, not the number of people (while from a production perspective, it is more the nature and location of production). Europe's share of CO_2 emissions growth is negative because many European nations had lower emissions in 2005 than in 1980, but if data were available for a consumption perspective analysis, this might well be different—with much higher proportions of emissions attributed to wealthy European nations (or, more correctly, to their wealthier citizens).

Table 3.2: Share of the World's Population Growth and CO_2 Emissions Growth, 1980–2005 and 1950–1980

		1980–2005		1950–1980	
		Share of population growth (%)	Share of CO_2 emissions growth (%)	Share of population growth (%)	Share of CO_2 emissions growth (%)
Regions	Africa, North	3.0	2.5	2.5	1.0
	Africa, sub-Saharan	18.5	2.4	10.7	2.2
	Asia	63.1	82.7	64.1	30.6
	Europe	1.8	-12.6	7.6	39.7
	Latin America and Caribbean	9.4	6.4	10.2	5.3
	Northern America	4.0	13.9	4.4	19.9
	Oceania	0.4	2.1	0.4	1.3
Nations	China	15.3	44.5		
	United States	3.4	12.6		
	India	21.7	9.9		
	Korea, Republic of	0.5	3.7		
	Japan	0.5	3.6		

Source: Derived from data from CAIT, 2009.

Table 3.3 shows the different contributions of nations to population growth and CO_2 emissions, 1980 to 2005 and 1950 to 1980, when they are classified by average per capita income levels. Nations classified as low-income in 2005 contributed far more to global population growth between 1950 and 2005 than they did to CO_2 emissions growth. Nations classified as high-income in 2005 accounted for far more CO_2 emissions growth than population growth. Again, if we shifted to a consumption-focused analysis, the contrasts between the nations contributing most to population growth and the nations contributing most to CO_2 emissions growth would be even more dramatic.

Table 3.3: Contributions to Population Growth and CO_2 Emissions Growth by Per Capita Income Category, 1980-2005 and 1950-1980

Income category in 2005	1980–2005		1950–1980	
	Population growth (%)	CO_2 emissions (%)	Population growth (%)	CO_2 emissions (%)
Low-income nations	52.1	12.8	36.0	5.6
Lower-middle income nations	35.7	53.2	47.1	39.7
Upper-middle income nations	5.0	5.0	5.7	9.6
High-income nations	7.2	29.1	11.2	45.1

Source: Derived from data from CAIT, 2009, and United Nations, 2008.

Population growth therefore can only be a significant contributor to GHG emissions if the people that make up this growth enjoy levels of consumption that cause significant levels of GHG emissions per person (or, from the production perspective, live in nations with a rapid increase in GHG-generating production). This, of course, has relevance not only for today but also for the future, in the lifetime contribution to GHG emissions of people born now. *If most of the growth in the world's population is among low-income households in low-income nations who never 'get out of poverty', then there is and will be little connection between population growth and GHG emissions growth.*

But even if a significant proportion of the future increase in GHG emissions is from nations with rapid population growth, if the increase is in nations below the 'fair share' level for average per capita emissions, it cannot be judged as comparable to that in nations above that level. More to the point, a growth in GHG emissions per capita among those individuals or households below the 'fair share' level (whatever the wealth of that nation) should be considered as qualitatively different from any growth in GHG emissions per capita among individuals or households above the 'fair share' level. Of course, this is very difficult to address, in part because of limited data, in part because it is difficult to support needed consumption increases among low-income groups while bringing down GHG emissions per person among groups above the 'fair share' level.

Perhaps the key issue to be gleaned from the above discussion is that far more attention needs to be given to changes in production and consumption within nations if we are to identify the main potential contributors to GHG emissions growth in the future. The main implications of Tables 3.2 and 3.3 are to caution against any assumption that population growth necessarily causes increases in CO_2 emissions. What is needed for any consideration of GHG emissions and population is a consideration of each nation's changes in production, in incomes and their distribution and in consumption. Of course, this is linked to urbanization because urbanization is driven by the increasing proportion of GDP generated by industry and services (most of which are located in urban areas) (Satterthwaite, 2007), while the form that urbanization takes is much influenced by the spatial distribution of investments in industry and services and the social and spatial distribution of the incomes arising from these economic changes. Demographic changes will be important influences, not only in terms of changes in the number of people but also in terms of changes in age structure and household size (and how these influence consumption).

This implies a need for caution against applying any generalization relating to climate change and population to 'developing countries' or even to particular regions (sub-Saharan Africa, for instance), because there will be such diversity between nations in almost all the factors that influence production and consumption patterns, as well as in a nation's possibilities to de-link CO_2 emissions from growing production and consumption (as in, for example, a nation that can draw on hydroelectricity for a significant proportion of demand for electricity).

Urbanization and Climate Change

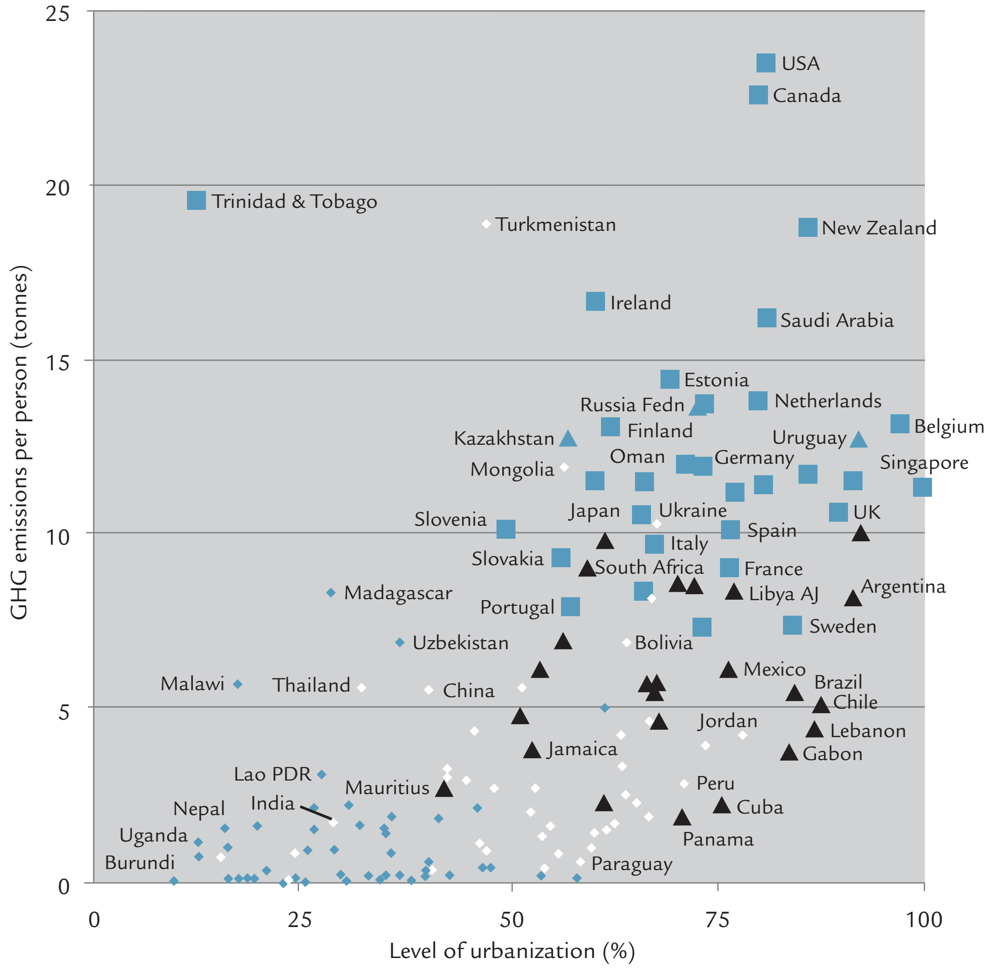
As noted, cities (or urbanization in general) are often held responsible for climate change. Sometimes this is based on estimates that seem to have no supporting evidence. This can be seen in the much-cited suggestion that cities account for 80 per cent of all GHG emissions worldwide. Actually, only around 35 per cent of the world's GHGs are emitted within city boundaries, although city populations account for a higher proportion of emissions if they are allocated to consumers (Satterthwaite, 2008). In other instances, the blame seems to be based on an assumption that urbanization brings higher GHG emissions—see, for instance, the assumption that per capita emissions in urban areas are higher than those in rural areas because of the ". . . big differences in productive and consumptive behaviours between rural and urban populations" (Jiang and Hardee 2009, p. 9). But this is certainly not always the case. With regard to consumption levels, in many nations, a large proportion of high-income, high-consumption households live in rural areas and are likely to have higher average GHG emissions per person or per household than urban-dwellers with comparable incomes—for instance, because of larger, less energy efficient homes and the greater use of (or, indeed, dependence on) private automobiles in rural areas. This explains in part why New York, London and Barcelona have much lower average GHG emissions per person than the national averages of the United States, United Kingdom or Spain, respectively (Chapter 4). This might be considered a phenomenon that is only common in high-income nations, but it is likely that a significant and often growing proportion of the high-income population in low- and middle-income nations now live outside urban boundaries. And, as already discussed, when viewing the energy use of low-income urban-dwellers in many low-income nations, it is not clear that their consumption patterns generate more GHG emissions than their rural counterparts.

Since most of the world's growth in population in the next few decades is likely to be in urban areas in low- and middle-income nations, the link between population growth and GHG emissions will be much influenced by the GHG emissions implications of urbanization in these countries. Urbanization can be viewed as one of the most serious 'problems' causing climate change in that, in general, the more urbanized a nation, the higher the GHG emissions per person. But it can also be viewed as a key part of the 'solution' in that it provides the basis for delinking high standards of living/quality of life from high GHG emissions per person. In the limited range of cities for which GHG emissions inventories have been undertaken, there are very large differences in per capita emissions among cities with high living standards. For instance, Barcelona, widely considered a city with a high quality of life, has one fifth of the GHG emissions per person of many cities in the United States. New York City has one third to one half of the GHG emissions per person of many other United States cities (Chapter 4). Many of the most desirable and expensive residential areas in or close to city centres in Europe have residential areas that are or can be made very energy efficient (typically terraces with three-to-six storey buildings), and settlement patterns and public transport systems that allow most trips to be made on foot, by bicycle or on public transport. Indeed, one of the drivers of urbanization is the economic advantages that close proximity provides for a great range of enterprises.

With regard to the impacts of climate change, urban areas can be seen as presenting one of the most serious 'problems', as they concentrate people and their assets, industries and infrastructure in ways that increase risk and vulnerability—and many cities and smaller urban centres are in locations that climate change is making (or will make) particularly hazardous (Bicknell et al., 2009). Conversely, urban areas can be viewed as having large potential advantages in building resilience to climate change impacts—i.e., in the economies of scale and proximity that they present for key protective infrastructure and services and for risk-reducing governance innovations to reduce risk and vulnerability, for instance, through partnerships between government agencies and civil society groups (Bicknell et al., 2009). It is also generally easier in urban than in rural areas to organize a rapid response to approaching extreme weather events that are judged serious enough to warrant moving many people temporarily from their homes.

Figure 3.1 shows the level of urbanization of selected nations plotted against per capita GHG emissions for 2005 (in CO_2e) based on the production perspective. The figure shows few surprises. In general, the more urbanized the nation, the higher the GHG emissions per person, although with considerable variations in emission levels per person for nations with comparable urbanization levels. Also, the wealthier the nation, the higher the GHG emissions per capita, although also with very considerable variations in GHG emissions per capita for nations with comparable levels of urbanization, and very considerable variations in levels of urbanization for nations with comparable GHG emissions per capita. Most low-income nations have less than half of their population in urban areas, and many have less than a quarter; many have per capita GHG emissions below 0.2 tonnes a year and very few above 2.5 tonnes a year. Of course, part of the large variations in GHG emissions per capita between nations with comparable levels of urbanization may be explained by the

Figure 3.1: Level of Urbanization of Countries plotted against Per Capita Greenhouse Gas Emissions (CO_2e) for 2005



Note: The small blue diamonds represent low-income nations, the small white diamonds lower-middle income nations, the black triangles upper-middle income nations and the large blue squares high-income nations. These figures include not only CO_2, but also the other greenhouse gases included in the Kyoto Protocol, and their contributions to global warming are converted into CO_2e.

different criteria used to define urban populations or urban places. But note that all of the upper-middle and high-income nations and many of the lower-middle income nations had GHG emissions per person above the ‘fair share’ level, with the United States and Canada having more than 10 times that level.

So, is urbanization a driver of climate change? It is generally assumed that it is, but urbanization cannot be the ‘driver’ in that it is itself propelled mainly by economic and political change. In almost all low- and middle-income nations, urbanization in the last few decades has been driven by investment patterns that have increased the proportion of production in industry and services (mostly located in urban areas) thereby increasing the proportion of the economically active population working in those industries and services. Increasing levels of urbanization therefore track the increasing proportions of GDP generated by industry and services and the growing proportions of the workforce employed therein (Satterthwaite, 2007). This strong association between growing levels of urbanization and changing investment/production patterns was less evident in many nations in Asia and Africa in earlier decades, around the time of the achievement of political independence, especially in countries where the rights of the population to live and/or work in urban areas had been controlled by the colonial government. Thus, much urbanization just pre- or post-independence resulted from the movement of individuals or households to urban centres that previously controlled their rights to live or work there, as well as from the building of the institutional infrastructure that is part of a nation-state. Here, then, political change was a major influence on increasing urbanization levels.[9]

From the production perspective, what drives the growth in GHG emissions in low-income and most lower-middle-income nations is the increasing use of fossil fuels in industries and services (and, usually, electricity generation). This is related to urbanization in the extent to which such production is within urban boundaries. For example, it is likely that the rapid growth in GHG emissions in cities such as Beijing and Shanghai is driven in large part by the very great expansion in manufacturing (Dhakal, 2004). Low-income nations that have little or no economic growth probably have little or no growth in GHGs in their urban areas, just as they generally have little or no increase in their urbanization levels (Potts, 2009). But for low- and middle-income nations that become wealthier (which also means becoming more urbanized), the location of consumers and the changes in their consumption behaviour become increasingly important contributors to GHG emissions. For instance, it can be assumed that, in India, it is generally urban areas with heavy industry that have the highest GHG emissions per person, but in particularly successful cities such as Delhi, Mumbai, Pune and Bangalore, GHG emissions per person may be increasingly driven by the consumption patterns of their higher-income groups (although this will only become fully apparent if city-based GHG emissions inventories can be done from the consumption perspective).

As noted already, in successful nations or successful cities, it is common for a growing proportion of middle- and upper-income households to live outside the city boundaries, in small urban centres or rural areas. In high-income nations there are also many manufacturing and service enterprises that are located in rural areas. But here, the division between rural and urban in terms of employment and access to infrastructure and services has disappeared; in effect, virtually all rural areas are 'urban' in that almost all of the population does not work in primary activities (including farming, forestry and fishing) and almost all enjoy levels of infrastructure and services that were previously only associated with urban locales. Thus, in high-income nations, there can be a large increase in per capita GHG emissions and very little or no increase in urbanization levels.

If the real driver of climate change is increasing consumption,[10] how can a more accurate understanding of the links between urbanization and climate change be achieved? It is known that allocating responsibility for GHG emissions through average per capita emissions figures for nations is misleading for at least two reasons. The first is that these figures are based on where GHGs are emitted and not on what caused them to be emitted. If GHG emissions were allocated to the location of the consumers whose consumption was the root cause of these emissions, it would considerably increase the GHG emissions per person in most high-income nations (and cities) and considerably decrease the GHG emissions per person in nations (and cities) that were successful exporters of consumer goods (especially those with high GHG emissions caused by their manufacture and transport to markets). The second is that it is very misleading to discuss responsibility for GHG emissions per person using national averages because of the very large differences in per capita emissions within each nation between the highest-income and lowest-income groups—perhaps a 100-fold or more difference between GHG emissions per person if the wealthiest 1 per cent and the poorest 1 per cent in many nations could be compared. As noted earlier, a proportion of the lowest-income households in rural and urban areas in many nations may not even have any net contribution to GHG emissions.

In summary, the real drivers of GHG emissions growth are high consumption and rapid growth in consumption, not population (or rapid population growth) or urbanization. If it was possible to assess GHG emissions by the consumption and lifestyles of households, it is likely that the very rich would have GHG emissions per person that were thousands of times greater than those of large sections of the poorest groups. If mapped on the whole world's population, irrespective of which nation they lived in, a figure would be produced that is similar to the 'champagne glass' used by the United Nations Development Programme's *Human Development Report* in 1992 to highlight global inequality in incomes, where the world's richest 20 per cent of the population receive at least 150 times the income of the poorest 20 per cent (UNDP, 1992).

Conclusions

It is not correct to suggest that it is the increase in population that drives the growth in GHG emissions, when the lifetime contribution to GHG emissions of a person added to the world's population varies by a factor of more than 1,000, depending on the circumstances into which he or she is born and his or her life possibilities and choices. It is not the growth in the number of people, but rather the growth in the number of consumers and the GHG implications of their consumption patterns that are the issue. In theory (leaving aside the difficulties in measurement), responsibility for GHG emissions should be with individuals and households and should be based on the GHG implications of their consumption, and not with nations (or cities) based on GHG inventories from the production perspective. From the consumption perspective, the 20 per cent of the world's population with the highest consumption levels is likely to account for more than 80 per cent of all human-induced GHG emissions and an even higher proportion of historical contributions. In considering how to reduce emissions globally, far more attention should be directed to reducing this group's GHG emissions. And, as responsibilities for addressing this are allocated to national and local governments (with city governments having particularly important roles), consideration should be given to the distribution among nations of this 20 per cent of the world's population (obviously most, but certainly not all, in high-income nations).

To obtain the much-needed rapid decrease in GHG emissions globally, there is an obvious need to focus on rapidly changing the consumption patterns of present (and future) consumers with above 'fair share' GHG emissions. With regard to development, the priority within energy policy is to support those living in 'energy poverty' (and its very serious health consequences) in moving to cleaner, more convenient fuels and in accessing electricity. While this will increase GHG emissions, it can nonetheless be achieved at emissions per person far below the 'fair share' level. It is only the high current and historical contributions of wealthy people's consumption to GHGs in the atmosphere that make the modest increases sought by low-income groups appear to be a problem.

This emphasis on allocating GHG emissions to consumers does not invalidate emissions inventories for cities based on the production perspective, as these serve to highlight particular sectors or activities with high GHG emissions and the high potential for reducing these. And as noted earlier, this production perspective has aspects of the consumption perspective, including GHG emissions linked to household energy use and transport (and usually also to electricity generation). There is now work under way to develop a common methodology for undertaking GHG emissions inventories that includes the consumption perspective, although this needs to be careful to subtract from city GHG emissions inventories the GHGs emitted in the production of goods that are exported from the city. Many of the key technologies for reducing GHG emissions, such as photovoltaic cells, windmills and motor vehicles with much reduced GHG emissions implications, will be produced in cities, and it would be misleading to allocate the GHG emissions used in their fabrication to these cities while the places in which they are used are credited with lower GHG emissions.

How the link between population growth and climate change is understood influences policy on sexual and reproductive health. Leaving aside the extreme positions—on one side, those opposing the provision of sexual and reproductive health services, including family planning; on the other, those demanding large reductions in population numbers as the only possibility for a 'sustainable' future—there is agreement on everyone's right to and need for good quality, accessible and affordable sexual and reproductive health services that include family planning. There is also a shared abhorrence for past coercive 'population control' measures. But beyond this, there are important differences.[11]

One is the different emphasis within development programmes between those who stress above all the need for more funding for family planning and those who stress the need for far more effective development programmes (that include good quality housing with good provision for water, sanitation, drainage, schools and health care and also greater legal protection for low-income groups and more possibilities for them to influence policies and hold government accountable). Of course, this focus on development includes support for family planning—but only recognizing this as one part of a good health care system and considering that unintended pregnancies are not simply the result of a lack of family planning but also of "... entrenched, gendered power dynamics at work within households, communities and nations worldwide" (Hartmann, 2008). A second difference is the stress on where investment in promoting behaviour change is needed, from those who emphasize the need for media campaigns to increase awareness of contraception and to foster a desire to use it, to those who stress the need for campaigns to "... challenge the overconsumption logic of global capitalism"(Hartmann, 2008) and its GHG implications.

It is the demographic changes associated with affluence or of increasingly affluent individuals, households and societies that are the most important demographic causes of the human-induced GHGs already present in the atmosphere and the most important drivers of their growth. From the consumption perspective, this is associated with urbanization only when an increasing proportion of consumption takes place in urban areas—which is only partly the case in high-income nations and perhaps in some middle-income nations (or areas within them) as well. And it is mostly in (responsibly governed) urban areas that it is possible to de-link a high quality of life from high GHG emissions per person. Whether or not population growth contributes to GHG emissions depends on the consumption patterns of those who make up this population growth.

Of course, from the perspective of adaptation to climate change, the critical issue in low- and middle-income nations is to reduce risks, with particular attention to doing so for vulnerable populations. But this has very strong complementarities with a successful development agenda and with the components noted above. There is an important 'population' component, in that it includes a high priority for ensuring that all individuals have good quality, affordable and easily accessible sexual and reproductive health services, within a larger commitment to ensuring other health care services, good environmental health, secure homes and adequate incomes. But this would not necessarily reduce GHG emissions.[12]

Notes

1 This is a condensed version of the paper of the same name published in *Environment and Urbanization* 21(2).

2 This is often labelled the 'production' perspective, but this implies that it is linked solely to what is produced when it also includes part of the consumption perspective—for instance, in fossil fuels used for transport and for heating buildings.

3 Apart, of course, from those appliances, such as radios, that can be powered by batteries.

4 It might be assumed that the use of fuelwood and charcoal by urban populations contributes to deforestation and thus to global warming, but detailed studies in the late 1980s showed that this assumption was not true in most instances (Arnold et al., 2006: Leach and Mearns, 1989).

5 Drawn from STATcompiler at http://www.statcompiler.com/, accessed June 15th 2009.

6 Using the US$1 a day poverty line, urban poverty appears to have decreased in many nations, but this poverty line is known to greatly understate the scale and depth of urban poverty because in many urban contexts, especially in successful cities in low- and middle-income nations, the costs of food and non-food needs (including rent for housing, payments for water and sanitation, school fees and costs for household energy, transport and health care) are much higher than US$1 a day (see: Satterthwaite, 2004).

7 CO_2e (carbon dioxide equivalent emission) is a measure of emissions where other greenhouse gases (such as methane) have been added to carbon dioxide emissions, with adjustments made for the differences in their global warming potential for a given time horizon.

8 This drew data from CAIT, 2009.

9 The influences of economic and political change on urbanization and how they and their relative importance have changed in low- and middle-income countries is discussed in more depth and detail in Satterthwaite, 2007.

10 Including the embedded energy in buildings and infrastructure.

11 See the discussion on population and climate change by a range of authors in: *Bulletin of the Atomic Scientists*, 2008.

12 The GHG emissions implications of directly meeting such needs would not be substantial and are unlikely to drive low-income nations into having per capita emissions above the 'fair share' level; however, if it is assumed that such needs are met by trickle down from economic growth, the GHG emissions implications would be far more serious.

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