



Cities' contribution to global warming: notes on the allocation of greenhouse gas emissions

DAVID SATTERTHWAITE

David Satterthwaite is a Senior Fellow at the International Institute for Environment and Development (IIED). He contributed to the chapters on human settlements within Working Group II for the Third and Fourth Assessments of the Intergovernmental Panel on Climate Change.

Address: IIED, 3 Endsleigh Street, London WC1H 0DD, UK; e-mail: david@iied.org

Acknowledgement: The author is grateful to Graham Haughton, Harriet Bulkeley, Jessica Budds and David Dodman for comments on an earlier draft.

1. In reference to the USA: "...with cities responsible for 75 per cent of the nation's greenhouse gas emissions – primarily from burning gasoline, coal, natural gas, diesel and oil..." Joe, Michael, Taryn Luntz, Janet Ahn and Jonathan Weinstein (2007), "Cities seek federal aid to buck US stance on Kyoto", Medill News Service, published 1 September at <http://www.tuscaloosaneews.com/article/20070901/LATEST/70901006/-1/NEWS03>.

ABSTRACT This paper suggests that the contribution of cities to global anthropogenic greenhouse gas emissions is often overstated. Many sources suggest that cities are responsible for 75–80 per cent of all such emissions. But as statistics drawn from the IPCC's Fourth Assessment show, this considerably understates the contributions from agriculture and deforestation and from heavy industries, fossil-fuelled power stations and high-consumption households that are not located in cities. It is likely that, worldwide, less than half of all anthropogenic greenhouse gas emissions are generated within city boundaries. However, if greenhouse gas emissions from power stations and industries are assigned to the location of the person or institution who consumes them (rather than where they are produced), cities would account for a higher proportion of total emissions. But it would be misleading to attribute this to "cities" in general, since these emissions would be heavily concentrated in cities in high-income nations and they should be ascribed to the individuals and institutions whose consumption generates them, not to the places where they are located.

KEYWORDS cities / global warming / greenhouse gas emissions / mitigation

I. INTRODUCTION

It has become common for cities to be blamed for generating most of the world's greenhouse gas emissions. For instance, many sources claim that cities are responsible for 75–80 per cent of global greenhouse gas emissions, including Munich Reinsurance, the United Nations Human Settlements Programme and the Clinton Climate Initiative, while this figure is also cited on official web pages for London and New York (Box 1 for more details). Perhaps this was an estimate for the United States,⁽¹⁾ which was then assumed to be valid worldwide. However, these figures are certainly inaccurate when applied to cities worldwide, although it is difficult to produce an accurate figure because there are too few cities for which there are detailed greenhouse gas emission inventories. In addition, as discussed in more detail below, there are greenhouse gas-emitting activities that are not easily assigned to any location (for instance, most road and rail, and sea and air travel) or that can be assigned to different locations (e.g. for goods: where they are produced or where they are consumed).

Data drawn from the most recent report of the Inter-Governmental Panel on Climate Change (IPCC) suggest that cities are not responsible for 75–80 per cent of greenhouse gas emissions. Carbon dioxide from fossil

BOX 1

Examples of statements that overstate the contribution of cities to anthropogenic greenhouse gas emissions

"Large cities take up only 2 per cent of the Earth's land mass, but they are responsible for about 75 per cent of the heat-trapping greenhouse gases that are released into our atmosphere" – Clinton Climate Initiative, William J Clinton Foundation, <http://www.clintonfoundation.org/what-we-do/clinton-climate-initiative/why-climate-change->

"...cities influence the climate on a global scale, for around 80 per cent of the greenhouse gases that affect the climate are emitted in cities..." – Munich Re Group (2004), *Megacities; Megarisks; Trends and Challenges for Insurance and Risk Management*, Munich Reinsurance, Munich, page 25.

"By some estimates, urban areas account for 78 per cent of carbon emissions from human activities" – Stern, Nicholas (2007), *The Economics of Climate Change: The Stern Review*, Cambridge University Press, Cambridge, page 517, citing <http://www.epa.gov/oppeoe1/globalwarming/greenhouse/greenhouse16/vanguard.html>, which no longer exists.

"Urban areas are responsible for over 75 per cent of all greenhouse gas emissions in the world" – Greater London Authority press release, http://www.london.gov.uk/view_press_release.jsp?releaseid=8786.

"Cities consume 75 per cent of the world's energy and produce 80 per cent of its greenhouse gases" – Mayor Michael Bloomberg delivers Keynote Address at the C40 Large Cities Climate Summit, May 2007, reported on http://www.mikebloomberg.com/en/issues/environment_sustainability.htm

"Cities are responsible for more than 75 per cent of global greenhouse gas emissions" – Paul Dickinson, The Carbon Disclosure Projects, "The Role of Cities in Managing Greenhouse Gas Emissions", <http://www.mipim.net/index.php?pid=515&id=19>.

"Roughly 78 per cent of carbon emissions from fossil fuel burning and cement manufacturing and 76 per cent of industrial wood use worldwide occur in urban areas" – O'Meara, Molly (1999), "Reinventing cities for people and the planet", Worldwatch Paper 147, Worldwatch Institute, Washington DC, page 7.

"...cities were responsible for 75 per cent of global energy consumption and 80 per cent of greenhouse gas emissions" – Anna Kajumulo Tibaijuka, Executive Director of the United Nations Human Settlements Programme (UN-HABITAT), in a speech to the United Nations, 62nd General Assembly, Second Committee <http://www.un.org/News/Press/docs/2007/gaef3190.doc.htm>

"... the experts say they (cities) generate 75 per cent of the greenhouse gases contributing to climate change" – attributed to Daniel Schrag, Director of Harvard's Center for the Environment, <http://www.news.harvard.edu/gazette/2008/03.13/11-greencities.html>

"Cities have a central role to play in tackling climate change as they are responsible for 80 per cent of international greenhouse gas emissions and consume 75 per cent of the world's energy" – Mayor of London website, <http://www.londonclimatechange.co.uk/greenorganisations/green-information-and-advice/london-leading-climate-change/>.

fuel use accounted for only 57 per cent of global anthropogenic greenhouse gas emissions in 2004, and a very large proportion of non-carbon-based greenhouse gas emissions are not generated within cities. In addition, deforestation needs to be considered within calculations of carbon dioxide emissions. In 2004, agriculture and gases released from land use changes and forestry accounted for 31 per cent of greenhouse gas emissions.⁽²⁾

In the statements about the very high contribution of cities to global warming, perhaps there is an assumption that all emissions from industries, power stations and transport are in cities but as discussed below, this is not correct. Or perhaps there is confusion between "greenhouse gas emissions" and "carbon dioxide emissions". In 2004, carbon dioxide emissions contributed around 77 per cent of global anthropogenic greenhouse gas emissions (methane contributed 14.3 per cent, nitrous oxide 7.9 per cent and fluorinated gases 1.1 per cent).⁽³⁾ Clearly, many cities concentrate industries and other businesses with high carbon dioxide emissions and people whose lifestyles/energy consumption generate high levels of carbon dioxide emissions. But it would be surprising if the small towns and rural

2. Barker T, I Bashmakov, L Bernstein, J E Bogner, P R Bosch, R Dave, O R Davidson, B S Fisher, S Gupta, K Halsnaes, G J Heij, S Kahn Ribeiro, S Kobayashi, M D Levine, D L Martino, O Masera, B Metz, L A Meyer, G-J Nabuurs, A Najam, N Nakicenovic, H-H Rogner, J Roy, J Sathaye, R Schock, P Shukla, R E H Sims, P Smith, D A Tirpak, D Urge-Vorsatz, D Zhou (2007), "Technical summary", in B Metz, O R Davidson, P R Bosch, R Dave, L A Meyer (editors), *Climate Change 2007: Mitigation – Contribution of*

Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, page 29.

3. See reference 2.

4. A very considerable proportion of the world's urban population live in urban centres that are either too small or too administratively unimportant to be considered as cities – see Annexe for more details.

5. Gilbert, Richard (1990), "Cities and global warming", in James McCulloch (editor), *Cities and Global Climate Change*, Climate Institute, Washington DC, pages 182–190. Note too the extent to which many cities in high-income nations have greenhouse gas emissions per person that are much lower than the average of their nation; see Dodman, David (forthcoming 2009), "Blaming cities for climate change? An analysis of urban greenhouse gas emissions inventories", *Environment and Urbanization* Vol 21, No 1, April.

6. See reference 2.

7. For instance, allocating aviation fuel used in London's airports to London would mean that this represented 34 per cent of London's carbon dioxide emissions in 2006; see Mayor of London (2007), *Action Today to Protect Tomorrow*; the Mayor's Climate Change Action Plan, Greater London Authority, London, 232 pages. Similarly, for New York, adding carbon dioxide emissions from fuel used in aviation and freight by sea would considerably increase New York's carbon dioxide emissions. See Bloomberg, Michael R (2007), *Inventory of New York Greenhouse Gas Emissions*, Mayor's Office of Operations, Office of Long-term Planning and Sustainability, New York, 65 pages.

8. For more discussion of these difficulties, see Dawson, Richard, Jim Hall, Stuart Barr, Mike Batty, Abigail Bristow, Sebastian Carney, Stephen

areas that contain roughly two-thirds of the world's population⁽⁴⁾ were responsible for only 20–25 per cent of carbon dioxide emissions, since many very wealthy high-consumption individuals and households live there, especially in high-income nations. Generally, wealthy households living in small urban centres or rural areas have higher carbon dioxide emissions per person than households with the same level of wealth living in cities (because of, for example, more automobiles, more automobile use and larger, worse-insulated houses).⁽⁵⁾ In addition, a considerable proportion of all heavy industry and coal, oil- or gas-fired power stations are located outside cities. The quotes in Box 1 from the Stern Review and from the paper by Molly O'Meara are notable for specifying that they are talking of urban areas, not cities, and that they are referring to carbon emissions, not all greenhouse gas emissions. Their estimates are certainly more credible than the others in Box 1, although they may under-estimate the carbon dioxide emissions in rural areas arising from deforestation, agricultural activities and rural households and businesses.

II. DO WE ALLOCATE GREENHOUSE GAS EMISSIONS TO THE PRODUCERS OR THE CONSUMERS?

If we are looking at the spatial location of activities that produce greenhouse gas emissions, and assigning these to particular types of settlement, many large fossil fuel power stations are not located in cities – yet these are a very significant contributor to total carbon dioxide emissions. In 2004, energy supply accounted for one-quarter of all greenhouse gas emissions.⁽⁶⁾ Many cement fabrication plants are also outside cities; so too are many heavy industries – for instance, petroleum refineries, fertilizer plants and pulp and paper mills. This is also the case for mining, where mining or the processing of what is mined is energy intensive (for instance, copper smelters and aluminium smelters). Looking at locations where emissions are generated, much transport-generated carbon dioxide emissions (from motorcycles, automobiles, commercial vehicles, sea freight, air travel) cannot be assigned to cities (even if a high proportion of these emissions might be tied to the movement of people and goods into or out of cities). For instance, it is not clear where fuel used in aviation or sea freight should be allocated; it would be inaccurate to allocate it to the cities where the ports or airports are located.⁽⁷⁾ It would also be misleading to allocate to cities the fossil fuels used in transporting to and from cities commuters who live in rural areas or small urban centres.⁽⁸⁾ There is also the issue of where to allocate methane emissions from landfill sites that take wastes generated in the city but that are located outside city boundaries; if greenhouse gas emissions are allocated to the location where they are produced, these would not be included in city figures.

Although increasing numbers of city studies are producing figures for the anthropogenic greenhouse gas emissions generated within their boundaries, there is no agreement on how the ambiguities noted above should be resolved, so comparisons between these statistics – for instance, between figures for different cities for greenhouse gas emissions per person (in tonnes of CO₂ equivalent) – need to be made with caution.⁽⁹⁾ In addition, these figures will be influenced by the boundaries used. Most large cities have three or four different boundaries – for instance, for the core city, the contiguous built-up area (which generally extends beyond the "city" boundaries), the metropolitan area and an extended planning

region.⁽¹⁰⁾ For most cities, the figures for greenhouse gas emissions per person will be much influenced by which of these boundaries are used.

A higher proportion of greenhouse gas emissions should be assigned to cities if emissions are assigned to the locations of persons who are the final consumers of products or services. Theoretically, this is a fairer system for allocating greenhouse gas emissions between nations because the final driver of most anthropogenic greenhouse gas emissions is the consumption patterns of middle- and upper-income groups. Almost all anthropogenic greenhouse gas emissions arise from the demand for goods and services (and the disposal of wastes from these). So, for instance, the carbon dioxide emissions from fossil fuel power stations would be assigned to the activity and location where the electricity was consumed, not where it was produced. Most city greenhouse gas emission inventories recognize this – as in, for instance, a report on New York that included the greenhouse gas emissions arising from electricity used within New York, although most of it was generated from outside New York; this report also took into account the methane generated by landfills that took the city's wastes but that were located outside the city's boundaries.⁽¹¹⁾

However, if the emissions from electricity generated outside city boundaries but consumed within the city are added to a city's greenhouse gas emission inventory, then the emissions from city businesses producing goods that are sold outside the city should be subtracted from this inventory. Then there is the issue of to which location to assign the greenhouse gas emissions arising from the use and disposal of these goods. Consider a city that manufactures state-of-the-art photovoltaic cells or windmills, which provide the basis for large cuts in greenhouse gas emissions all over the world. To whom or to where should the "negative" greenhouse gas emissions that the photovoltaic cells and windmills save when used by people or institutions outside this city be allocated? Certainly, it would not be fair for this city to be allocated the greenhouse gas emissions generated by their fabrication – but should the city or the people/institutions who buy the photovoltaic cells or windmills be allocated the greenhouse gas emissions that have been avoided?

The carbon dioxide emissions from fossil fuel power stations, cement plants and other heavy industries, and air, sea and motor vehicle travel can be assigned to the people who use the electricity, cement and industrial goods and who do the travelling. So a resident of London who travelled abroad or outside of London for work or holidays would have the greenhouse gas emissions that these travels generated assigned to London. Also, all the greenhouse gas emissions that came from the goods and services they consumed while outside London (and, for instance, used in transporting these to the point where they were purchased) would be allocated to London. But this would also mean that the greenhouse gas emissions that arise from the consumption of tourists visiting London would be allocated to their home locations. Within this system, the carbon dioxide emissions generated by industries in (for instance) China or India to fabricate and deliver goods used by inhabitants of Europe or the USA should be allocated to these inhabitants (or spatially to where they live). Presumably, this would also apply to services used – for instance, the greenhouse gas emissions generated by international call centres or back-office services that are assigned to the location of the consumers of these services.

Evans, Alistair Ford, Jonathan Köhler, Miles Tight and Claire Walsh (2007), *A Blueprint for the Integrated Assessment of Climate Change in Cities*, Working Paper 104, Tyndall Centre for Climate Change Research, 154 pages.

9. See Dodman, David (forthcoming 2009), reference 5.

10. See Satterthwaite, David (2007), "The transition to a predominantly urban world and its underpinnings", Human Settlements Discussion Paper – Urban Change 4, IIED, London, 90 pages. This can be downloaded from www.iied.org/pubs/display.php?o=10550IIED

11. See reference 7, Bloomberg (2007).

For wealthy cities where most industrial goods are imported, assigning to these cities the greenhouse gas emissions that went into the goods consumed within their boundaries brings major changes in emissions figures per person. This is illustrated in the analysis by Shobhakar Dhakal of Tokyo, Seoul, Beijing and Shanghai for 1998. Beijing and Shanghai had higher per capita emissions than Tokyo, when considering the emissions produced within these cities, but Tokyo had much higher per capita emissions than these cities if emission inventories for the cities included emissions that went into the goods purchased by city residents.⁽¹²⁾

In the search for the best ways to reduce total anthropogenic greenhouse gas emissions, a focus both on the producers and the consumers will be needed. Greenhouse gas emissions from deforestation can be reduced at the production end by better forest management and by consumption habits that reduce demand for wood or that use wood products that are certified as having come from forests that are sustainably managed. There are also many ways in which both food producers and food consumers can contribute to lower greenhouse gas emissions. Greenhouse gas emissions from the fabrication of consumer goods are more easily reduced at the production end, although information on the goods' carbon footprint (and, for appliances that use energy, their efficiency) can encourage consumer choices that reduce emissions. For electricity generation, action is needed at the production end (for instance, shifts away from fossil fuels, especially coal, unless carbon capture can be achieved and applied) and at the consumption end (minimizing electricity use, perhaps incorporating some electricity generation at the consumption end through the use of photovoltaic cells, and choices made to draw electricity from non-fossil fuel sources). But it is important that global agreements to limit greenhouse gas emissions that allocate responsibilities to nations do recognize the limitations (and unfairness) of basing these only on the locations where emissions are produced.

III. BACK OF THE ENVELOPE CALCULATIONS FOR CITIES

From the perspective of where greenhouse gas emissions are generated, worldwide, cities probably emit between 30 and 40 per cent of all anthropogenic greenhouse gas emissions (Table 1). This is no more than a (hopefully educated) guess and the text in the Table specifies the assumptions made to arrive at these figures. Even if some of the assumptions prove to be wrong, it is difficult to see the greenhouse gas emissions generated within cities coming close to the widely used figure of 75 to 80 per cent of all greenhouse gas emissions.

But it is a little misleading to attribute such emissions to cities in general in that there will be very large differences between cities with the highest emissions per person and cities with the lowest emissions per person. A review of the findings from city greenhouse gas emission inventories pointed to a ten-fold difference in emissions per person,⁽¹³⁾ and if comparable inventories were available for cities in low-income nations, this would probably increase to a hundred-fold difference. Thus cities in high-income nations would emit a higher proportion of greenhouse gas emissions than the proportion of the world's population they house – although many of the wealthiest cities would not be among the highest

12. Dhakal, Shobhakar (2004), *Urban Energy Use and Greenhouse Gas Emissions in Asian Cities: Policies for a Sustainable Future*, Institute for Global Environmental Strategies (IGES), Kitakyushu, 170 pages.

13. See Dodman, David (forthcoming 2009), reference 5.

TABLE 1
Global anthropogenic greenhouse gas emissions by sector, 2004

Total emissions for the GHGs covered by the Kyoto Protocol: 49 Gt CO₂ equivalent

Sector	Percentage of GHGs	Notes	What proportion from cities from the perspective of the location of activities that produced them	Percentage allocated to cities
Energy supply	25.9	A large part of this is from fossil fuel power stations. Excludes refineries, coke ovens etc., which are included under industry	A high proportion of fossil fuel power stations are not in cities, especially the largest cities. A guess of one-third to one-half of energy supply GHGs emitted from city-based power stations?	8.6–13.0
Industry	19.4		A large proportion of heavy industry (which accounts for most GHGs from industry) is not located in cities, including many cement factories, oil refineries, pulp and paper mills, metal smelters.... A guess of two-fifths to three-fifths of industry GHGs in cities? None assigned to cities	7.8–11.6
Forestry	17.4	Land use and land use changes		
Agriculture	13.5		Some large cities have considerable agricultural output but mostly because of extended boundaries encompassing rural areas. None assigned to cities	
Transport	13.1		Impossible to say how much to assign to cities. Private use of automobiles a large part of this. But much car use by rural dwellers and small urban centre dwellers in high-income nations. Should commuting by car by those living outside cities be assigned to cities? Should city dwellers driving outside city boundaries be assigned to their city? Guess that 60–70 per cent of transport GHGs assigned to cities.	7.9–9.2
Residential and commercial buildings	7.9		Difficult to know how to assign this between cities, urban centres that are not cities and rural areas. Large sections of middle- and upper-income groups in high-income nations do not live in cities – and a significant and increasing proportion of commercial buildings are located outside cities. Assign 60–70 per cent of GHGs from this to cities	4.7–5.5
Waste and wastewater	2.8		More than half of this is landfill methane, but a proportion of this would be outside city boundaries	1.5
Total	100			30.5–40.8

SOURCE: For columns 1 to 3, see Barker T, I Bashmakov, L Bernstein, J E Bogner, P R Bosch, R Dave, O R Davidson, B S Fisher, S Gupta, K Halsnaes, G J Heij, S Kahn Ribeiro, S Kobayashi, M D Levine, D L Martino, O Maseira, B Metz, L A Meyer, G-J Nabuurs, A Najam, N Nakicenovic, H-H Rogner, J Roy, J Sathaye, R Schock, P Shukla, R E H Sims, P Smith, D A Tirpak, D Urge-Vorsatz, D Zhou (2007), "Technical summary", in B Metz, O R Davidson, P R Bosch, R Dave, L A Meyer (editors), *Climate Change 2007: Mitigation – Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. This report notes that these values should be regarded as indicative only, as some uncertainty remains, particularly with regards to CH₄ and N₂O emissions, for which the margin for error is estimated to be in the order of 30–50 per cent, and CO₂ emissions from agriculture, which have an even larger margin for error.

14. See Dodman, David (forthcoming 2009), reference 5. Note too that many city greenhouse gas emission inventories do count the carbon emissions created by the electricity brought into the city as part of the city's emissions. This calculation also needs to assess what proportion of the electricity brought into the city comes from sources that do generate carbon dioxide – for instance, not counting electricity from nuclear or hydro power or electricity drawn from wind or solar power.

15. See reference 7, Mayor of London (2007); also Air Quality Division (2005), "District of Columbia greenhouse gas emissions inventories and preliminary projections", Department of Health, Air Quality Division, Washington DC.

greenhouse gas emitters per person because most electricity and energy-intensive goods are imported.⁽¹⁴⁾ For instance, most electricity consumed in London and Washington DC is generated by power stations outside these cities.⁽¹⁵⁾ Centres of heavy industry would figure among the highest greenhouse gas emitters, as would high-income cities with high levels of private automobile use. Cities such as London and New York would not figure among the cities with the highest emissions per person within their nations, in part because they have little heavy industry (in both cities, industry accounts for a relatively small proportion of greenhouse gas emissions) and they import most of their electricity, and in part because they have lower levels of private car use and less energy-intensive housing than many other settlements in their nation.

Another relevant measure of city performance would be the ratio of the city's gross domestic product to greenhouse gas emissions. Ultimately, one of the keys to greenhouse gas emissions reduction is to make economic activities much less energy intensive. Cities such as London and New York may perform relatively well on this when compared to many other cities in high-income nations although, again, this is in large part because there is relatively little production of energy-intensive goods within their boundaries.

A shift from assigning emissions to production to assigning them to consumption would increase the proportion assigned to cities. The figures in Table 1 focus on production and cover all anthropogenic greenhouse gas emissions. No adjustments are made of the kind noted above – for instance allocating to cities the greenhouse gas emissions generating the electricity they import. The proportion of greenhouse gas emissions allocated to cities would rise, if adjustments were made for this. If the focus was also production but consideration was given only to carbon dioxide emissions, the proportion produced in cities would be higher still. If greenhouse gas emissions are assigned to the location of the people whose travelling or demand for goods, services or waste disposal was what ultimately produced the greenhouse gas emissions, the proportion allocated to cities is likely to be higher than all the above. Here, emissions from agriculture and deforestation would be assigned to the people who consumed the forestry and agricultural products. But again, there would be very large differences between people (and cities) with the highest emissions per person and people (and cities) with the lowest emissions per person. In addition, a significant proportion of the high-income, high-consumption population live outside cities in high-income nations; and also perhaps a significant proportion in some middle-income nations (especially in wealthier parts of these nations). In general, as noted earlier, wealthy households living outside cities have higher greenhouse gas emissions per person than those living in cities. Private automobile and airplane use by those living outside cities would not be assigned to cities, even though a proportion of the fuels used for these purposes is used in cities. So the carbon dioxide emissions that arise from commuting would be assigned to where the commuters lived.

Thus, assigning anthropogenic greenhouse gas emissions to the location of the person whose consumption was the cause of the emissions would result in cities being assigned a higher proportion of these emissions than if emissions are assigned to the spatial location of their production. But it is difficult to see this as being more than 60–70 per cent of total emissions. Of course, with this method, a much higher proportion of

greenhouse gas emissions would be assigned to high-income nations, and this could have major implications within any global system that allocates responsibilities for greenhouse gas emissions reduction.

IV. AVOIDING BLAMING CITIES

These perhaps over-detailed discussions as to which spatial location to assign responsibility for greenhouse gas emissions can be considered a little pedantic. The functioning of cities cannot be understood without understanding the multiple connections to other people and places in their surrounds and nearby, and often to "distant elsewhere".⁽¹⁶⁾ And of course, it is not cities that generate greenhouse gases; greenhouse gas emissions are produced by particular (production and consumption) activities by individuals, enterprises and institutions. These may be allocated to cities on the basis of being produced within city boundaries or on the basis of being generated as a result of city inhabitants' consumption and waste generation. But it is these producers and consumers that have to change if global greenhouse gas emissions are to fall.

Most cities in low-income nations will have far lower levels of greenhouse gas emissions per person within their boundaries than cities in high-income nations, from both a production perspective and a consumption perspective. If we compare cities according to the greenhouse gas emissions generated within their boundaries, it is likely that the differentials between them per person will vary by a factor of 100 or more. So it is not "cities" but "particular cities" that are considered "the problem".⁽¹⁷⁾ If it was possible to assign all the anthropogenic greenhouse gas emissions generated to the final consumer of the goods and services (and also assign to them the greenhouse gas emissions in disposing of wastes arising from this consumption), this would produce even larger differentials between cities in per capita emissions. Cities that concentrate wealthy people with high-consumption lifestyles would probably have greenhouse gas emissions per person that were thousands of times larger than many small cities in low-income nations.

It can also be misleading to focus on city averages for per capita figures in that there will be very large differentials within cities in per capita emissions. For instance, in Mumbai, the per capita emissions for Dharavi, the large, predominantly low-income, high-density, inner-city settlement (where around 600,000 people live and work in an area of around two square kilometres),⁽¹⁸⁾ will be a very small fraction of the per capita emissions of a high-income district in Mumbai where a high proportion of the population commutes to work by car. In Dharavi, average levels of consumption for (for instance) energy-intensive capital goods, energy used for space heating and cooling and energy used going to and from work will be very low. Dharavi also has a very large industry for reclaiming, re-using and recycling wastes, so if anthropogenic greenhouse gas emissions are allocated to final consumers, many of Dharavi's residents might have "negative greenhouse gas emissions", as they are credited with the greenhouse gas emissions saved by their collection of waste materials and their return to goods production. So assigning greenhouse gas emissions to cities misses the very large differentials in per capita emissions between different city individuals and households. Since the poorest households, whose livelihoods come from recycling, are going to have very small per capita emissions (or even negative emissions), the differentials between

16. See Rees, William E (1992), "Ecological footprints and appropriated carrying capacity", *Environment and Urbanization* Vol 4, No 2, October, pages 121–130. See also Massey, Doreen B (2005), *For Space*, Sage Publications, London, 232 pages; and Haughton, Graham (2007), "In pursuit of the sustainable city", in Peter J. Marcotullio; and Gordon McGranahan (editors), *Scaling Urban Environmental Challenges: from Local to Global and Back*, Earthscan Publications, London, pages 274–290.

17. However, most of the cities most at risk from the impacts of global warming are in low- and middle-income nations and it is generally among their low-income populations that risks are concentrated. See Satterthwaite, David, Saleemul Huq, Mark Pelling, Hannah Reid and Patricia Romero-Lankao (2007), *Adapting to Climate Change in Urban Areas: The Possibilities and Constraints in Low- and Middle-income Nations*, International Institute for Environment and Development, London, 107 pages. This can be downloaded from <http://www.iied.org/pubs/pdfs/10549IIED.pdf>.

18. For more details of Dharavi, see Patel, Sheela and Jockin Arputham (2007), "An offer of partnership or a promise of conflict in Dharavi, Mumbai?", *Environment and Urbanization* Vol 19, No 2, October, pages 501–508; also Patel, Sheela and Jockin Arputham (2008), "Plans for Dharavi: negotiating a reconciliation between a state-driven market redevelopment and residents' aspirations", *Environment and Urbanization* Vol 20, No 1, April, pages 243–254.

19. See Hardoy, Jorge E, Diana Mitlin and David Satterthwaite (2001), *Environmental Problems in an Urbanizing World*, Earthscan Publications, London, 448 pages, for more discussion of the differentials in the contribution of individuals to global unsustainability.

20. Newman, Peter (2006), "The environmental impact of cities", *Environment and Urbanization* Vol 18, No 2, October, pages 275–296.

21. World Bank, World Development Indicators Online, The World Bank, Washington DC, accessed 21 May 2008.

22. See Dodman, David (forthcoming 2009), reference 5, for a review of city greenhouse gas emission inventories.

the individuals or households with the highest and the lowest per capita emissions are going to be very large.⁽¹⁹⁾

Thus, focusing on the role of "cities" in greenhouse gas emissions (or carbon dioxide emissions) draws attention away from the fact that the driver of most anthropogenic carbon emissions is the consumption patterns of middle- and upper-income groups, regardless of where they live and the production systems that profit from their consumption. It also draws attention away from the very large differentials in average greenhouse gas emissions per person between cities and within cities. Finally, focusing on cities as large carbon emitters mainly because of fossil fuel consumption within their boundaries ascribes too much importance to energy efficiency within climate change mitigation and adaptation strategies for low-income nations, whose cities have very low fossil fuel use (and thus far less scope for reducing it). It also generates many myths about the size of the co-benefits for mitigation and adaptation that are not present in nations or cities with low levels of fossil fuel use (and without denying that there can be strong co-benefits in wealthy successful cities).

But perhaps worse than this, blaming cities for greenhouse gas emissions misses the point that well-planned and governed cities are central to delinking high living standards/quality of life from high consumption/greenhouse gas emissions. This can be seen in part in the very large differentials between wealthy cities in gasoline use per person;⁽²⁰⁾ most US cities have three to five times the gasoline use per person of most European cities – and it is difficult to see that Detroit has five times the quality of life of Copenhagen or Amsterdam. Singapore has one-fifth of the automobile ownership per person of most cities in other high-income nations, yet also has a higher income per person.⁽²¹⁾ It is also evident in the fact that many cities in high-income nations have greenhouse gas emissions per person that are far below their national averages.⁽²²⁾

Many of the most desirable (and expensive) residential areas in the world's wealthiest cities have high densities and building forms that can minimize the need for space heating and cooling – much more so than housing in suburban or rural areas. Most European cities have high-density centres where walking and bicycling are preferred by much of the population, especially where good provision is made for pedestrians and bicyclists. Many European cities also have high-quality public transport that keeps down private automobile ownership and use. Cities also concentrate so much of what contributes to a very high quality of life that need not imply high material consumption levels (and thus high greenhouse gas emissions) – theatre, music, museums, libraries, the visual arts, dance and the enjoyment of historic buildings and districts. Cities have also long been places of social, economic and political innovation; indeed, in high-income nations, city politicians often demonstrate a greater commitment to greenhouse gas emissions reduction than do national politicians. Achieving the needed reduction in global greenhouse gas emissions depends on seeing this potential of cities to combine high quality of life with low greenhouse gas emissions and acting on it.

ANNEXE: DEFINING CITIES AND NON-CITY URBAN AREAS

The terms "city" and "urban centre" are often used interchangeably – but this is confusing in that most urban centres lack the size or commercial or political importance to be considered cities.

The term “urban centre” encompasses all settlements designated as urban by their governments. There is considerable variation between nations as to how their governments define “urban” – from those that include as urban all or almost all settlements with a few hundred inhabitants, to others that only designate as urban those settlements with more than 5,000 or 10,000 or 20,000 inhabitants and/or that meet other criteria (for instance, relating to a minimum density, or the proportion of non-agricultural workers in the labour force).⁽²³⁾ Thus, in almost all nations, every settlement with 20,000-plus inhabitants is classified as urban, but the proportion of the population living in settlements with a few hundred to 20,000 inhabitants that is classified as urban varies a lot. Since in most nations, a significant proportion of the population lives in settlements with between 500 and 20,000 inhabitants (for instance, in India most of the population lives in villages or urban centres with between 500 and 20,000 inhabitants), the proportions that are classified as rural or urban have a large influence on the proportion of the population said to live in urban centres. There are also nations whose urban population is based on an administrative criterion – it is the population living in specified “urban centres” – and this often means that settlements that in other nations would be considered urban are still classified as rural.⁽²⁴⁾ This means that the proportion of the world’s population said to live in urban areas could change significantly if one of the world’s large-population nations chose to change the criteria by which it defined its urban population.

The term “city” is not the same as the term “urban centre”, and in all nations, the urban population is made up of the population of cities and the population of “urban centres that are not cities”. Cities are generally considered to be urban centres that acquire city status because they have sufficient size or population or administrative status (in the UK, for example, historically, by being the seat of a diocese). But there is also no consensus as to when or how an urban centre becomes a city. Settlements that acquired city status many centuries ago may still be considered cities, even though they are relatively small (for example, St Davids in Wales is considered a city but actually has a smaller population than many villages in Asia). However, perhaps the most relevant point is that a very considerable proportion of the world’s urban population lives in urban centres that lack the size, population, importance or administrative status to be considered cities. For instance, if we arbitrarily decide that cities are urban centres with 500,000-plus inhabitants, then around one-quarter of the world’s total population live in cities and another quarter live in urban centres that are not cities. If a smaller population threshold was applied – for instance, cities are urban centres with 20,000-plus inhabitants, obviously a much higher proportion of the world’s population would live in cities and a lower proportion would live in urban centres that are not cities. However, in many nations, a significant proportion of the urban population does live in urban centres with fewer than 20,000 inhabitants.⁽²⁵⁾

23. The United Nations Population Division lists the “urban” definitions used by all governments in their World Urbanization Prospects reports, which are published every two years.

24. See reference 10.

25. Satterthwaite, David (2006), “Outside the large cities; the demographic importance of small urban centres and large villages in Africa, Asia and Latin America”, Human Settlements Discussion Paper – Urban Change 3, IIED, London, 30 pages. This can be downloaded from www.iied.org/pubs/display.php?o=10537IIED.

REFERENCES

- Air Quality Division (2005), “District of Columbia greenhouse gas emissions inventories and preliminary projections”, Department of Health, Air Quality Division, Washington DC.
- Barker T, I Bashmakov, L Bernstein, J E Bogner, P R Bosch, R Dave, O R Davidson, B S Fisher, S Gupta, K Halsnæs, G J Heij, S Kahn Ribeiro, S Kobayashi, M D Levine, D L Martino, O Masera, B Metz, L

- A Meyer, G-J Nabuurs, A Najam, N Nakicenovic, H-H Rogner, J Roy, J Sathaye, R Schock, P Shukla, R E H Sims, P Smith, D A Tirpak, D Urge-Vorsatz, D Zhou (2007), "Technical summary", in B Metz, O R Davidson, P R Bosch, R Dave, L A Meyer (editors), *Climate Change 2007: Mitigation – Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 862 pages.
- Bloomberg, Michael R (2007), *Inventory of New York Greenhouse Gas Emissions*, Mayor's Office of Operations, Office of Long-term Planning and Sustainability, New York, 65 pages.
- Dawson, Richard, Jim Hall, Stuart Barr, Mike Batty, Abigail Bristow, Sebastian Carney, Stephen Evans, Alistair Ford, Jonathan Köhler, Miles Tight and Claire Walsh (2007), *A Blueprint for the Integrated Assessment of Climate Change in Cities*, Working Paper 104, Tyndall Centre for Climate Change Research, 154 pages.
- Dhokal, Shobhakar (2004), *Urban Energy Use and Greenhouse Gas Emissions in Asian Cities: Policies for a Sustainable Future*, Institute for Global Environmental Strategies (IGES), Kitakyushu, 170 pages.
- Dodman, David (forthcoming 2009), "Blaming cities for climate change? An analysis of urban greenhouse gas emissions inventories", *Environment and Urbanization* Vol 21, No 1, April.
- Gilbert, Richard (1990), "Cities and global warming", in James McCulloch (editor), *Cities and Global Climate Change*, Climate Institute, Washington DC, pages 182–190.
- Hardoy, Jorge E, Diana Mitlin and David Satterthwaite (2001), *Environmental Problems in an Urbanizing World*, Earthscan Publications, London, 448 pages.
- Haughton, Graham (2007), "In pursuit of the sustainable city", in Peter J. Marcotullio and Gordon McGranahan (editors), *Scaling Urban Environmental Challenges: from Local to Global and Back*, Earthscan Publications, London, pages 274–290.
- Joe, Michael, Taryn Luntz, Janet Ahn and Jonathan Weinstein (2007), "Cities seek federal aid to buck US stance on Kyoto", Medill News Service.
- Massey, Doreen B (2005), *For Space*, Sage Publications Ltd, London, 232 pages.
- Mayor of London (2007), *Action Today to Protect Tomorrow; the Mayor's Climate Change Action Plan*, Greater London Authority, London, 232 pages.
- Munich Re Group (2004), *Megacities; Megarisks; Trends and Challenges for Insurance and Risk Management*, Munich Reinsurance, Munich, 79 pages.
- Newman, Peter (2006), "The environmental impact of cities", *Environment and Urbanization* Vol 18, No 2, October, pages 275–296.
- O'Meara, Molly (1999), "Reinventing cities for people and the planet", Worldwatch Paper 147, Worldwatch Institute, Washington DC, 94 pages.
- Patel, Sheela and Jockin Arputham (2007), "An offer of partnership or a promise of conflict in Dharavi, Mumbai?", *Environment and Urbanization* Vol 19, No 2, October, pages 501–508.
- Patel, Sheela and Jockin Arputham (2008), "Plans for Dharavi: negotiating a reconciliation between a state-driven market redevelopment and residents' aspirations", *Environment and Urbanization* Vol 20, No 1, April, pages 243–254.
- Rees, William E (1992), "Ecological footprints and appropriated carrying capacity", *Environment and Urbanization* Vol 4, No 2, October, pages 121–130.
- Satterthwaite, David (2006), "Outside the large cities; the demographic importance of small urban centres and large villages in Africa, Asia and Latin America", Human Settlements Discussion Paper – Urban Change 3, IIED, London, 30 pages.
- Satterthwaite, David (2007), "The transition to a predominantly urban world and its underpinnings", Human Settlements Discussion Paper – Urban Change 4, IIED, London, 90 pages.
- Satterthwaite, David, Saleemul Huq, Mark Pelling, Hannah Reid and Patricia Romero-Lankao (2007) *Adapting to Climate Change in Urban Areas: The Possibilities and Constraints in Low- and Middle-income Nations*, International Institute for Environment and Development, London, 107 pages.
- Stern, Nicholas (2007), *The Economics of Climate Change: The Stern Review*, Cambridge University Press, Cambridge, 692 pages.
- World Bank, *World Development Indicators Online*, The World Bank, Washington DC.