POPULATION DYNAMICS AND POLICIES IN THE CONTEXT OF GLOBAL CLIMATE CHANGE

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Abstract - *Intensified concern with global climate change (GCC) has brought a resurgence of interest in the role of population dynamics in environmental outcomes. Clarity as to the actual influence of population change is often diminished by an undifferentiated treatment of "population" and by a simplified understanding of its relation to development processes. Improved understanding of demographic dynamics and greater disaggregation of population components would help refine future emission scenarios. The impacts of population size and rate of growth are crucial but variable by country and not subject to quick fixes. Urbanization is a driving force for GCC but its impact is over-estimated and its positive potential generally ignored. Scant attention is paid to the possible impacts of different population compositions that affect consumption patterns and ecological footprints of different social groups. This paper reviews the demographic processes that necessitate more explicit consideration and discusses their implications for policy.*

INTRODUCTION

Interest in demographic dynamics and their interactions with other mediating factors on environmental threats is resurgent in the wake of increasing concern with climate change. Most discussions of this global menace include some mention of population factors, yet treatment of population dynamics is frequently incomplete or incorrect. Most attention is focused on population growth, widely portrayed as a major offender that could easily be fixed. "Urbanization" is repeatedly cited as an important driver of increasing emissions, but without consideration of its potential contribution to mitigation. Significant changes in population composition and their implications for mitigation and adaptation receive scant attention outside the demographic community.

Simplistic assumptions about demographic trends and their impacts debilitate emission scenarios and lead to misleading policy suggestions. Moreover, when trying to decipher the probable impacts of demographic processes and policy options, it is critical to look beyond population growth and to also examine the significance of changes in spatial distribution and population composition.

This paper will summarize some of the key issues involving the relationship between global climate change and each of the three major components of demographic trends – growth, distribution and composition. Each of these sections will conclude with a brief discussion on implications for population policy. Given space limitations, this paper will focus mostly on the interface between demographic processes and mitigation.[1]

PERSPECTIVES ON POPULATION GROWTH AND ENVIRONMENTAL CHANGE

Few panaceas in any domain generate as much popular backing in developed countries as the notion that:

- a reduction of population size and growth would go a long way towards solving the world's major problems, including those related to climate change;
- this reduction could be easily achieved through family planning programs.

A typical quote in an American ecologist's blog recently stated: – "Support of a global plan of voluntary birth control and family planning is a simple solution to world overpopulation and virtually all the world's environmental problems."(Gibbons, n.d.) A poll taken by The Daily

[1] An earlier version of some of the arguments made here appeared in a previous paper which broached both mitigation and adaptation: cf. Martine and Guzman (2009).

Scientist in April of 2009 concluded that "Overpopulation is the world's top environmental issue, followed closely by climate change…" Literally thousands of variations on this same theme – which has been dubbed "The Northern Perspective" (Hummel et al 2009) – can easily be found in internet documents spanning a variety of substantive fields. This view that population growth (which occurs mostly in developing countries) constitutes a major but easily resolved threat to climate change has multiplied itself in the media. Though it contains an undeniable core message, the uncritical repetition of this mantra can confound issues and policy options.

The contribution of demographic growth to the aggravation of climate change threats is irrefutable. Nevertheless, there is no quick and painless fix: massive family planning campaigns in developing countries, where fertility is high, provide only a partial and longer-term answer to this problem. Population effects on emissions are determined by consumption patterns of different social groups throughout the world and, ultimately, by our very model of civilization. The groups experiencing the fastest demographic growth are making the least environmental impact right now, while the slowest growing have already brought humankind to the brink of disaster. Such observations do not deny that everything possible should be done now to ensure that people the world over have access to good reproductive health and that this will be crucial for future generations, in terms of global climate as well as human welfare. They do, however, emphasize the limitations of unilateral population control solutions.

Despite the pressure of "The Northern Perspective", the IPCC appears to have downplayed the importance of population policy in mitigation and adaptation efforts – whether from apprehension of political repercussions in developing countries, or from failure to perceive its vital implications. The 2007 IPCC Report does allude to "population" in its very first schematic framework, wherein main anthropogenic drivers, impacts of and responses to climate change, and their linkages are depicted. Moreover, population projections constitute, implicitly or explicitly, "the backbone of GHG emissions scenarios" (IPCC,2001:3.2.1) Nevertheless, the Report generally fails to go beyond considering each additional person as an undifferentiated unit contributing to one more unit of GHG emission.

The IPCC's most significant attempt at incorporating demographic dimensions was made in response to a request by the 1996 Plenary of the IPCC for a broader set of scenarios. The resulting Special Report on Emissions Scenarios (SRES) included path-breaking consideration of different demographic processes within the context of its analysis of a wide range of the main driving forces of future emissions. Chapter 3 of that Special Report focused explicitly on the links from demography and the economy to resource use and emissions. In addition to recapitulating the discussions of the impacts between population, environmental change and economic growth, the SRES contemplated how such issues as ageing, household composition and urbanization will influence future emissions (IPCC, 2001: Section. 3.2.4.1).

Despite this contribution, neither the 2001 nor 2007 IPCC final Reports seems to have made considerable headway in these more refined directions. Population was mentioned repeatedly, but as an aggregate, and generally in allusion to negative imagery such as 'growth', 'pressure', 'concentration', 'health', 'mobility', 'at risk', 'density', etc.. As far as could be ascertained, the effects of aging and household composition were not explicitly mentioned. Urbanization and urban concentration were mentioned repeatedly but generally with respect to vulnerability issues, rather than in terms of their possible roles in the expansion or mitigation of emissions.

In short, there is need for a more penetrating understanding and for better balance in considering the role of demographic dynamics on GCC. The Northern Perspective overstates its case for population control while the IPCC understates the significance of demographic factors and

policies. Viewed in perspective, this gap reflects long-standing misapprehensions and discrepancies concerning the actual significance of population dynamics for environmental change.

The population/environment debate has long been fraught with ideological overtones and substantive oversimplifications. The more vociferous proponents of population control have been natural scientists, particularly biologists/ecologists. Criticism of their earlier approaches spawned the ubiquitous I = PAT equation (Environmental Impact = Population X Affluence X Technology) and inspired various later refinements of that formula (Hummel et al... 2009). Although oversimplified and a-historical, the IPAT recipe stressed the need to address overpopulation, excessive affluence and faulty technology simultaneously and, as such, it has survived the ensuing years. As has been pointed out repeatedly, each of these factors is itself interlinked with more encompassing political, socio-economic and institutional factors. Subsequent attempts to account for the way humankind pressures the environment through equations have found it difficult to address the intricate interactions between development efforts, population and environment. Moreover, other aspects of population dynamics, such as composition and spatial distribution, have been largely ignored.

The most outspoken disagreement with neo-malthusianism, viewed as a generic approach, came from the self-entitled "revisionists", whose influence was reinforced by the invigoration of economic liberalism in the 1990s. Despite support from mainstream economic policy, the revisionist stance on population has been given less play in the media than the neo-malthusian approach. The population control solutions are simpler and more appealing, having had considerably more influence on public opinion. Such approaches also constitute the "safe" outlook in the sense that, *ceteris paribus*, early reductions in population growth - while the dimensions of the population mass are somewhat more manageable - would appear to be a more prudent course than waiting for a possible world catastrophe. Yet in taking this simpler one-dimensional stance, it also detracts attention from the key factor defining both population and environment outcomes – namely, the current world approach to "development" and its impacts on the growth trajectories of different countries. Moreover, proponents of the population control approach generally overestimate our ability to reduce fertility through one-dimensional changes.

The revisionist message is more complex, phrased in scholarly terms, and does not hold out any simple panaceas that activists from different fields the world over can easily comprehend and support. Moreover, faith in the miracle-of-the-markets places a riskier bet for humankind – that continuous growth in GDP will result in a world-wide Kuznets environmental curve. In the end, neither the liberal blueprint for economic growth nor the neo-malthusian family planning solution is adequate or sufficient for the 21st century scenario. A more discriminating look at the strengths and limits of population control, as well as a better understanding of other population dynamics are needed in order to fill out the slate of population policies that are germane to global climate change.

Population Growth, Economic Growth and GHG Emissions

A population's size and rate of growth fundamentally affects the dimension and gravity of environmental problems through efforts made by countries to achieve "development". In our civilization, under present technological and environmental control levels, both population growth and economic growth are environmentally dangerous. Even if humankind failed to produce a single baby during the next generation, its life on Planet Earth would still be endangered by climate change. On the other hand, if the per capita consumption levels of the relatively small and slow-growing developed countries (under the same technological and environmental control conditions) were to be achieved by some of the large and/or rapidly-growing countries, the serious environmental problems of Planet Earth would inevitably take a quantum leap. As has repeatedly been demonstrated, many

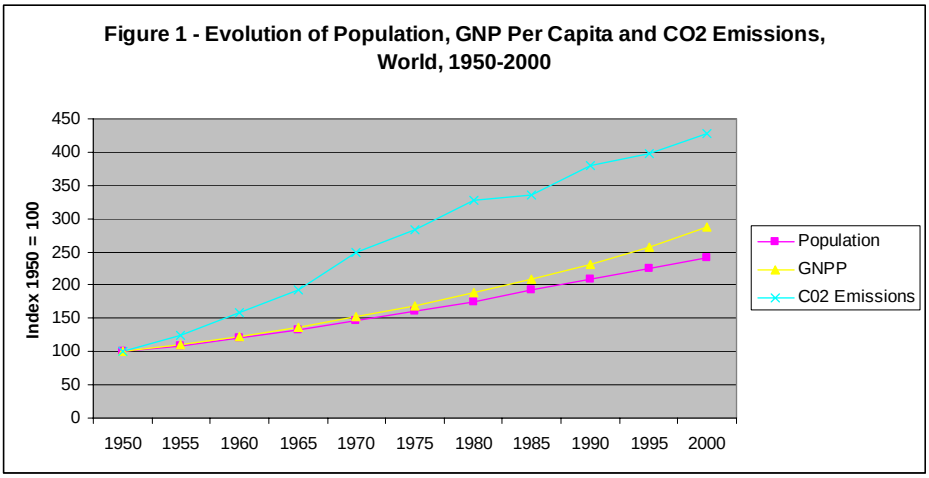
planets would be needed to provide the resources that would allow the rest of the world to attain the same standard of living currently enjoyed by industrialized countries.

For the future, population's contribution to global environmental problems will depend on a combination of patterns:

- the rate and degree of incorporation, by poor countries, of the production and consumption patterns which currently prevail in industrialized countries;
- the size and rate of population growth in countries which manage to achieve or maintain high levels of economic growth;
- the pattern of development and the adoption of technologies which will permit more environmentally-friendly patterns of production and consumption, both in developed and developing countries - but particularly in large, populous ones.

World population experienced its fastest growth in history during the second half of the 20th century, swelling from 2.5 billion in 1950 to 6.1 billion in 2000, as shown in Figure 1. However this increase is still smaller than the growth in world GNPP during the same period and also considerably smaller than the fourfold increase in carbon emissions. Global climate change in the 21st century will depend on the trajectory of these three patterns.

Figure 1 - Evolution of Population, GNP Per Capita and CO2 Emissions, World, 1950-2000



Sources: Population data from United Nations (2008); GNPP data from Maddison (2004); and CO_2 emissions from Marland et al (2007).

Of the three trajectories, the easiest to foresee would seem to be that in the domain of population because demographic processes have a built-in inertia that determine short and mid-term outlooks more predictably than trends in the economics or environmental fields. Nevertheless, the art of population projection is not an easy one, and recent shifts in demographic trends have made it even more capricious. A spate of unexpected demographic transformations have radically altered traditionally-expected patterns, disrupted customary cleavages between groups of countries, and altogether modified our traditional understanding of demographic processes.[2]

[2] Unless otherwise noted, all data on population growth, fertility trends and population composition in this paper are drawn from United Nations (2009). Similarly, data on urbanization and urban growth are taken from United Nations (2008)

Over the previous half-century, most countries could be easily classified into tidy compartments: developed countries had high incomes and low fertility while poor and developing countries had low incomes and high fertility. These traditional (though somewhat misleading) categories linking development levels to population growth rates have lately become blurred. Widespread and unexpectedly rapid declines in birthrates have been registered in most of the developing world, including much of Latin America, Asia, and the Middle East. Previous scenarios of "population explosions" are now restricted to most of Sub-Saharan Africa, plus a few other isolated countries (Timor Leste, Afghanistan, Yemen and Palestine) which still conform to the traditional mold of high fertility (with Total Fertility Rates of 5.0 and over) and high poverty.

On the other hand, the list of lowest-low fertility countries has shrunk noticeably in recent years (Goldstein et al, 2009). Only Russia and the Eastern European countries continue to have low and declining below-replacement fertility. Contrary to all expectations, Northern Europeans are having more babies, with several countries now anticipating steady population growth through the middle of the century. Does this signal a regional rebound in fertility rates? Possibly, but not necessarily: A previous rebound was experienced in the Nordic countries where the total fertility rate was raised from 1.7 in 1985 to 2.0 in 1990; however, by the end of that decade, fertility levels had again receded to 1.85 (Lutz et al, 2005 in Smil, 2008:97). By contrast, in the USA, by far the world's largest economy and largest bloc of consumers, the combination of immigrant and native reproductive patterns has boosted vigorous fertility rates that are likely to remain high in the foreseeable future.

Meanwhile, several developing countries, now have the type of low fertility rates that until recently were found only in high-income countries. The Chinese decline has been well publicized but Iran, among others, has experienced an even faster decline over recent decades. Brazil has attained fertility levels that are lower than those of France, thus well below replacement level. Conversely, a doubling of population is being anticipated in the USA.

In the midst of these diverse and confounding trends, world population growth – the main focus of interest in demographic patterns over the last sixty years – continues to increase, but at a decreasing rate and volume. The fastest annual rate of increase occurred in the 1965-70 period (2.02) and has been reducing ever since. The largest annual increments in population occurred in the 1985-90 period, when some 89 million people were added on every year. Overall, according to the latest UN projections, the world population reaches 6.8 billion people in July of 2009 and is currently increasing at a rate of 78 million per year (United Nations, 2009:11). Since another paper in this conference will present the United Nations projections, they will not be discussed here. Suffice it to note that, barring natural or man-made cataclysms, world population will continue to grow in large numbers during the first half of this century.

Policies in Relation to Population Growth

Whatever one's starting point, the threat to global environmental security posed by this vastly growing population simply cannot be dismissed. Practically any environmental challenge which one can perceive as facing humankind today, from ozone depletion to waste disposal, is made more difficult by a larger population size. However, this broad perception is insufficient in depicting the actual influence of population dynamics on environmental outcomes in general and on climate change in particular. A more discriminating perspective needs to understand:

- the limits of what can be achieved through efforts to reduce population growth and size;
- the effect that such a reduction can have on mitigation of climate change;
- the significance of other ongoing demographic processes.

Importance and limitations of family planning programs

A large proportion of the world's women still do not have access to the means that would allow them to have the number of children that are desired (UNFPA and Alan Guttmacher Institute, 2004). There is even a substantial gap between actual and desired family size among the fastest-growing demographic groups within developed countries. It is of considerable significance that the 2.5 billion difference between the United Nations' highest and lowest projection is the result of only one child difference in world fertility. That being the case, human-rights based policies that empower women and address unmet needs for reproductive health services -- whether in developed, developing or poor countries -- would have an important impact on reducing the rate of population growth and thus the eventual size of world population. While giving people, especially women, more control over their lives, this would also have some short and long-term impacts on the environment and on climate change. In this light, everything possible should be done to provide women with the means to achieve their desired family size.

However, it should be clearly understood that effectively addressing the issue of family planning needs will not give humankind a reprieve from its obligation to face the more critical environmental challenges posed by our civilization's model of "development". Both demographic and environmental outcomes are linked to development processes that occur within particular historical contexts. An exaggerated focus on a-historical simplifications that do not take into consideration the complexities of the 21st century development scenario, nor their differential implications for distinctive social contexts, favors simplistic policy suggestions.

Part of the reason that worldwide attention is increasingly focused on the population question stems from its painless simplicity. Attacking environmental issues from a demographic standpoint is immensely easier than trying to deal with the causes of global environmental damage that are rooted in our very model of civilization. However, the two approaches cannot be expected to have comparable effects. Suggesting cutbacks in consumption when "happiness" itself is predicated on having access to more goods is an extremely unpopular approach and threatens the very foundations of "progress" and "well-being" as it is defined today. By contrast, efforts to change "irrational" and "obsolete" reproductive patterns are "obviously" much simpler. Common sense seems to indicate clearly that people (especially poor people) would be better off with fewer children and, if they did, society itself and the environment would be better off. However, this simplification can be misleading and results would be considerably less incisive than generally expected.

The actual magnitude of the impact that future fertility declines will have on the mitigation of climate change is far from being proportional to the number of people who are "not born" under a scenario of rapid fertility decline. Enormous differentials in social organization and in consumption patterns between regions and social groups translate into highly differentiated impacts of additional numbers. Moreover, the practical ability to "deal with the population problem" through population control and/or family planning programs is overestimated. It is generally difficult to reduce fertility rapidly through family planning programs alone, that is, without some minimal social transformation that motivates people to perceive some increment in well-being as a result of fertility control. This is especially true in countries that still have a predominantly rural population. Throughout history, rural families have been larger in order to be able to work the land. Practically all least-developed countries still have a large majority of their population residing in rural areas, where family planning programs are more difficult to implement and have understandably had lesser impact -- unless some form of coercion is applied. Not to be overlooked here is the fact that when development – often accompanied by urbanization – unfolds sufficiently to motivate people to reduce their fertility, it inevitably increases their consumption levels as well.

Over the last few centuries, population has grown rapidly in response to some startling improvements in living conditions that generated a reduction in mortality. By the same token, fertility has declined significantly, in most regions of the world, in response to the profound socio-economic transformations associated with many different patterns of development. Spectacular declines in fertility have been facilitated by family planning programs such as in Iran, Indonesia and China; yet it can be argued that underlying social transformations in each of these countries were also critical.[3]

The comparably rapid decline of fertility in Brazil was not effectively supported by any large-scale family planning program, being largely driven by social transformations, including urbanization, that prompted people to use any means at hand to limit their offspring (Martine, 1996). Meanwhile, several other countries with large-scale family planning programs spanning several decades have experienced very slow and deliberate fertility declines. Fertility has declined in some poor countries or regions having exceptional social and institutional structures, such as in Kerala, India, but this only reinforces the lesson that some minimal social improvements are essential in order to motivate people to have a smaller number of children (Martine, das Gupta and Chen, 1998).

In short, the population control approach to mitigation has to be situated in the context of the world's updated demographic profile, as well as its stage of development. The timing and magnitude of the probable effects of a fertility reduction on climate change will vary considerably according to the current stage of each country on both of these dimensions. On the one hand, reducing fertility in poor and least developed countries – where fertility levels are still invariably high – would bring important social benefits in the short run and, perhaps most importantly, help to decrease the vulnerability of these populations to the effects of climate change. However, since their consumption levels and their impact on emissions are comparatively low, a reduction in their population growth will not represent a major boost to global mitigation efforts in the short run. Moreover, the social transformations that are minimally necessary to motivate the adoption of family planning are likely to have an equally significant impact on increased consumption.

In the medium and longer run, given the inertia of demographic processes (i.e. - the fact that populations continue to grow long after they have reached replacement fertility), and the hope that all countries will move quickly out of poverty and under-development, it is clearly important for global mitigation efforts to achieve slower population growth now rather than later. Should they be successful in emulating the recent development experiences of such countries as China and India, having smaller populations will clearly be significant for GCC over the longer range.

On the other hand, reducing fertility in developed countries would have a greater effect in the short term on reducing consumption and emissions than it would in poor countries. In purely logical terms, this is where a major fertility-reducing effort would seemingly have the greatest impact at this time. However, in practical terms, attempts to limit fertility in this group of countries are more difficult than in poorer countries. With the glaring exception of the United States, most industrialized countries have actually found themselves obliged to make energetic efforts to *increase* their birth rates. Such policies, aimed at stimulating fertility, are grounded in vital national interests inspired by demographic concerns such as diminishing size, reduced labor force and population ageing, as well

[3] Even in the case of China, the impact of birth control measures is questionable. Amartya Sen, for instance, wrote: "What is also not clear is exactly how much **extra** reduction in birth rate China has, in fact, been able to achieve through these coercive methods? We have to bear in mind that China has had many social and economic attainments that are favourable to fertility reduction, including expansion of education in general and female education in particular, augmentation of health care, enhancement of employment opportunities for women, and recently, rapid economic development... While China gets too much credit for its authoritarian measures, it gets far too little credit for other - supportive policies it has followed that have helped to cut down the birth rate" (Sen, 1994:22)

as in other less tangible concerns in the domain of national identity and sovereignty. Official and popular reactions to news of increased birth rates in these countries have been jubilant. Under these circumstances, it is hard to envision that great enthusiasm would be generated for birth control internally within these countries.

Secondly, it must be observed that even rapid fertility declines would not quickly produce the stabilization or reduction of population sizes. Family planning simply does not have retroactive capabilities. Given the effects of demographic inertia, a country's population continues to grow in absolute numbers for some decades after it has reached below replacement fertility. Thus, China reached a below-replacement level of fertility in the early 1990s, but its population is expected to grow by an additional 320 million more people from that point on before it finally stabilizes and starts to decrease after 2035. Worldwide, the majority of population growth today is due less to current fertility patterns than to imbedded demographic inertia, that is, the result of fertility and mortality patterns of previous generations. This inertia results in a time lag of several decades between the initial reduction in fertility levels and any population decline. It has been estimated that over half of world population growth during the first half of this century will be attributable to inertial factors (National Research Council, 2000). The proportion of inertial growth would be even larger if Sub-Saharan countries were discounted from these calculations.

Such sobering observations on the limitations of endeavors to achieve rapid population stabilization, however, should not dampen ever-greater efforts to empower women, and to provide them with access to family planning services in the framework of high quality reproductive health services. Even inertial growth could be reduced if age at marriage was postponed and the age at conception of the first child was delayed (Bongaarts, 2007). However, these modifications in marital patterns themselves require important cultural changes that may not be forthcoming.

Thirdly, the limitations of the "demographic solution" must be made clear. Sheer numbers do not tell the whole story. The world is already on the threshold of a major climactic threat, with or without population growth. The latest United Nations projections indicate that the world could have as few as 7.96 billion people and as many as 10.46 billion in 2050.[4] No one would dispute the fact that this 2.5 billion difference could greatly aggravate global environmental problems. Nevertheless, it is also true that a world population of 7.96 billion could actually inflict greater damage on the global environment than one with 10.46 billion, depending on its relative patterns of production and consumption.

In short, population control in the absence of some measure of development or social transformation is not likely to work from a demographic standpoint. Without drastic changes in the production and consumption patterns of the developing countries it would not work from an environmental standpoint.

URBANIZATION AND THE SUSTAINABLE USE OF SPACE

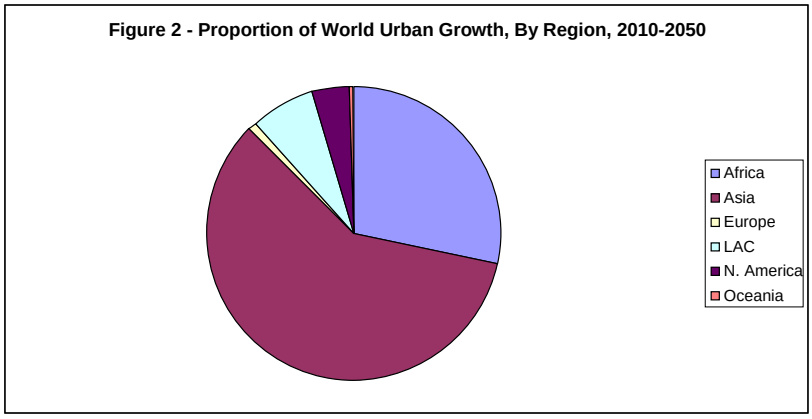
Public attention to demographic factors in environmental change has focused almost exclusively on population size and rate of growth. However, population dynamics also involve the changing distribution of population over space, as well as its evolving composition over time. The spatial dimension of population and its relation to environmental dynamics warrants much greater attention than it has received so far. The battle for a sustainable environmental future is being waged primarily in the world's cities where population, economic activity and environmental issues are increasingly concentrated.

[4] United Nations, Population Division. http://esa.un.org/unpp/index.asp (Consulted May 12, 2009)

Contrary to standard belief, higher levels of urbanization can constitute a positive factor in dealing with population/environment problems. As observed in a recent issue of **Science***:* "*Cities themselves present both the problems and solutions to sustainability challenges of an increasingly urbanized world… large urban agglomerations are fonts of human ingenuity and may require fewer resources on a per capita basis than smaller towns and cities or their rural counterparts*" (Grimm et al, 2008:756). Fulfilling the potentialities of cities for long-term sustainability, however, will require changes in approaches and policies. Local decisions have far-reaching effects and, conversely, climatic or ecosystem changes may have a local impact. Poorly managed urban development can have destructive local and even global consequences.

By comparison to the increasing diversity in fertility patterns, the spatial distribution of population is marked by an inexorable and universal trend towards urban concentration. For the first time in history, more than half of all human populations are now living in towns and cities. At the aggregate level, almost all population growth is occurring in cities. The number of urban dwellers will continue to rise quickly, reaching almost 6.2 billion people in 2050. About 95% of this upcoming future growth will be concentrated in developing countries, especially in Africa and Asia (cf. Figure 2). These two lag far behind other continents in terms of urbanization levels; present and future growth in absolute numbers of urban people in these regions is massive and unprecedented.

Figure 2 - Proportion of World Urban Growth, By Region, 2010-2050



Source: United Nations, 2008. (Data Online)

This transformation will have enormous implications for climate change, given both the increasing concentration and magnitude of economic production in urban localities, as well as the higher living standards that urbanites enjoy with respect to rural populations. Urban concentration will also be critical for mitigation and adaptation efforts in view of the greater vulnerability of urban populations to some of the more hazardous consequences of GCC.

For the most part, however, the significance of urbanization and urban growth for environmental change and, in particular, for climate change, has not been appropriately depicted. The IPCC 2007 Report, for instance, refers to urban areas on several occasions, often in connection with "land use change" and generally in reference to their role in stressing environmental limits, generating problems in services and infrastructure, aggravating health, food or other social problems or otherwise contributing to climate change. The special vulnerability of urbanites, especially in low-lying coastal zones or in urban slums is also highlighted. But nowhere are the inherent advantages of urban areas for mitigation mentioned.

The IPCC's perspective on urbanization mirrors the dominant public and environmentalist perspective, wherein cities are pictured as having an inordinate ecological footprint and making decisive contributions to global climate change. Traditionally, environmentalists have generally taken a dim view of urbanization and city growth. From the inception of the modern environmental movement, concern with the preservation of nature has focused attention on rural areas. "*Ecologists shunned urban areas for most of the 20th century, with the result that ecological knowledge contributed little to solving urban environmental problems*." (Grimm et al, 2008:756)

Within this context, cities have traditionally been viewed primarily as the locus of the critical environmental problems generated by the production and consumption patterns of modern civilization. Well-meaning approaches, such as the "ecological footprint" measurements – initially focused on cities – have served to increase environmental awareness but, in the process, have also reinforced the idea that cities are the world's major environmental culprits. Given the high concentration of energy use and industrial production in urban areas, identifying them as major culprits in GHG emissions has been almost automatic.

This stance is indeed commonplace today (cf. Dodman, 2009: 186), and the environmental impacts attributed to urbanization go beyond climate change. The aforementioned *Science* article provides a useful list of major types of global environmental change that affect and are affected by urban ecosystems: altered biogeochemical cycles; modification of hydrologic systems; biodiversity changes; land use and land cover change, and; climate change (Grimm et al, 2008:756). The best-documented example of anthropogenic climate modification is the urban heat island (UHI) effect: The built up areas tend to have higher air and surface temperatures than their rural surroundings, especially at night. However, the UHI is a local phenomenon with negligible effect on global climate (Grimm et al, 2008:758).

It is generally acknowledged that the two most important anthropogenic activities associated with urbanization that impact climate are changes in land use and the increase of greenhouse gases. The following pages will review some of the evidence in relation to these two aspects, with emphasis on land use change. The relation between urbanization and GHG emissions has been the object of recent analysis and has generated surprising results that are briefly summarized in the next section.

Urban Localities and Greenhouse Gas Emissions

If there is one feature on which environmentalists and laymen are likely to be in complete agreement it is that cities are at the root of GHG emissions throughout the world. As a corollary, urbanites are seen to be more prolific in the production of GHGs on a per capita basis. This generalized impression has been assimilated by influential agencies: Dodman quotes both the Clinton Foundation and UN Habitat as stating that cities produce some 75-80% of all GHGs. Similarly, an American-based initiative called "Zapping Greenhouse Gases, One Zip Code at a Time" which offers Urban EcoMap, an Internet-based tool that enables cities around the world to provide smarter climate-change information justifies its initiative on the grounds that "*because cities produce 80 percent of GHG emissions worldwide, they present the largest opportunity for innovation and social behavior changes." (Cisco Systems Inc.: 2009)*

Comparable statements, whose origins are unclear, abound and are widely accepted. Even advocates of urbanization have found themselves forced to recognize this "obvious" fact and to justify the urban concentration of emissions by pointing out that cities are, after all, the hub of

economic production; the consequent concentration of industry, automobiles and other motor vehicles inevitably causes this imbalance but it benefits the entire country.

Much to everyone's surprise, however, recent research has challenged this supposedly obvious fact and shown that per capita emissions are often lower in cities than in the rest of the country. Satterthwaite, using the most recent figures from the IPCC, estimates that cities produce between 30 and 41 percent of all GHGs. This is considerably less than the current proportion of urban population worldwide. He argues that other sources of emissions are not found in cities but in rural areas or small towns, including many coal, oil and gas fired power stations, many heavy industries as well as a number of wealthy high-consumption households who live in the countryside, especially in high-income nations. Satterthwaite does observe that if greenhouse gas emissions from power stations and industries were 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*" (Satterthwaite, 2008).

The alleged leading role of cities in GH emissions is further questioned by Dodman, on the basis of reasonably detailed and recent evidence from a sample of large cities in Asia, Europe, North America and Latin America. This research prompts him to report that – "*detailed analyses of urban greenhouse gas emissions for individual cities suggest that – per capita – urban residents tend to generate a substantially smaller volume of greenhouse gas emissions than residents elsewhere in the same country*" (Dodman: 209:185)

Specifically, Dodman reviewed data from twelve large metropolitan areas and found that – "*with the notable exceptions of Beijing and Shanghai, all the cities surveyed generate a substantially smaller volume of carbon dioxide equivalent (CO2eq) emissions per capita than the countries in which they are found*" (Dodman, 2009:188) Summary data from his work, presented in Table 1, is sufficient to illustrate the surprising direction, as well as the dimension, of differentials between large cities and the remainder of the country on per capita GHG emissions. As can be seen therein, in half of the cases reviewed, per capita emissions in cities are less than half the national average, and two more are around the 55% mark. Only the two Chinese cities in the sample show higher emissions than the national average.

Particular circumstances in each country help to explain the relative levels of GHG emissions as well as city-country differentials in per capita emissions.[5] Given the fact that future changes in urban emissions will come mostly from developing countries, the case of the two Brazilian and the two Chinese cities merit particular attention here.

By comparison to cities in the industrialized world, Rio de Janeiro and São Paulo – although accounting for a significant portion of Brazil's sizeable economic activity – present relatively low absolute levels of GHG emissions per capita, as well as a low percentage of national emissions on a per capita basis. Part of these relatively low levels of per capita emissions in Brazil's two major

[5] Moreover, as pointed out by Habitat, cities vary enormously according to their spatial organisation and environmental approaches. San Diego generates more CO_2 emissions than the much larger Tokyo, in part because of its greater dependence on individual automobile transport (UN Habitat, 2008:133). This research additionally shows that CO_2 emissions are also more related to consumption patterns and gross domestic product per capita than they are to urbanisation levels per se. Thus, the megacity of São Paulo in Brazil, despite being four times larger than San Diego, produces one-tenth of the latter's emissions (UN Habitat, 2008:xiv).

cities may be attributable to the industrial deconcentration that began to take place in the 1970s, especially from São Paulo, *inter alia,* because of stricter environmental controls that began to be applied at the time in that metropolitan region (Martine and Campolina, 1997). Be that as it may, the main sources of emissions at the national level in this country are attributable to deforestation, cattle raising and agriculture, all of which are carried out on a large scale.

Table 1 – Comparison of City and Country per Capita Greenhouse Emissions

City and Country	GHG emissions per capita (tonnes of CO2 equivalent)	National GHG emissions per capita (tonnes of CO2 equivalent	City emissions as percentage of national emissions (per capita)
Barcelona, Spain	3.4	10.03	33.9%
Glasgow, UK	8.4	11.19	75.1%
London, UK	6.2	11.19	55.2%
District of Columbia, USA	19.7	23.92	82.4%
New York City, USA	7.1	23.92	29.7%
Toronto, Canada	8.2	23.72	34.4%
Rio de Janeiro, Brazil	2.3	8.2	28.0%
Sao Paulo, Brazil	1.5	8.2	18.3%
Beijing, China	6.9	3.36	205.4%
Seoul, S. Korea	3.8	6.75	56.3%
Shanghai, China	8.1	3.36	241.1%
Tokyo, Japan	4.8	10.59	45.3%%

Source: Dodman, 2009:189, Table 2

By contrast, the two Chinese cities in Dodman's sample both show elevated levels of GHG emissions per capita, and by far the largest proportion of national emissions per capita of any of the cities in this sample. These high figures dispel any sense of elation or complacency regarding the role of cities in HGHs, and reinforce the need for actions and policies aimed at devising and implementing more sustainable production and consumption practices. Again, however, attributing blame is a complicated process, given the fact that a significant proportion of such emissions in Chinese cities stem from their industrial production of goods destined for high income markets. Moreover, although total carbon dioxide emissions from China are now even larger than those from the United States, per capita emissions are still much lower than those of the U.S. or Europe.

In the end, as Satterthwaite aptly points out, the culprits in GHG emissions are not particular places such as cities or rural areas that produce GHGs but particular activities and actual consumption. Thus, if GHGs are allocated to the homes of the consumer, rather than to the place where it was produced, then people in high-income cities would suddenly have much higher levels of emissions per capita. Prosperous world cities with high consumption lifestyles ultimately account for a significant proportion of all GHGs. But the "urban" condition is not the determining factor in this equation since wealthy households in rural areas and small towns tend to have a higher per capita emissions than equally wealthy urban households because of such things as greater private automobile use and larger heating and cooling demands for their homes. Moreover, per capita figures for individual cities can also be misleading given the enormous differentials in consumption between rich neighborhoods and slums. (Satterthwaite, 2008).

The underlying issue here is that the process of "urbanization" – whereby an increasing proportion of the total population lives in urban areas – is being conflated with other long-term processes. Urban people do indeed consume more than rural people, on average, but that is because they are better off, or less poor, on average. This does not mean that "ruralization" or keeping people in rural areas is an acceptable or feasible policy option, any more than it would be acceptable to keep people poor in order to ensure that they consume less.

As lucidly phrased in a recent IIED/UNFPA study - "… *urbanization is often linked to economic growth, and economic growth is, in turn, often linked to increased environmental degradation. This means that increased urbanization will often take place at the same time as increased environmental degradation, so that the two will be correlated. Again, however, there is not necessarily a causal link… Other environmental degradation such as increasing emissions of particulate matter, SO_2, or CO_2, can more appropriately be attributed to economic growth, or at least to the growth of specific economic activities, rather than to urbanization. Environmental problems linked to consumption, such as CO_2 emissions, tend to increase when average incomes increase, but this is caused by increased consumption rather than by increased urbanization. That the overall environmental problems are nonetheless usually worse in cities is partly because urban populations are more concentrated and partly because incomes are frequently higher. Similarly, just as the land use for housing tends to be higher per capita for rural dwellers than for urban dwellers at comparable levels of income, the overall environmental impacts also tend to be higher. This is especially so with higher-income households."* (Stage, Stage and McGranahan, 2009:28)

Unravelling the effects of urbanization from the effects of other broad ongoing trends is thus crucial if adequate policies are to be adopted. Population growth is, as shown earlier, inevitable for some time to come and, at the aggregate level, this growth will occur almost exclusively in urban areas and almost all in developing countries. Ultimately, the main question here is whether concentration in urban localities has a greater impact on human welfare than the perpetuation of the present rural-urban distribution. It does! Whatever the prism, urban concentration is, *ceteris paribus,* not only less damaging but necessary. Policy options have to centre on sustainable production and consumption rather than on reverting the spatial distribution of population.

Land Use and Land Cover Change

Land use changes are considered a first order climate forcing factor: Around 31 percent of all greenhouse gas emissions are reputed to arise from the land use sector (Scherr and Sthapit, 2009:32). Although the changes in land use brought about by urban growth are routinely cited as a major factor in the growth of this source of GHG emissions, the actual level of this impact appears open to question. In principle, "*Replacing natural vegetation with roads and buildings often decreases the surface albedo and alters the local surface energy balance, increasing sensible heat flux and decreasing latent heat flux*" (Kueppers et al, 2006: 251). Although this effect has been verified with respect to local Urban Heat Islands, the empirical evidence linking urban land use to regional or global climate change does not yet appear to be robust.

Initially, it appears that most studies over a larger area find it difficult to distinguish the temperature impacts of urban land use from other land use changes. One study estimated that land-use changes accounted for half of the observed reduction in diurnal temperature range and an increase in mean air temperature of 0.27°C in the continental United States during the past century (Kalnay and Cai, 2003:528). Another study on temperature changes in the USA covering a span of 40 years (1960-1999*)* corroborated verifiable changes in temperature that are

attributable to land use changes, but again failed to distinguish between the effects due to urban growth from those that would be derived from agriculture and deforestation (Ming et al n.d.: 2).

A study in Zhujiang Delta of China did conclude that strong and uneven urban growth caused the land surface temperature to rise by 4.56°C in the newly urbanized part of the study area, (Qian, Cui and Chang, 2006), but it is not clear whether this is simply a UHI effect. In the United States as a whole, analyses of the impacts of urban land cover change on climate change have apparently not yielded significant results - in the order of 0.006C/dec. and 0.015C/dec. (Ming et al. n.d: 1). One recent study concluded that "*… urban areas show a large warming second only to barren areas*" (Kalnay et al, 2008:7) while another found that "*Converting natural vegetation to urban land-cover produced less pronounced temperature effects in all models, with the magnitude of the effect dependent upon the preexisting vegetation type and urban parameterizations*" (Kueppers et al, 2008:250). Part of the reason for these low correlations, the latter authors explain, is simply *the relatively smaller spatial extent* of urban areas.

In this light, it would seem critical to quantify the amount of land that is actually being converted to urban use.[6] At the present, this quantity is not yet as enormous as seems to be generally assumed; however, it is important to examine how massive urban growth could change that in the future. Much improved estimates on the dimensions of the Earth's land area that is covered by urban localities are now available. These new sets of global databases on urban population and extent combine census data, satellite imagery and different methods of analysis in an integrated geospatial framework. Two of the best known recent studies based on such technologies can, for purposes of this paper, be taken as the upper and lower limits of the area currently occupied by urban localities.

The Global Rural Urban Mapping Project (GRUMP) estimates that urban localities occupied, in the year 2000, a land area of 3.506.656 km². This would correspond to about 2.7 per cent of the Earth's total land area, equivalent to less than half of Australia's total land area.[7] In light of current discussions among specialists, these figures can be considered as the upper limit of current estimates of urban land use.

The low estimate can be taken from a recent study commissioned by The World Bank (Angel et al., 2005). This focused *only* on cities having more than 100,000 persons and, within them, *only on their built-up areas* (i.e. - excluding green areas and other interstitial spaces). Using a sample of 120 cities worldwide, this study estimated that cities of 100,000 or more inhabitants contained 2.3 billion of the estimated 2.84 billion urban inhabitants in the year 2000. These urban inhabitants used up a total built-up space of 400,000 km² worldwide, equivalent to 0.3 per cent of the Earth's land area.

Assuming that the total urban population living in urban localities having *less* than 100,000 inhabitants (540 million) had an average density of 6,000 persons per square kilometre[8], they would occupy another 90,000 km². Under such assumptions, the total built up land area in all urban localities around the world would amount to 490,000 km² (400,000 + 90,000), or an area slightly smaller than Spain and less than half of one per cent of the Earth's total land area.

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[6] The following discussion of land use is based in part on Martine (2008)

[7] The denominator in this calculation (130.429.559 km_2) is that used in the GRUMP data set, which omits small islands and other places that have no urban areas. Also, GRUMP's land area is derived from the spatial boundary data, not the official estimates, which in some places may be outdated.

[8] This estimate is based on the study by Angel et al (2005) which assumed an average density of 8,000 per km2 in developing countries and 3000 per km2 in industrialized countries.

In short, approximately half of the Earth's population occupied an area equivalent to between 0.4 and 2.7 per cent of the Earth's surface, with the larger number reflecting all spaces within the perimeter towns and cities, and the smaller number measuring only their built-up areas. For present purposes, the exact figure is not an issue here since any number within this range would not seem to represent, in itself, a critical threat to the Earth's sustainability.

Although human settlements have so far taken up a relatively small fraction of the Earth's surface area, *future* land use has understandably raised some red flags. The aforementioned World Bank study (Angel et al., 2005) shows that urban land areas are growing faster than ever because of a combination of absolute increases in numbers of people with a decreasing average density. The study observes that urban density in built-up areas has been declining for the past 200 years, but finds that the reduction has been particularly rapid in recent years (Angel et al, 2005). This tendency towards declining density, combined with unprecedented absolute increases in the urban population, could greatly expand the land area of cities in the future.

At the present, cities in the developing world occupy less space per inhabitant than in developed countries. In both developing and industrialized countries, average densities of cities have been declining quickly: at an annual rate of 1.7 per cent over the last decade in developing countries, and of 2.2 per cent in industrialized countries (Angel et al, 2005:1-2). Table 1 presents a projection of urban land use between 2010 and 2050 under two assumptions: a) that urban density during that period would remain the same as it was in the GRUMP study (columns in green), and; b) that density would continue to decrease over those four decades at the same rate as it did during the 1990s in the World Bank study (i.e. 1.7% per decade in developing countries and 2.2% per decade in developed countries; columns in blue). It is important to note that the urban land use data used as a basis for the projection are those provided by the GRUMP analysis, that is, the estimate being considered here to represent the upper limit of urban land use

Table 2 – Projection of Urban Land, 2010-2050, By Region, According to Two Assumptions

Region	Urban Land in 2010 (Sq km)	Urban Land as % of Total in 2010	Urban Population in 2010 (in 000s)	Projected Pop. growth 2010-2050 (in 000s)	Urban Land in 2050*	% of Total in 2050*	Urban Land in 2050#	% of Total in 2050#
Northern Africa	81.378	0,99%	107.312	115.969	169.321	2,06%	181.132	2,20%
Sub-Saharan Africa	138.287	0,65%	304.879	705.812	458.429	2,15%	490.406	2,31%
East Asia	401.045	3,53%	757.180	421.689	624.395	5,50%	667.949	5,88%
South Central Asia	349.993	3,35%	571.987	878.689	887.654	8,50%	949.571	9,09%
South Eastern Asia	96.874	2,17%	286.579	275.001	189.834	4,25%	203.076	4,55%
West Asia	144.247	3,55%	153.870	141.014	276.442	6,80%	295.725	7,28%
Eastern Europe	299.382	1,64%	198.951	(21.732)	266.680	1,46%	290.933	1,59%
Europe (Remainder)	533.250	12,97%	331.297	48.208	610.845	14,86%	666.399	16,21%
L. America and Caribbean	526.991	2,59%	471.177	211.374	763.404	3,75%	816.654	4,01%
Northern America	885.876	4,68%	286.316	115.162	1.242.193	6,56%	1.355.166	7,16%
Oceania	49.211	0,58%	25.059	12.188	73.146	0,86%	79.798	0,94%
WORLD	3.506.534	2,70%	3.494.607	2.903.374	5.562.342	4,28%	5.996.810	4,62%

Sources: For current urban land use, CIESIN (2009); population projections from United Nations (2008)

*Assumption 1: Land use per person will continue the same over the 2010-2050 period.

#Assumption 2: Land use per person will increase at rate of 1.7% per decade in developing regions and 2.2% in developed regions over the 2010-2050 period.

These numbers have to be taken as merely illustrative of broad tendencies rather than as reliable projections. Nevertheless, they do serve to accentuate the fact urban land use will indeed expand significantly in those regions that can be expected to undergo massive urban growth in coming decades, notably in South-Central and Western Asia, but in North America as well. Nevertheless, even under the assumption of increasing sprawl (last two columns in Table 1), the increase in the amount of land is not extraordinary, and the proportion of all land that is urban in 2050 would still be less than 5% worldwide. Moreover, if one uses the definition proposed by the World Bank, in which only built-up areas are considered "urban", the proportion of all land utilized by urban areas would still be less than one per cent in 2050 (Not Shown).

Much could be done to lower these proportions with urban planning that favours a more sustainable use of space. The good news is that most of this growth in Asia and Africa is still to come and therefore that there is still an opportunity to make future growth more sustainable and more satisfying for the millions of poor people who will make up this future urban boom. For this to happen, as has been argued recently by UNFPA, attitudes and policies with respect to inevitable urban growth must change radically (UNFPA, 2007).

Policy Implications Regarding Urbanization and Urban Growth

The scale of urban growth that will be faced by the developing world in coming decades has no parallel in history. The world's urban population will show an increase of over 2.9 billion people between now and 2050, most of this in Asia and Africa. How, where, and in what conditions such growth will occur will have a huge impact on poverty reduction as well as sustainability.

Contrary to prevailing feeling, densely-populated urban areas can become an important ally in efforts to mitigate GCC. Cities are the primary font of environmentally-favourable technological innovations. Urban localities actually offer better chances for long-term sustainability: Dispersion of existing population would, in most cases, exacerbate pressures on ecosystems. Well designed and administered, the compactness and economies of scale of cities can reduce per capita costs and energy demand, while minimizing pressures on surrounding land and natural resources. High density agglomerations can also be useful in avoiding such problems as deforestation and loss of biodiversity, while generally helping to optimize the rational use of resources and the provision of cost-effective environmental services. Moreover, urbanization itself is a powerful factor in fertility decline. Historically, fertility decline has always occurred first and quickest in cities, making urbanization a powerful ally in fertility reduction efforts.

Longer-term urban sustainability depends on policymakers' ability to take a broader view of the utilization of space and to link local developments with their global consequences. Developing and developed countries face different sets of challenges and opportunities. The one advantage that potentially benefits developing countries is that much of their urban growth is still to come, giving them the opportunity to make more sustainable use of space at lesser human and financial expense. Taking advantage of this opportunity, however, will require a radical change in the anti-urbanization stance taken by many developing country policymakers who still try to impede or slow urban growth rather than prepare ahead for it.

Mitigation and adaptation are affected by the physical location of the city and the way in which it spreads. Disorderly spatial expansion of cities is the pattern that currently prevails. As stated in the aforementioned World Bank study "*the key issue facing public sector decision-makers – at the local, national and international levels – is not whether or not urban expansion will take place, but rather what is likely to be the scale of urban expansion and what needs to be done now to adequately prepare for it…the message is quite clear – developing country cities should be*

making serious plans for urban expansion, including planning for where this expansion would be most easily accommodated, how infrastructure to accommodate and serve the projected expansion is to be provided and paid for, and how this can be done with minimum environmental impact" (Angel et al, 2005: 91 and 95).

The social and sustainable use of urban space would, in and of itself, make a significant difference in the welfare of people and in environmental outcomes. Moving in that direction will require foresight to orient the use of urban land within an explicit concern for both social and environmental values.

Moreover, the built environment will have to be re-conceptualized through urban planning in combination with architectural and engineering solutions. This will include, for instance, alternatives to mechanical air conditioning, e.g. through passive ventilation, building design, planning, green roofs, more energy efficient manufacturing techniques, renewable energy systems, better landfill management to capture GHG emissions and many other technological initiatives (Abriola et al, 2007).

One specific aspect that requires much greater attention by policymakers in developing countries is attending the land and housing needs of the poor, who represent the largest social category (40%) of developing country cities and make up an even larger segment of new urban growth. Their needs are rarely considered effectively in urban planning; this omission has severe implications, not only for urban poverty, but also for urban environmental outcomes and for the quality of life of the entire city population.

Disregard for the land and housing needs of the poor affects both ecosystem services as well as the city's ability to responsibly and effectively plan for sustainable growth. Given little choice, the poor sometimes occupy ecologically-fragile areas and watersheds, thereby endangering the city's water supply and other ecosystem services. The lack of access to water, sewage or solid waste management systems in informal settlements pollutes rivers and ends up affecting the appearance, the air quality and the health of the entire city. Deforestation, the occupation of steep slopes and the occupation of urban floodplains and wetlands increases the probability of flood damages and landslides.

The lack of attention to the land and housing needs of the poor ultimately affects the very ability of a city to attract investments, to create jobs and to generate a better financial base for implementing improvements in the city. In short, attending to the land and housing needs of the urban poor not only has a direct impact on the reduction of poverty but also affects the city's economic viability and thus its ability to implement climate-friendly policies.

THE RELEVANCE OF DEMOGRAPHIC COMPOSITION

Within the framework of the IPCC, as noted earlier, the Special Report on Emissions Scenarios (SRES) initiated a discussion on how such issues as ageing, household composition and urbanization will influence future emissions. It also reported then-recent research showing that aging may influence the household formation rate and that small households consume significantly more energy per person.[9]

Subsequent research has delved in greater depth into these relationships and provided further insights into how changes and differences in population composition affect GHG emissions. Jiang and

[9] *Ibid.* Section. 3.2.4.1

Hardee recently provided a succinct summary of some of these most important findings, while criticizing climate models for considering only one demographic variable – population size and growth. They argue that projections of future climate change (including that of the IPCC), based on existing research showing that a one percent increase in population growth is associated with a one percent increase in carbon emissions, underestimate the real impact of population factors: Since consumptive and productive patterns vary among different population groups and over time, emission projections should take account of these different compositions.

Within this perspective, Jiang and Hardee summarize the existing literature showing that: a) population groups of different demographic composition (developed vs. developing countries, small vs. large households, rural vs. urban areas, and young vs. elderly) have significantly different consumption and emission behaviors; b) the proportion of population groups with significantly different consumption and emission behaviors change importantly over time as the shares of population groups representing significantly different consumption patterns are altered. Such findings argue for a more disaggregated approach to demographic factors in order to measure the extent of demographic impacts on greenhouse gas emissions and climate change (Jiang and Hardee, 2009:1-5).

Within this framework, urbanization and changes in household composition seem to have the largest impact on GHG emissions. The authors suggest that considering only population size as the demographic variable in climate models leads to an underestimation of the real contribution of "population" to climate change. However, since these figures on the effect of household size are drawn from studies in developing countries, their conclusion may be somewhat ambiguous. Smaller households are as much a part of "consumption" as they are of "population". They represent a choice in lifestyles and levels of comfort. Paradoxically, from a population standpoint, they are the result of fertility decline. What this type of analysis shows is why the responsibility of developed country populations is so much greater in GCC; not only do they normally consume more on a per capita basis, but they also have household arrangements that are conducive to even higher consumption. By comparison, at this time, household size in developing countries is considerably larger.

The impact of ageing is also shown by Jiang and Hardee to be important, but it is less consistent over time since the direction of ageing's influence is affected by such things as alterations in the composition of the labor force over time, as well by technological changes and variations in household composition. By contrast, the trend towards shrinking household size is associated with clear increases in consumption per capita, as is a rising proportion of the population residing in urban areas.[10]

This trend is particularly noticeable in developed countries. For instance, it has been observed that the population in the European Economic Area increased by 5 % between 1980 and 1995, while the number of households increased by 19 % (EEA, 2001). This means that average household size has decreased and emissions increased since small households consume more, on a per capita basis, than large ones because of greater residential land use, larger dwellings per capita, greater consumption of appliances and automobiles and thus of energy. However, such changes will be even more meaningful in developing countries where the bulk of world population and population growth is increasingly concentrated. Analyzing the impacts of household change on consumption in different

[10] Jiang and Hardee also illustrate how the understanding of vulnerability and approaches to adaptation could be strengthened with greater attention to demographic factors and changes. Here they emphasize the fact that rapid population growth is likely to occur among population groups—poor, urban, and coastal—that are already highly vulnerable to climate change impacts and in poor countries that cannot cope with their current population sizes.

sectors of developing countries would thus appear to be a useful and largely untouched direction for future research.

A review of data on ongoing changes in household composition in Brazil provides a glimpse of what may be in store in important segments of the developing world. The country has experienced a remarkable fertility decline, from a Total Fertility Rate of 6 in the mid 1960s, to below replacement level in the mid 2000s. In addition to rapid population ageing, Brazil is now also experiencing important changes in household composition. According to its annual household survey, Brazil had a total of 39.8 million occupied households in 1996 and 54.6 million in 2006. Thus, while the population grew at annual rate of 1.41% during this period, the number of households grew by at an annual rate of 3.21%. In both surveys, the most common household arrangement was that composed of a couple with children, but the number of such arrangements decreased from 59.7% in 1996 to 51.6% in 2006 (Barros, 2009:36-36).

The number of households in which both partners worked outside the home also increased significantly in the interim, from 29.7% in 1996 to 41.1% in 2006. A relatively new type of family arrangement, which has been dubbed "the DINK family" (Double Income, No Kids) in the United States, is also showing rapid growth in Brazil. The number of such households increased from 1.1 million in 1996 to 2.1 million in 2006. Compared to other households, the DINKs are considerably younger, with 68% of them headed by a person between the ages of 20 and 39. By comparison, the corresponding proportion for households in that age group having one, two and three children is 90%, 40% and 23%, respectively. Evidently, some of the DINK couples may eventually have children, but the 90% increase in the number of such young couples between 1996-2006 – at a time when the Brazilian population was going through an ageing process – would suggest that a large proportion of these couples have indeed chosen to be childfree, rather than temporarily childless (Barros, 2009: 35-36).

For our purposes, it is particularly interesting that the consumer profile of the DINKs differs considerably from other family arrangements. In general, the DINKS put more value on self-satisfaction and the realization of their current consumer and leisure appetites than in preparing the way for future generations (Barros, 2009:14). The DINKs have much higher income; on a per capita basis, it is at least 70% higher than any other group. They are clearly at the apex of the country's income distribution (Alves and Barros, 2009).

The Brazilian DINKs also have higher education and more promising careers in the labor market. Their residential conditions are superior to those of all other groups, in terms of access to water and sanitation, and in terms of number of rooms, as well as number of bathrooms per capita. They also have greater access to goods and services, including appliances, cell phones, computers and access to the internet. No data is available on ownership of automobiles but the breakdown of expenses among different household arrangements indicates that the DINKs spend a greater proportion of their income on leisure and transport than other groups (Barros: 2009:42-47); such a distribution would seem to be compatible with higher automobile ownership.

In brief, these data would appear to indicate that: a) the tendency to smaller households is already occurring in some of the large developing countries that have achieved very low fertility. The same trends have also been observed, for instance, in China (About, cited in Barros, 2009) and in other countries of Latin America (Rosero-Bixby, 2008); b) the smaller household arrangements that spring up after a rapid fertility decline in developing countries would appear to be associated with higher consumption, and thus higher emissions, as has been observed in developed countries. The one positive environmental perspective that was noted in the Brazilian case was the fact that a much greater proportion of all DINKs tends to live in apartments, rather than individual houses (Barros,

2009:45). In principle at least, this pattern would be compatible with reduced land use and energy efficiency in edifices, materials and in such energy critical areas as cooling or heating systems – provided that a conscious planning effort is made in that direction.

Changing Population Compositions and Policy Options

What kinds of population policies might be envisaged in relation to the effects of ageing and changing household composition? The demographic options with respect to ageing are as narrow as they have always been with respect to mortality: any action that would affect increased life expectancy in a negative way is as objectionable as suggesting that Malthusian controls will keep population down to manageable levels. Relevant policies, on the contrary, relate to health care improvements and making city infrastructure and services more friendly to an ageing population. In principle, urban areas offer a more favorable environment for actions that can contribute to a healthy and successful ageing: population concentration, with its advantages of scale and proximity, helps increase access to social services and to new technologies that can have significant implications for their well-being. More than for any other group, urban planning and architecture will have to devise building arrangements that attend to the special needs of the aged while also intensifying energy efficiency in buildings, transportation and other service needs.

As concerns household composition, the policies involved would seem to relate to the economic rather than the demographic domain. Again, it would be politically and socially inapt to suggest that people live in multi-person households, or even less that they have more children. On the other hand, fertility reduction policies are little help in respect to household composition since they inherently move demographic blocs towards smaller households. In this sense, it is interesting that Jiang and Hardee, after lucidly exposing the obvious need for consideration of differentiated household compositions when modeling climate change, end up falling back on undifferentiated fertility control policies as the answer to demographic changes. Actually, smaller household sizes are a product of reduced fertility; moreover, they can actually be viewed as part of the consumption cluster of driving factors, rather than of the demographic cluster. The same disaggregation that has been advocated when breaking down the influence of demographic factors on GHG emission would seem to be also necessary when discussing where and how fertility reduction would affect global emissions.

Improving the relationship between smaller households and emissions would entail both economic measures, as well as urban planning and architectural innovations. Economic incentives, such as energy taxes, would help limit the environmental consequences of smaller and more consumptive households in larger buildings, as well as promote the production of energy efficient appliances and products. Innovative planning of urban spaces, allied with engineering advances and construction blueprints that benefit energy efficiency, will have to be forthcoming. Moreover, one might contemplate increased environmental awareness raising and information on the environmental impacts of products. Be that as it may, the point is that, just as there are no acceptable demographic policies to counteract the increasing ageing of populations, it seems that little can be done from a demographic standpoint with relation to reduced household sizes.

CONCLUSIONS

The scale and breadth of the well-publicized GCC threat seem to demand positive and interventionist measures capable of turning things around quickly. Intervening in population growth processes appears to be one such initiative. There are already too many of us exploiting our planet, and the prospect of adding on a few billion more is indeed alarming. Energetic family planning campaigns thus seem to be a good way out for the world, as well as for those women and families burdened with undesired fertility.

Unfortunately, this apparently-simple solution has limitations. Family planning does not have retroactive effects and the world will continue to have a huge environmental problem even without a single additional birth. Family planning also does not produce immediate results. It requires prior social development to provide the motivation to use contraception effectively, but this same development also stimulates consumption. Also, the demographic effect of family planning is retarded by inertial factors that extend rapid population growth for decades beyond the initial fertility decline. Rapid declines of high fertility levels will thus have little impact on GCC in the short run. Even more problematic is the fact that economic growth in large and populous developing countries – whether or not they have already attained low fertility – will ultimately be totally incompatible with the scale of current mitigation efforts.

In short, if the current resurgence of concern with population growth generates support for the basic right to good reproductive health for all women, especially those who are incapable of achieving their desired fertility size, then it constitutes a most positive step for women's empowerment, for social human welfare and for longer-term environmental outcomes. However, not even the most intense population control efforts will relieve humankind of the need to drastically redefine development, as well as the pathways that will achieve it.

Insufficient attention has been paid to other demographic processes and their potential contribution to mitigation. Urban growth processes are currently at a critical stage, given the unprecedented scale, the sheer numbers of people involved and the importance of cities in future global economic, social, demographic and environmental scenarios. Long treated as prime offenders in environmental processes, cities could actually play a key role in both mitigation and adaptation efforts. Countries in Asia and Africa that are undergoing rapid urban growth have an opportunity to make this process work for their own welfare as well as for global environmental well-being. Taking advantage of this opportunity will require radical changes in approaches and the adoption of effective and participative strategies to urban planning aimed at improving energy efficiency, reducing emissions and providing adequate housing and living conditions for the poor.

Population composition, especially as concerns age, sex, income and household arrangements are beginning to appear on the horizon of interest in emission scenarios. Recent research demonstrates the need to discriminate the impacts of different population groups when drawing up future scenarios. Advances made in this field, however, are still skimming the tip of the iceberg and further research is needed in order to understand how the impacts of ageing and differentiated household structures will vary in countries at different levels of development and having different patterns of social organization. Population policies capable of adjusting to this changing and differentiated context have yet to be clearly defined.

Ultimately, the painful truth that humankind is loathe to face seems to be that consumption aspirations and practices will have to be seriously downgraded in order to reduce the threats of GCC. Stabilizing population growth, putting urbanization to work for mitigation, designing more energy efficient homes to accommodate new demographic compositions – all this is necessary and helpful, but insufficient. By many accounts, industrialized countries have already outstripped our planet's capacity to withstand "development" as we know it. Yet, developing countries are desperately trying to emulate consumption practices of industrialized societies. Although, at the aggregate level, they still have a long ways to go, they are already starting to make their own massive impact on GCC. Solving this conundrum will require redefining not only "development" but also the strongly material composition of modern-day "happiness". Demystifying the savior ethos of important but partial solutions, such as those from the demographic domain, is a necessary small step in refocusing the agenda and convincing world society of inevitable and critical cultural changes.

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