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Population Dynamics and Policies in the Context of Global Climate Change

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Introduction

Interest in demographic dynamics and their interactions with other mediating factors on potential environmental threats is resurgent in the wake of increasing concern about climate change. Most discussions of this global menace include some mention of population processes, yet the treatment of these is frequently incomplete or incorrect. Attention is generally focused on population growth, widely portrayed as a major driver that could easily be reduced. 'Urbanization' is also repeatedly cited as an important driver of increasing emissions, but without recognition 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 weaken emissions scenarios and lead to misleading policy suggestions.

This chapter 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 chapter will focus mainly on the interface between demographic processes and mitigation.[1]

Perspectives on Population Growth and Environmental Change

Few panaceas generate as much popular backing in developed countries as the notion that: a) a reduction in population size and growth would go a long way towards solving the world's major problems, including those related to climate change; and b) this reduction could be easily achieved through family planning programmes. Thousands of variations on this message—which has been dubbed "The Northern Perspective" (Hummel et al., 2009)—can easily be found in internet documents spanning a variety of substantive fields.

Despite the pressure of the Northern Perspective, the Intergovernmental Panel on Climate Change (IPCC) has downplayed the importance of population policy in mitigation and adaptation efforts—either because of apprehension about political repercussions in developing countries or from a failure to perceive its vital implications. Population projections constitute, implicitly or explicitly, the backbone of greenhouse gas (GHG) emissions scenarios. The 2007 IPCC report repeatedly mentions 'population', but without getting into the specifics of 'population dynamics' and, generally, with negative connotations (Metz et al., 2007).

There is thus a need for a more penetrating understanding and for a better balance in considering the role of demographic dynamics on Global Climate Change (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. A more discriminating look at the strengths and limits of population programmes, 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 the current predominant mode of civilization, and under present technological and environmental control levels, both population and economic growth are threatening. If the per capita consumption levels of the demographically small and slow-growing developed countries were to be reached by some of the large and/or rapidly growing countries under the same technological and environmental control conditions, the serious environmental problems of Planet Earth would inevitably take a quantum leap. As has repeatedly been demonstrated, many more 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.

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 1.1. However, this increase was smaller than the growth in world GNPP during the same period and much smaller than the fourfold increase in carbon emissions. Global climate change in the 21st century will depend on the interaction of these three trajectories.

The easiest to foresee is that in the domain of population: Demographic processes have a built-in inertia that determines short- and mid-term outlooks more predictably than trends in the economic or environmental fields. Nevertheless, the art of population projection is not an easy one, and recent shifts in fertility-level

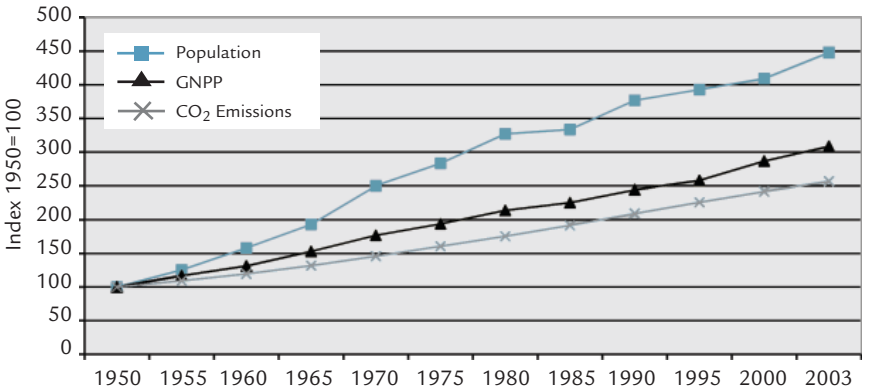
trends have made it even more capricious. Unexpected transformations have radically altered traditionally expected patterns, disrupted customary cleavages between groups of countries and altogether modified our traditional understanding of demographic processes.[2]

Over the previous half-century, most countries could easily be 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 the developing world, including much of Asia, Latin America and the Middle East. Previous scenarios of 'population explosions' are now restricted to most of sub-Saharan Africa plus a few other isolated countries (Afghanistan, Palestine, Timor Leste and Yemen) that still conform to the traditional mould of high fertility and high poverty.

On the other hand, the list of lowest-low fertility countries has shrunk noticeably in recent years (Myrskylä 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 rose from 1.7 in 1985 to 2.0 in 1990; however, by the end of that decade, fertility levels had fallen to 1.85 (Lutz et al., 2005, in Smil, 2008, p. 97). By contrast, in the United States—with by far the world's largest economy and 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

Figure 1.1 Evolution of Population, GNP Per Capita and CO_2 Emissions, World, 1950-2000



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

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 anticipated in the United States.

In the midst of these diverse and confounding trends, aggregate world population—the main focus of interest over the last 60 years—continues to increase, but at a decreasing rate and volume. The fastest annual rate of increase occurred in the 1965-1970 period (2.02) and has been decreasing ever since. The largest annual increments in population occurred in the 1985-1990 period, when some 89 million people were added every year. However, levels of absolute increases have also slowed. Overall, according to the latest United Nations projections, world population reached 6.8 billion in July of 2009 and is currently increasing at a rate of 78 million per year (United Nations, 2009, p. 11). The bottom line is 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 possible environmental challenge facing humankind today, from ozone depletion to waste disposal, is made more difficult by a larger population size. However, this broad perception is insufficient to characterize the actual influence of population dynamics on environmental outcomes in general and on climate change in particular. A more discriminating perspective needs to consider:

- 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 programmes

A large proportion of the world's women still do not have access to the means that would allow them to have only the number of children they desire (UNFPA and Alan Guttmacher Institute, 2004). There is even a substantial gap between actual and desired family size among the fastest-growing demographic groups in developed countries. It is of considerable significance that the 2.5 billion difference between the United Nations' highest and lowest projections is the result of only a one child per woman 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 least developed countries—would have an important impact on reducing the rate of population growth and thus on the eventual size of world population. While giving people, especially women, more control over their lives, this would also

have critical longer-term impacts 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 addressing the issue of family planning needs effectively will not give humankind a reprieve from its obligation to face the more critical environmental challenges posed by the prevailing 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 different implications for distinctive social contexts, favours inadequate 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 seems 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 they are defined today. By contrast, efforts to change 'irrational' and 'obsolete' reproductive patterns are 'obviously' much simpler. Common sense seems to indicate that people (especially poor people) would be better off with fewer children, and, if they did have fewer offspring, both society and the environment would be better off. However, the results of this change could 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 differences 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 family planning programmes is overestimated. Under the threat of climate change, the traditional view of the population establishment—that fertility declines as a result of family planning programmes and that it is therefore urgent to intensify such programmes in high-growth countries—has made a resurgence. However, this perspective overlooks well-documented arguments that rapid reductions in fertility depend at least as much on speeding up economic development and social transformations, as well as on empowering women and meeting individual's needs in sexual and reproductive health (see, for instance, Demeny, 1992 and 1994; Sen et al., 1994; Presser, 1997).

Over the last few centuries, population has grown rapidly as a result of some startling improvements in living conditions that generated a reduction in mortality. By the same token, fertility has recently declined significantly in most regions of the world in response to the profound socio-economic transformations asso-

ciated with many different patterns of development. While spectacular declines in fertility have been facilitated by family planning programmes, such as those in China, Indonesia and Iran, 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 programme but was largely driven by social transformations—including urbanization—that prompted people to use any means at hand to limit the number of their offspring (Martine, 1996). Meanwhile, several other countries with large-scale family planning programmes spanning several decades have experienced very slow and deliberate fertility declines. Fertility has also decreased 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 et al., 1998).

In brief, family planning programmes alone, without some minimal social transformation that motivates people to perceive that limiting fertility would yield some increment in well-being, and that empowers women to take control over their lives, are unlikely to reduce fertility rapidly. This is especially true in countries that still have a predominantly rural population. Throughout history, rural families have had more children in order to work the land. Practically all the least-developed countries still have a large majority of their population residing in rural areas, where family planning programmes are more difficult to implement and have understandably had a lesser impact—unless some form of coercion was applied.

Given the association between development and fertility decline, even a reduction in population growth does not necessarily result in reduced consumption. Not to be overlooked here is the fact that when development—often quickened by urbanization—unfolds sufficiently to motivate people to reduce their fertility, it inevitably increases their consumption levels as well. Thus, while it is clear that fertility decline is absolutely essential for sustainability in the long term, it is only the starting point for more effective measures addressing consumption.

In short, the Northern Perspective's approach to mitigation through family planning 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 demographic and development situation of each country. 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 important, 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 still comparatively low, a reduction in their population growth will not represent a major boost to global mitigation efforts in that time span. Moreover, the social transformations that are minimally necessary to motivate the adoption of family planning are likely to have an equally significant but opposite 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 important for global mitigation efforts to achieve slower population growth now rather than later. Should they reach the recently successful development levels—and thus increased consumption—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, it would obviously be more difficult to attempt to limit fertility in this group of countries than it would be 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 labour force and population ageing, as well as in other less tangible issues related to national identity and sovereignty. Official and popular reactions to news of increased birth rates in these countries have bordered on the jubilant. Under these circumstances, it is hard to envision that great enthusiasm would be generated for fertility reduction efforts within these countries.

Secondly, it must be observed that even rapid fertility declines would not quickly produce the stabilization or reduction of population sizes. 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 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 the 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 contribution of inertial growth would be even larger if sub-Saharan countries were discounted from these calculations.

Such sobering observations on the limitations of endeavours to achieve rapid population stabilization should not, however, 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. Family planning simply does not have retroactive capabilities. Even if humankind failed to produce a single baby during the next generation, its quality of life on Planet Earth would still be endangered by climate change. 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 (United Nations, 2009). No one would dispute the fact that this difference of 2.5 billion 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, if the former achieved the production and consumption patterns of industrialized countries.

In short, efforts to limit fertility through family planning programmes, in the absence of some measure of development or social transformation, are not likely to work from a demographic standpoint. Without drastic changes in the production and consumption patterns of our civilization, they would also not work from an environmental standpoint.

Urbanization and the Sustainable Use of Space

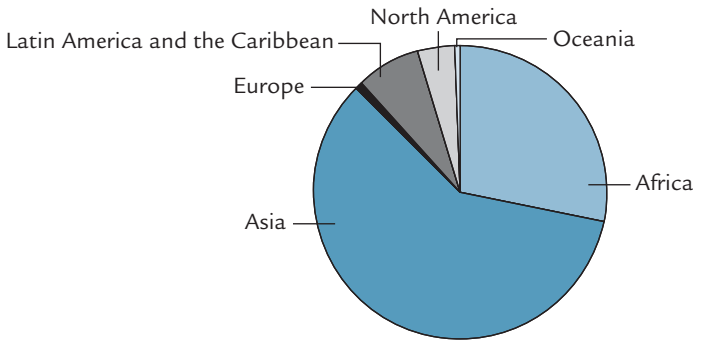
As noted, public attention to demographic factors in environmental change has focused almost exclusively on population size and rate of growth. However, population dynamics also involve the changing distribution of population over space, as well as its evolving composition over time. The spatial dimension 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.

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, p. 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. Even more important, at the

aggregate level, almost all population growth is occurring in cities: *Population growth issues are thus primarily urban issues.* The number of urban-dwellers will continue to rise quickly, reaching almost 6.2 billion people in 2050. About 95 per cent of this future growth will be concentrated in developing countries, especially in Africa and Asia (see Figure 1.2). These two lag far behind other continents in terms of urbanization levels, but the present and future growth in absolute numbers of urban people in these regions is massive and unprecedented.

Figure 1.2: Proportion of World Urban Growth, By Region, 2010-2050



Source: United Nations, 2008a.

This transformation will have enormous implications for climate change, given the increasing concentration and magnitude of economic production in urban localities, as well as the higher living standards that urbanites enjoy by comparison 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 urban slums, is also highlighted. But nowhere are the inherent advantages of urban areas for mitigation mentioned nor their potential advantages for adaptation.

The IPCC's negative perspective on urbanization mirrors the dominant public and environmentalist perception, wherein cities are pictured as having an inordinate ecological footprint and making decisive contributions to global climate change. Traditionally, environmentalists have 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, p. 756).

Within this context, cities have generally 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.

This stance is indeed commonplace today (see, for example, Dodman, 2009, p. 186). It is generally acknowledged that the two most important anthropogenic activities associated with urbanization that impact climate involve changes in land use and the increase in greenhouse gases. The following section focuses on land-use change; the relation between urbanization and GHG emissions is analysed in Chapters 3 and 4.

Land-use and land-cover change

Land-use changes are considered a first order climate forcing factor: Around 31 per cent of all greenhouse gas emissions are reputed to arise from the land-use sector (Scherr and Sthapit, 2009, p. 32). Although the changes in land use brought about by urban growth are routinely cited as a major factor in the growth of GHG emissions, the actual level of this impact appears open to question. In principle, "[r]eplacing 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., 2008, p. 251). Although this effect has been verified with respect to local 'Urban Heat Islands' (UHI), the empirical evidence linking urban land use to regional or global climate change does not appear to be robust.

Initially, it appears that most studies over a larger land 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 the 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, p. 528). Another study on temperature changes in the United States covering a span of 40 years (1960-1999) corroborated verifiable changes in temperature that are attributable to land-use changes, but failed to distinguish between the effects due to urban growth from those derived from agriculture and deforestation (Cai et al., 2004, p. 2).

A study in the 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 et al., 2006); however, it is not clear whether this refers to a UHI or a regional 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. (Cai et al., 2004, p. 1). One recent study concluded that ". . . urban areas show a large warming second only to barren areas" (Kalnay et al., 2008, p. 7) while another found that "[c]onverting 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, p. 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.[4] At 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 situation 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 chapter, be taken as the upper and lower limits of the area currently occupied by urban localities.

The Global Rural-Urban Mapping Project (GRUMP) (CIESEN, n.d.) estimates that urban localities occupied, in the year 2000, a land area of 3.506.656 km². This corresponds to about 2.7 per cent of the Earth's total land area, equivalent to less than half of Australia's total.[5] 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 population living in urban localities having less than 100,000 inhabitants (540 million) had an average density of 6,000 persons per square kilometre,[6] 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 1 per cent of the Earth's total land area.

In short, approximately half of the Earth's population occupies 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 of towns and cities and the smaller number measuring only the built-up areas of towns and cities. 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 concern. 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 and 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 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 rapidly: 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, pp. 1-2). Table 1.1 presents a scenario 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 blue); 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 (last two columns). It is important to note that the urban land-use data which serves as a basis for these scenarios are those provided by the GRUMP analysis, that is, the estimate being considered here constitutes the upper limit of urban land use.

These numbers have to be taken as merely illustrative of broad tendencies within the bounds of the supplied scenarios, rather than as reliable projections. They do, however, serve to accentuate the fact that urban land use is likely to expand significantly in those regions that are expected to undergo massive urban growth in coming decades, notably in South-Central and Western Asia, as well as in North America. Nevertheless, even under the assumption of increasing sprawl (last two columns in Table 1.1), 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 per cent worldwide. Moreover, if one uses the definition proposed by the World Bank study, in which only built-up areas are considered 'urban', the proportion of all land utilized by urban localities would be less than 1 per cent in 2050 (not shown).

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

Table 1.1: Scenarios of Urban Land Use, 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 Population 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	8.5	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
Latin 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

* 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 cent per decade in developing regions and 2.2 per cent in developed regions over the 2010-2050 period.

Sources: Current urban land use from CIESIN, n.d.; population projections from United Nations, 2008b.

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 for long-term sustainability and, specifically, in efforts to mitigate GCC. Cities are the primary font of environmentally favourable technological innovations. If well designed and administered, the compactness and economies of scale of cities can reduce per capita costs and energy demand, while also 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. Dispersion of existing population would, in most cases, exacerbate pressures on ecosystems. Moreover, urbanization itself is a powerful factor in fertility decline. Historically, fertility

decline has always occurred first and quickest in cities, making urbanization a potent ally in fertility reduction efforts.

Longer-term urban sustainability depends on the ability of policymakers 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 cost. 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 by the way in which it spreads. Disorderly spatial expansion of cities is the pattern that currently prevails. As aptly 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, pp. 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 would include, for instance, alternatives to mechanical air conditioning, e.g., through passive ventilation, building design, 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 to the land and housing needs of the poor, who constitute the largest social category (40 per cent) in 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 and 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 affects the appearance, air quality and health of the entire city. Deforestation and the occupation of steep slopes, urban floodplains and wetlands increase the probability of flood damage 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

Recent research has examined how changes and differences in population composition affect GHG emissions (see, for instance, Dalton et al., 2005). Jiang and Hardee (2009) recently provided a summary of some of the most important findings of these studies, while criticizing climate models for considering only population size and growth.

The literature summarized by Jiang and Hardee shows 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 behaviours; and b) the proportion of population groups with significantly different consumption and emission behaviours changes importantly over time. Such findings argue for a more disaggregated approach to demographic factors in order to measure the extent of their impacts on greenhouse gas emissions and climate change (pp. 1-5). In brief, the authors suggest that considering only population size as the demographic variable in climate models (as in the IPCC report) leads to an underestimation of the real contribution of 'population' to climate change.

However, existing studies on the effect of household size are largely drawn from developed country experiences. Moreover, smaller households can be seen to be as much a part of 'consumption' as they are of 'population'. They represent a choice in lifestyles and levels of comfort that lead to higher consumption. Thus, what this type of analysis actually does is explain 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.

The impact of ageing is also shown by Jiang and Hardee to be important, but it is less consistent over time since it is affected by such things as alterations in the composition of the labour force, 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.[7]

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 per cent between 1980 and 1995, while the number of households increased by 19 per cent (EEA, 2001). This means that average household size has decreased and emissions have increased, since small households consume more, on a per capita basis, than large ones because of greater residential land use, larger dwellings, greater consumption of appliances and automobiles and thus of energy.

Such changes will be even more meaningful in developing countries, where the bulk of world population and population growth is increasingly concentrated. Analysing the impacts of household change on consumption in different sectors of developing countries would thus appear to be a useful and largely untouched area 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 well-below replacement level in the mid-2000s. In addition to rapid population ageing, Brazil is also experiencing important changes in household composition. According to its annual household surveys, Brazil had a total of 39.8 million occupied households in 1996 and 54.6 million in 2006. Thus, while the population grew at an annual rate of 1.41 per cent during this period, the number of households grew at 3.21 per cent. In both the 1996 and 2006 surveys, the most common household arrangement was that of a couple with children, but the number of these decreased from 59.7 per cent in 1996 to 51.6 per cent in 2006 (Barros, 2009, p. 35-36).

The number of households in which both partners worked outside the home also increased significantly in the interim, from 29.7 per cent in 1996 to 41.1 per cent in 2006. A relatively new type of family arrangement, 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, DINKs are considerably younger, with 68 per cent 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 or three children is 90 per cent, 40 per cent and 23 per cent, respectively. Some of the DINK couples may eventually have children, but the 90 per cent 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, pp. 35-36).

DINKs have a much higher income; on a per capita basis, it is at least 70 per cent higher than any other group. They are clearly at the apex of the country's income distribution (Alves and Barros, 2009). For our purposes, it is particularly interest-

ing to note that the consumer profile of DINKs differs considerably from those of other families. In general, DINKS place 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, p. 14).

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

In brief, these data would appear to indicate that the tendency to smaller households is already occurring in some of the large developing countries that have achieved very low fertility. Indeed, the same trends have also been observed in other countries in Latin America (Rosero-Bixby, 2008) and in China (about.com, n.d.). The data also seem to show that the smaller household arrangements that spring up after a rapid fertility decline in developing countries are 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 DINKs tends to live in apartments rather than individual houses (Barros, 2009, p. 45). In principle at least, this pattern is compatible with reduced land use and energy efficiency in edifices, materials and in such energy critical areas as cooling and 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 limited as they have 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 here relate to health care improvements and making city infrastructure and services more friendly to an ageing population. Generally, urban areas offer a more favourable environment for actions that can contribute to a healthy and enjoyable 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 ageing while also intensifying energy efficiency in buildings, transportation and other services.

As concerns household composition, the policies involved would seem to relate to the economic rather than the demographic domain. Paradoxically, smaller households result from fertility decline: Fertility reduction policies are obviously not the answer here since smaller households consume more. It would also be politically and socially inapt to suggest that people should have more children, or that they should live in multi-person households. In this sense, smaller households can more properly 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 emissions would also seem to be necessary when discussing where and how fertility reduction would affect global emissions.

Improving the relationship between smaller households and emissions would entail 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 living 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 developed. 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 except to prepare for new housing arrangements.

Conclusions

The scale and breadth of the well-publicized GCC threats 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; even small differences in fertility have huge impacts in the long run. 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 for climate change. Family planning does not have retroactive effects, and the world will continue to have a massive environmental problem even without a single additional birth. The demographic effect of family planning is retarded by inertial factors that extend large population growth for decades beyond the initial fertility decline. Family planning thus 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. 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 under present standards.

In short, if the current resurgence of concern about population growth generates support for the basic right to good reproductive health care for all women, especially those who are unable to achieve their desired family 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 to forge the pathways that will achieve new development models.

Insufficient attention has been paid to other demographic dynamics and their potential contribution to mitigation. Urban growth processes are currently at a critical stage, given 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 participatory strategies to urban planning aimed at improving energy efficiency, reducing emissions and providing adequate housing and living conditions for the poor.

Recent research demonstrates the need to discriminate between the impacts of different population groups when drawing up future scenarios. Advances made in the field of population composition, however, are still skimming the tip of the iceberg, and further research is needed in order to understand how the impacts of ageing and different household structures will vary in countries at different levels of development and that have 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 is that consumption aspirations and practices will have to be seriously curtailed 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 the lifestyles and consumption practices of industrialized societies. Although, at the aggregate level, they still have a long way 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 content of modern-day 'happiness'. Demystifying the 'saviour' ethos of important but partial solutions, such as those of the demographic domain, is a

necessary small step in refocusing the agenda and convincing world society to adopt the inevitable and crucially needed cultural changes.

Notes

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

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

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, p. 22).

4 The following discussion of land use is based in part on Martine, 2008.

5 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.

6 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 3,000 per km^2 in industrialized countries.

7 Jiang and Hardee (2009) 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.

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