Population and consumption trends

WHEN people think of the human impact on the environment, they often think in terms of total population numbers and population growth. These elements are important, but they are only two of the demographic factors that have an environmental impact. Population density and distribution, determined by migration and urbanization, are also important, as is population composition in terms of age and household size. All of these impact on consumption levels and trends.

POPULATION NUMBERS AND GROWTH RATES

Along with consumption and technology, our sheer numbers affect the total burden we place on the environment. Rough estimates suggest that the population of the entire world 2 000 years ago may have been around 300 million. Over the whole of the next millennium, the period of the Dark Ages in the West, this rose by as little as 10 million.

The acceleration of human expansion can be seen dramatically in the time it took for each milestone of a billion to be reached. Our first billion, passed around 1804, took perhaps 200 000 years to reach. The second billion took only 123 years and the third, reached in 1960, a mere 33 years. Since then we have been in overdrive, adding a billion every 13 or 14 years. We passed the 6 billion mark late in 1999[1].

Rates of population growth are also significant. Together with the growth in consumption levels, these affect our ability to adapt our technology and institutions to environmental challenges. The faster the growth rates of population and consumption, the faster we must be able to adapt if we are to prevent an increase in environmental damage – and the more likely it is that we will not adapt quickly enough.

Human population has grown in a flattened S-shaped curve, rising very slowly at first, then gradually building up speed and entering a sharp upward hike. Although we are still on the riser of that steep slope, the growth rate has slowed considerably and the curve will begin to level out in the next few decades.

The growth rate was very slow up to 1500, averaging less than 0.1 percent per year. The agricultural and industrial revolutions of the 18th century spurred growth to 0.4 or 0.5 percent per year up to the beginning of the 20th century. After the Second World War, further advances in agriculture and medicine spread to developing countries. World population growth rates of around 1 percent a year between 1920 and 1950 rose to an all-time peak of 2.04 percent in the later 1960s.

Since 1965-70 the growth rate has slowed considerably. In the early years of the 2000s, it is running at a projected 1.2 percent, but there are sharp differences between regions. Developed countries are growing at only 0.2 percent a year, while Africa's rate is 2.36 percent a year, with other regions ranged in between.

The absolute increase in numbers per year continued to rise for three decades after the peak growth rate had passed because the rate was being applied to a much larger overall total. Annual additions grew from 67 million people a year in the 1960s to a peak of 86 million a year in 1985-90. But these too have now begun to slow, to a projected 75 million a year in 2000-05. However, this

is still equivalent to adding almost a new Germany every year, or a new United States in less than four years.

Fertility and mortality

Put simply, the human population spurt came about because death rates fell faster than birth rates. Antibiotics, immunization, clean water and improved food availability produced instant improvements in infant and child mortality. Reproductive habits and entrenched cultural values about family size take much longer to adjust.

The total fertility rate (TFR) for a given year expresses the number of children the typical woman will have over a lifetime, if patterns in that year persist. In almost all countries, total fertility rates have been moving downwards.

Fertility is the most important factor in determining future population growth over the long run. A TFR of about 2.1 is needed to keep population stable over time. By 1995-2000 no less than 61 countries had fallen below this replacement level. Between them they housed 44 percent of the world's population. Many developing countries had lower fertility than the United States – for example, China (with a TFR of 1.8), Thailand (1.74), Republic of Korea (1.65) and Cuba (1.55)[2].

Some 23 countries had very low fertility rates, below 1.5 in 1995-2000. The average fertility rate for Western Europe was only 1.7, while in Eastern Europe it was 1.36. The lowest rates of all were found in Southern Europe, where Spain, Italy and Greece had rates below 1.3. Spain was lowest of all with 1.15.

In all these countries population will eventually start to decline unless fertility rates rise sharply. In Southern Europe this is already occurring; in Western and Northern Europe it is expected to begin in the next 15 to 20 years.

Mortality does have some effect on future projections. In most regions a continued decline in infant and child mortality is expected, along with a rise in average life expectancy.

But in sub-Saharan Africa, rising mortality is a factor. Here AIDS has cut life expectancy at a time when it would otherwise have been increasing. In the 29 African countries hardest hit by AIDS, life expectancy at birth is currently estimated at only 47 years – without AIDS it was expected to reach 54. In Botswana, where one out of every four adults is infected, life expectancy was only 41 years in 1995-2000, right back to the level of 50 years earlier. Because of this, by 2015 Botswana's population will be 20 percent smaller than it would have been without AIDS[3].

Population projections

The United Nations Population Division has had a remarkable record of accuracy in its predictions since 1950. But at the turn of the millennium we are entering uncharted waters.

The Population Division has had to revise its projections significantly downwards in the 1990s. The latest medium projection, produced in 1998, expects world population to reach 8.9 billion in 2050. This is a massive 1.1 billion less than was expected in the projection made in 1990[4].

On the current medium projection 97 percent of the future increase will occur in today's developing countries. Today's developed countries will drop from 20 percent of the total in 2000, to only 13 percent in 2050. Africa will undergo the most rapid growth, increasing from 784 million in 2000 to nearly 1.8 billion in 2050. India will overtake China as the most populous country, rising from just over 1 billion to more than 1.5 billion between 2000 and 2050[5].

The most recent long-range medium projection, based on the previous 1996 projection, had world population rising to 10.4 billion in 2100 and levelling out at just under 11 billion around 2200.

However, these projections depend heavily on what might happen to human fertility in the future, and that is more uncertain today than ever before. In many countries, fertility rates have fallen faster than anyone expected – in some cases to levels not previously seen outside economic depression or war.

Demographer John Bongaarts believes that very low fertility may be at least in part due to birth deferment, and fertility may rise again[6]. However, so many countries now have below-replacement

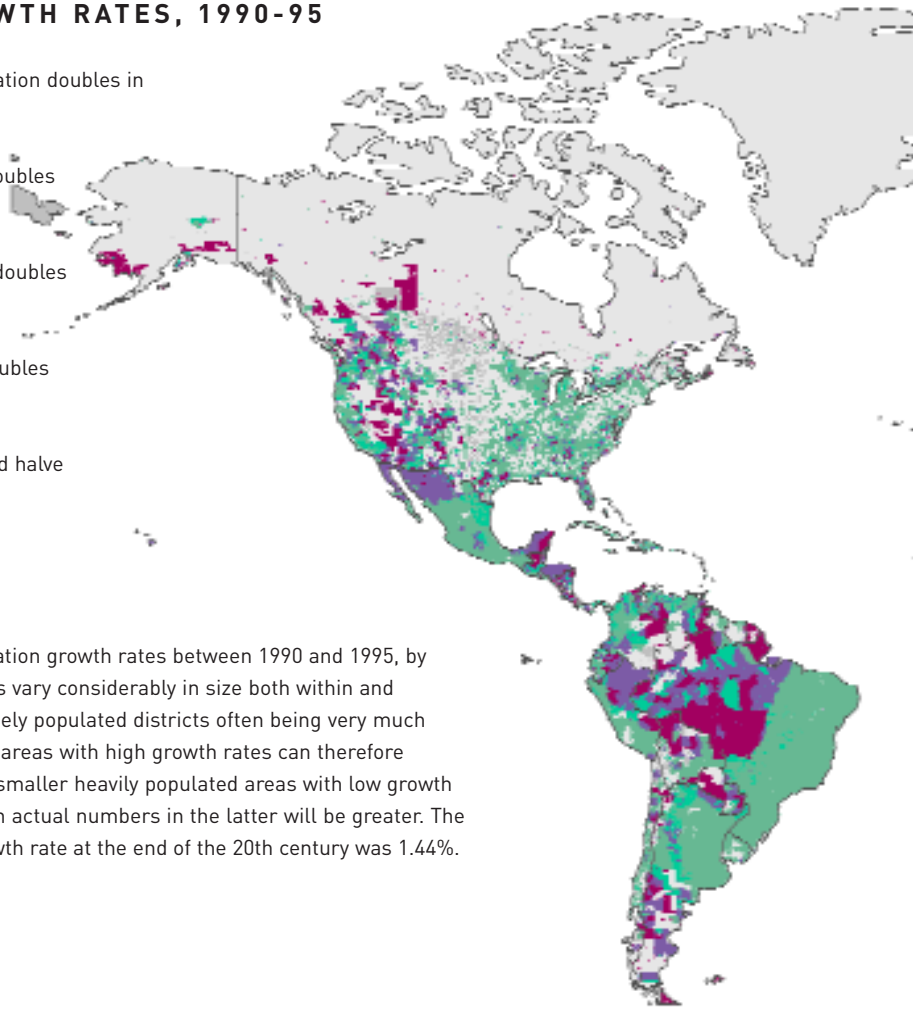
Rapid fertility decline

It used to be said that cultural factors kept fertility unusually high in some areas, especially sub-Saharan Africa and Islamic countries. But there are now examples from every continent and culture area to show that fertility rates can fall dramatically as soon as good quality family planning becomes widely available. Fertility rates in China, for example, fell from 6.1 to 2.47 in just 20 years between 1965-70 and 1985-90. Kenya's total fertility rate dropped from 8.1 in 1975-80 to 4.4 in 1995-2000. Iran, under a traditional Islamic regime, saw fertility fall from 6.8 in 1980-85 to 2.8 in 1995-2000. These drops are among the fastest ever seen in any country on Earth.

Again, it used to be thought that poverty kept fertility rates high. Yet Bangladesh managed to reduce fertility from 6.44 in 1980-85 to 3.1 just 15 years later, even while infant and child mortality and female illiteracy all remained high.

These success stories all rely on the widespread availability of a choice of family planning methods and usually on improved reproductive rights, female education and health. They contrast markedly with countries from the same regions such as Malawi, Iraq and Pakistan (see page 15).

POPULATION GROWTH RATES, 1990-95



More than 3.5% population doubles in less than 20 years

2.5-3.5% population doubles in 20-30 years

1.44-2.5% population doubles in 30-50 years

0-1.44% population doubles in 50 years or more

–2-0% population could halve in around 35 years

Less than -2%

The map shows annual population growth rates between 1990 and 1995, by census district. These districts vary considerably in size both within and between countries, with sparsely populated districts often being very much larger. Large thinly populated areas with high growth rates can therefore appear more prominent than smaller heavily populated areas with low growth rates, although the increase in actual numbers in the latter will be greater. The world average population growth rate at the end of the 20th century was 1.44%.

THREE VIEWS OF POPULATION GROWTH

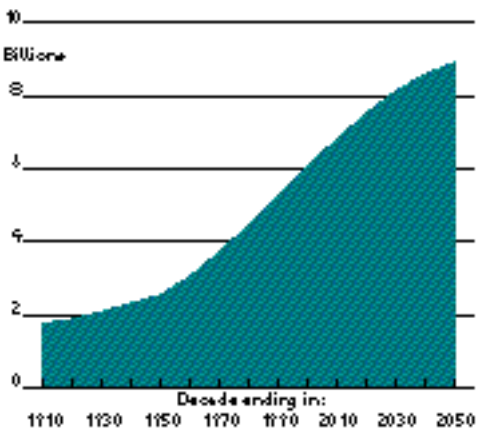
How current population growth is perceived depends very much on the data you look at. Popular approaches concentrate on total numbers (chart 1), which are important for our overall impact. These show a curve getting steeper from 1950 onwards, beginning to level out in 2050. We are currently on the steep section.

Annual additions (chart 2) are important as they show the total numbers of new human beings the planet must provide with resources each year. These passed their peak more than a decade ago, at 86 million a year in the latter half of the 1980s. Currently they are running at some 75 million a year.

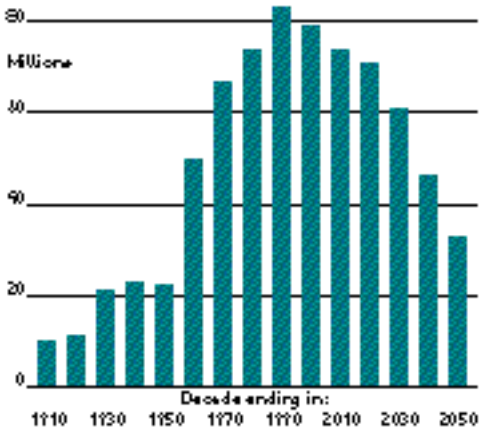
Population growth rates (chart 3) – which determine the rate at which we must adapt our technology and institutions to avoid increasing environmental damage – hit their highest 35 years ago, between 1965 and 1970, at 2.1 percent a year. In the current decennium they are projected to average only 1.2 percent a year.

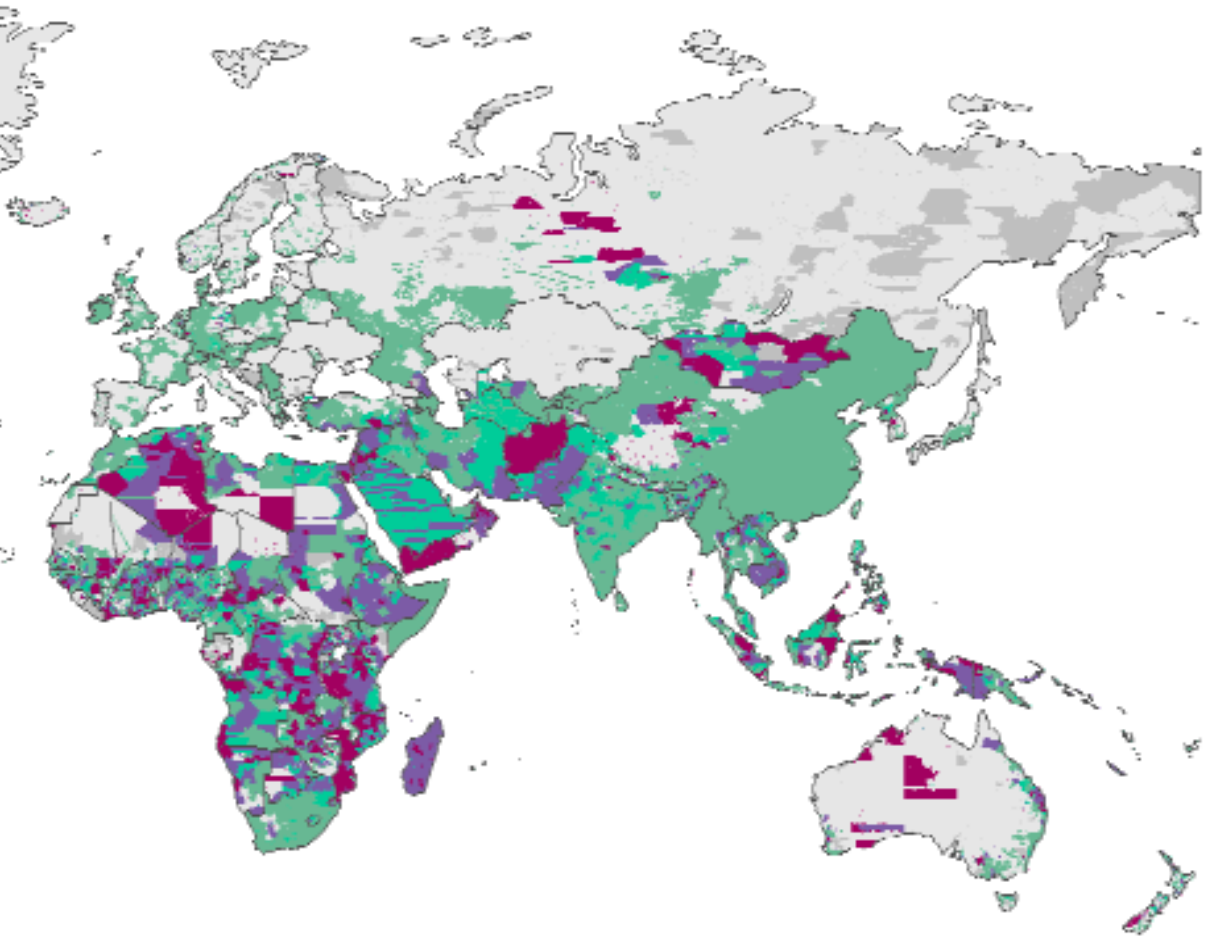
Source:UNPD.

1. Total numbers



2. Annual additions

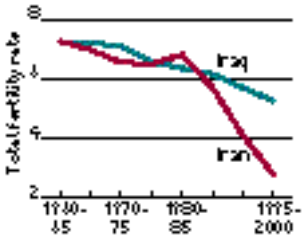


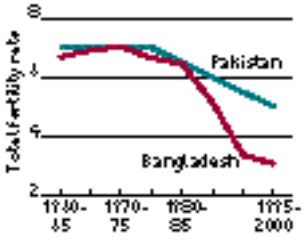


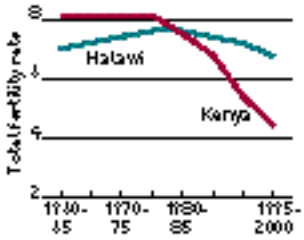
Source: CIESIN.

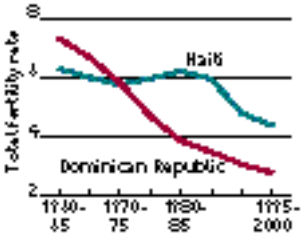
CONTRASTING FERTILITY

Many countries have seen steep declines in total fertility rates due to serious efforts to ensure access to family planning and other reproductive rights, usually, but not always, along with improvements in mother and child health and female education. Meanwhile other countries in the same region which did not make similar efforts have seen their fertility remain high.



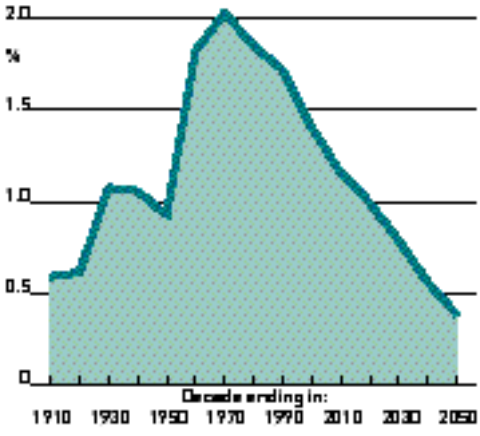




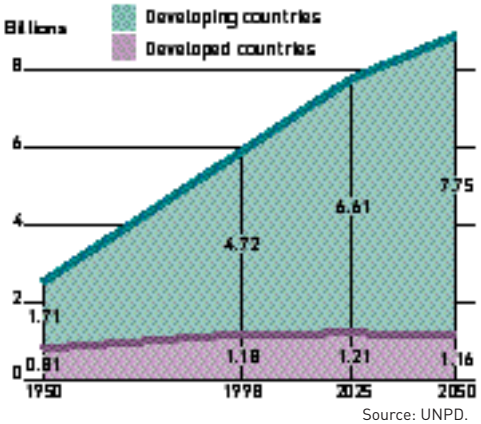


Source: UNPD.

3. Growth rates



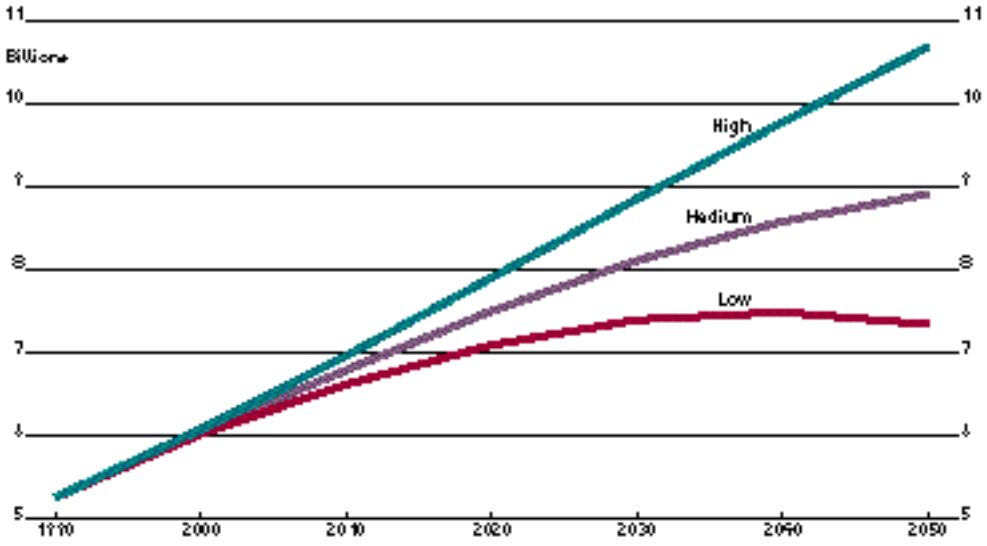
WORLD POPULATION GROWTH



Source: UNPD.

The 1998 projections from the United Nations Population Division trace three paths, largely depending on how fertility changes. The medium projection assumes that countries with fertility above 2.1 will not fall below that level, and countries with current fertility below 1.6 will rise again to between 1.6 and 1.9. The low projection allows fertility to fall more rapidly, to a floor of 1.6 in most countries, and to remain below that level where it is already below. The high projection assumes eventual stable fertility levels of 2.1 to 2.6 in all countries.

POPULATION PROJECTIONS



Source: UNPD.

fertility, in so many culture areas, in so many different stages of the economic cycle, that demographers are beginning to believe it may be more than a temporary blip[7]. Surveys in these countries still show that people typically want to have two children, but many pressures prevent them from achieving their goals. They include rising women's employment, rising age at marriage and at first birth, rising rates of divorce and single parenthood, and infertility. Cultural shifts in most developed countries have removed the pressure on people to have marriages for show, and couples in most Western countries can now choose to remain childless without suffering social stigma.

The Population Division's medium projection assumes that countries with low present fertility will see it rise again to between 1.6 and 1.9 and remain there. In countries with fertility currently above 2.1, the assumption is that it will decline towards replacement level (2.1) and remain there.

But as we get further into the next century, this looks more like guesswork than any previous projection. From 2010 onwards, more and more rows in the tables of projected fertility rates fill up with unchanging entries of "stable" fertility levels, in some cases stretching for 40 years up to 2050. Of course some assumption about fertility has to be made, or projection is impossible. It is certain that the reality will be different, but not certain in what direction it may be different.

Most discussions of future populations refer to a time of stabilization or levelling off. But human population has never remained stable in the past, and there is no strong reason to assume it will do so in the future. It is possible that in many more countries fertility rates will in fact fall below 2.1. The Population Division's low projection assumes that fertility will remain low where it is currently low, and in other regions will drop to 1.6. In this case, world population would peak around 2040 at 7.5 billion and would then begin to drop. The long-range low projection, based on 1996 figures, had world population falling further to 5.6 billion in 2100 and 3.55 billion another 50 years later[8].

This scenario is not very probable in the shorter term, because it assumes rapid drops in fertility everywhere in the next couple of decades. But if present success in ensuring reproductive rights continues, and if women everywhere follow the pattern of today's developed countries, it is quite possible that world population may peak at 8 or 9 billion around the middle of the next century and then begin to fall.

It is unlikely but not impossible – for example in a world of constant warfare, insecurity, and deteriorating health and women's rights – that fertility might stick higher, at 2.1 to 2.6. In that case population would continue to rise. The high projection reaches 10.7 billion in 2050 and over 18 billion a century later.

POPULATION DISTRIBUTION

Population distribution in space has a significant impact on the environment by way of population density. The impact of a given number of people may be very different, depending on whether they are focused in a smaller or larger area.

Population distribution is affected partly by different fertility rates in different areas (cities tend to have lower fertility rates than rural areas) and partly by migration.

Most migration occurs within national boundaries. Some of it is forced, by warfare or by severe environmental degradation. The United Nations High Commissioner for Refugees estimates that the number of people internally displaced just by conflict is around 20 to 25 million, with up to 16 million of these in Africa and 6 or 7 million in Asia. Much larger numbers may be environmental refugees, forced to migrate because their home area cannot provide land or work[9].

In conflict situations internal migration may be from one rural area to another. When large numbers move, this can have disastrous environmental consequences. In the exodus from Rwanda into Zaire in the mid-1990s, massive numbers of people were concentrated in small areas, forcing them to plunder forests and local wildlife for food, fuel and shelter.

Slower environmental change or population pressure can also produce rural-to-rural flows. In the Sahel people from the more densely populated semi-arid areas have shifted towards the more humid south, where they have increased rates of land clearance and deforestation. They have also extended northwards into even more arid zones not suitable for rainfed agriculture, leading to accelerated soil degradation.

More commonly, migration occurs from rural areas to urban, as people move in search of better incomes and opportunities, or are driven by the lack of opportunities in their home area. Over the past half century there has been a dramatic shift in the distribution of the world's population towards towns and cities. In 1950 only 29 percent of the world's people lived in urban areas. At the end of the 20th century the proportion was 47 percent, expected to rise to 61 percent by the year 2030. At the turn of the century, urban areas are growing at an average 2.2 percent a year, while rural areas are growing at only 0.4 percent. Approximately half of urban growth is fuelled by migration from rural areas[10].

Some experts believe that urbanization is not all bad for the environment. The shift of populations from rural to urban helps to reduce the pressure of land clearance on forests and other natural habitats. Urban women also tend to have fewer children than rural women. On the other hand, urbanization in developing countries has tended to increase energy use and carbon dioxide (CO_2) output. People shift from fuelwood to fossil fuels, and food and other needs must be transported over bigger and bigger distances. Urbanization covers large areas with impervious surfaces such as tarmac and concrete, which increases runoff.

Rapid urban growth can also bring environmental problems for cities themselves. With many cities growing at 4 to 5 percent a year, provision of clean water, sewage, electricity and roads can rarely keep up with population growth.

Lack of sewage treatment leads to water pollution, eutrophication and loss of biodiversity in rivers and around outlets. Water demand may lower river and groundwater levels. As industry and traffic grow, there is an initial rise in urban air pollution, which affects human health and natural habitats around the cities. As incomes grow and with them concern about environmental standards, however, local air and water quality tend to improve as a result of political pressure[11].

International migration also has environmental impacts. After a seemingly inexorable rise in refugees worldwide up to the early 1990s, the end of the Cold War has seen a considerable drop in cross-border refugees, with millions being repatriated to Afghanistan, Cambodia, Ethiopia and other "hotspots". Total refugee numbers dropped from 18.2 million in 1993 to 13.2 million in 1997[12].

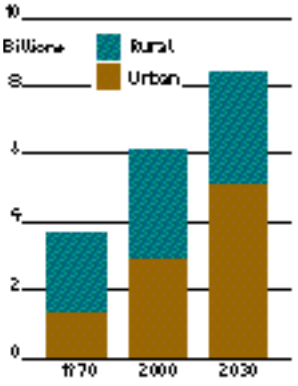
But overall international migration has increased steeply in recent decades. In 1965 an estimated 75 million people were not living in their home countries. By 1990 this had risen to 120 million. The majority of these were in developing countries, but migration from developing to developed countries was growing faster than other flows, especially into North America and Oceania[13].

Water for urban dwellers

The International Decade for Drinking Water Supply and Sanitation (1980-90) saw massive efforts to extend services, and registered impressive achievements. In urban areas, the numbers with access to clean water rose from 701 million in 1980 to 1.128 billion in 1990. The numbers with safe sanitation also grew by 425 million[14].

But the pace of population growth meant that the numbers of people without coverage also grew, especially in Africa and Asia. In urban Africa the numbers without clean water grew from 28 million to 31 million, and those without safe sanitation from 38 million to 47 million[15].

AN URBAN WORLD



Source: UNPD.

The world is becoming increasingly urbanized, rising from 37 percent urban in 1970 to a projected 61 percent in 2030. Urban areas will see 95 percent of population growth between 1996 and 2030.

Migration from poorer developing to richer developed countries can increase the consumption levels of individual families. However, families adjust to the fertility level of their new host country, and have fewer children than they would have had in their home country.

Tourism can be seen as a temporary form of migration that has environmental impacts through coastal development, increased air flights, pressure on coral reefs, national parks and so on. In the decade from 1988, international tourist arrivals grew at an average 3.7 percent a year, reaching 625 million in 1998. The World Tourism Organization expects this figure to rise to 1.6 billion by 2020[16].

POPULATION COMPOSITION

Population composition – its makeup in terms of age, sex, marital status and so on – is another important demographic factor that affects human impact on the environment, mainly through its effects on consumption.

The most dramatic change in composition is the ageing of the world population. Age distribution can be represented as a building, with each storey representing a five or ten year age group, and the width of each storey determined by the numbers of people in that age group.

In developing countries with high fertility the building looks like a pyramid, with wide floors at the lower, younger levels. As you move upwards into older age groups, each storey gets narrower. In developed countries the shape is more like a bulging urn, with more people in middle age groups than young or old. In the future, in countries where fertility is already low, the shape will be more like that of a skyscraper with a wide upper storey representing the over-80s. As countries develop, their age distribution will come to resemble that of the West.

The UN's medium population projection assumes that life expectancy will continue to advance, reaching an average 81.2 years in developed countries and 75.5 in developing ones by the year 2050. In developed countries today, there is roughly the same number of under-15s as over-60s. By the middle of the century the over-60s will make up 33 percent of the population and will outnumber the under-15s by more than two to one[17]. There will be a dramatic "population explosion" of elderly folk: while the total population is projected to increase by only 40 percent between 2000 and 2050, the numbers of over-60s will rocket by 232 percent[18].

Ageing has consequences for the environment. On average, over-60s consume more per person than under-15s, so the shift is likely to increase average consumption per person. On the other hand, the increasing burden of supporting older dependents and the shortage of young entrants to the labor force may depress economic growth and reduce consumption.

ENVIRONMENTAL IMPACTS ON HUMAN DEMOGRAPHICS

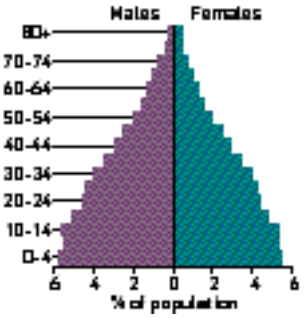
In the past the changes we wrought on the environment typically worked to reduce mortality and increase population growth. But many current changes may raise morbidity and mortality. Antibiotics, for example, lowered mortality rates, but there is concern that the spread of antibiotic-resistent bacteria may reverse this trend. Fertilizer use made great headway in providing sufficiently nutritious diets to lower mortality levels, but the environmental degradation resulting from overuse is deteriorating water quality and so raising mortality levels.

Burning fossil fuels originally enabled a rapid growth in incomes, which improved nutrition, reduced mortality and accelerated population growth. But excess use of fossil fuels is driving global warming, which may increase mortality by enlarging the zones susceptible to warm-climate diseases, and increasing the frequency of heatwaves, storms and flooding. Rising sea levels could lower the productivity of soils in certain areas and lead to increased malnutrition.

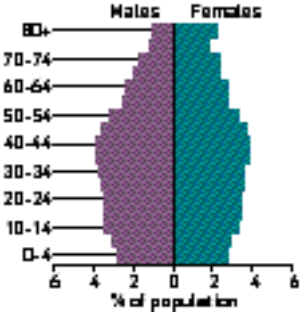
CONSUMPTION

The human demand for resources at any given level of technology is always the result of population multiplied by consumption, and in many fields, consumption has grown more rapidly than population. Between 1980 and 1996, for example, the number of cars in the world increased from 320 million to 496 million[19], an annual growth rate of 2.8 percent. Of this, the growth in car ownership

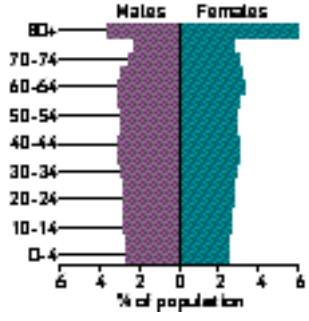
THE AGEING POPULATION
Developing countries, 2000



Developed countries, 2000



Developed countries, 2050



Source: US Bureau of the Census.

per person accounted for 43 percent and population growth for 57 percent. Over this same period the number of television sets in the world grew from 561 million to 1.361 billion[20] – an average of 5.7 percent per year. Of this, the increase in television ownership levels accounted for 70 percent, and population growth for only 30 percent.

As population growth is slowing, consumption growth is emerging as the dominant factor increasing our pressure on the environment. Currently, world population is rising at around 1.2 percent per year. Between 1965 and 1997, average world income per person grew at an average 1.4 percent a year[21]. If economic growth continues this long-term trend, then consumption growth is already a larger factor than population growth in our rising demand.

In the future the role of consumption will become more significant, as in all probability population growth will slow to a halt some time around the middle of this century. This also highlights one of the limitations of the IPAT model. This, and many other population-environment models, assumes that population means an aggregate of individuals. MacKellar et al., and Lutz, show how important alternative views can be[22]. If we count population as households rather than as individuals, the impact of population on CO_2 emissions in the developed world is much greater. This is quite reasonable, since numbers of households in the developed world, unlike those in the less developed world, are growing more rapidly than population, and it is often households rather than individuals that are the real units of consumption. Moreover, Lutz has shown that disaggregating population by age, sex, education and labor-force participation provides a far better picture of population than if we view it as a simple aggregate of undifferentiated individuals. In Lutz's view, people are not merely consumers; they are also producers, and their differences in skill level indicate differences in efficiency and productivity.

Most people's underlying family size desires moderate as countries develop: on average they aspire to replace themselves, no more, and in many cases constraints prevent them even from achieving that. But consumption ambitions are not so moderate. There is a constant increase in expectations as families find that having two or more of everything is more convenient than squabbling over one: two bathrooms, two televisions, two cars, two homes. Increasingly, better-off families with older children may have one car per person.

Yesterday's luxuries become today's necessities. In the 1970s a United States survey asked people what elements were necessary for a good life: 19 percent mentioned a vacation home and 26 percent home air-conditioning. When the same question was put two decades later, the proportions saying they needed these items had almost doubled[23].

HOUSEHOLD SIZE AND THE ENVIRONMENT

The average household size in developed countries fell from around 3.6 in 1950 to 2.7 in 1990. This rapid decline can largely be accounted for by ageing, rising divorce rates, rising age at marriage and increasing childlessness.

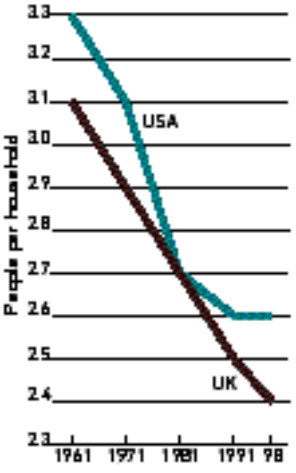
Household size in developing countries that still had high fertility actually increased over this period – but in the majority of countries, where fertility dropped, it declined. Since more and more countries now come into the latter category, household size can be expected to decline in developing countries too[24].

Generally, smaller households have higher consumption per person. This happens because each household usually has a dwelling unit with its own heating and lighting, and all basic consumer items from televisions and refrigerators to cars.

A survey in the United States found that one-person households spent an average of US$774 on residential energy, while the increase for each additional person above two in the household was only US$120 to US$160.

A study by the International Institute for Applied Systems Analysis found that between 1970 and 1990, the growth in the number of households in developed regions had more than double the impact on growth in CO_2 emissions than did the growth in population numbers[25].

HOUSEHOLD SIZE



Source: US Bureau of the Census; STATBASE.

Moreover, consumption is not just pursued for need or even convenience. It is an arena where people express social status and power, and for these purposes consumption appears to have no practical upper limit.

TECHNOLOGY

Population and consumption taken together determine the level of human demand for resources, but the way in which demand is satisfied – the chosen technology – is also crucial. It is possible to satisfy demand through sustainable technologies, such as solar power, or through unsustainable ones like burning fossil fuels.

As a general rule almost all technologies that were sustainable when first introduced became unsustainable as human population densities and consumption levels increased. We are currently engaged in a race with time and with our own limitations to find and adopt technologies that can sustain up to 9 or 10 billion humans on a finite planet with sensitive ecosystems.

POPULATION CARRYING CAPACITY

Carrying capacity is a term derived from ecology and range management, where it means the maximum number of animals of a species that a habitat can support indefinitely – that is, without degrading the resource base.

It has been tempting to try to sum up the population-environment nexus by applying this to humans, and there have been many attempts to calculate the Earth's carrying capacity for human populations. The first two estimates, dating from the late 17th century, were surprisingly close to the central range of modern projections: 6 to 12 billion (Gregory King) and 13.4 billion (Leeuwenhook). Some science fiction estimates, based on capturing the total energy flow from the sun, have been as high as a billion billion[26].

More serious recent estimates range from David Pimentel's 1 to 2 billion people in relative prosperity, to the Food and Agriculture Organization's estimate of 33 billion people fed on minimum rations and using every available hectare of suitable land for high-intensity food production[27].

It is not the number of people that makes a difference to the environment: it is our total burden of resource use and waste output. It is possible, useful and necessary to specify the maximum sustainable burden beyond which a given resource will degrade or become unstable, in specific fields. It can be done item by item, say, for ocean fish (where we are near to the maximum) or CO_2 emissions (where we have exceeded it). But there is no way to aggregate these different limits into one overall global figure.

We could adopt the law formulated by German chemist Justus von Liebig, that the population of a species is constrained by whatever survival resource is in shortest supply. However, this is very difficult in the case of humans, because we are such consummate resource-shifters.

Even if this could be done, because the total burden is the product of population, consumption and technology combined, it is not possible to single out the population element separately. A huge range of combinations of population, consumption and technology levels would produce the same range of impact. For every population estimate you would need to specify the consumption level and the technology involved.

Given the complex reality of population-environment interactions, estimating the Earth's carrying capacity for human populations is a forlorn task. We have no choice but to look individually at each area of our resource use and waste output, and at the impact these are having on the planet's diverse ecosystems.