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Population Growth and the Coastal Ocean

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Growth of World Population

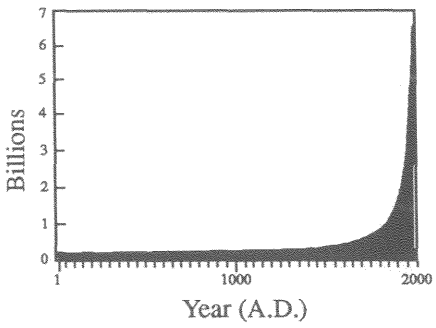

Figure 1

In this Bulletin, we examine the growth of human population since the appearance of *Homo erectus* more than 1.5 million years ago. We discuss future predictions of population growth and implications for planet Earth, particularly for the Earth's coastal oceans.

POPULATION GROWTH FROM EARLY HUMANS

The first record of upright (bipedal) animals that closely resembled modern humans can be traced back to about 1.5 million years ago. The number of humans increased relatively slowly for most of this time, but over the past several hundred years, has grown very rapidly. This rapid increase, called a "population explosion," has occurred partly because of major advances in the control of disease and partly because of expanded food supplies, both the result of technological advances.

In the year 1 A.D., the world population was roughly 250 million. By 1850 A.D., it had increased to nearly 1 billion—a fourfold increase in 1,850 years. By 1950 it had increased to 2.5 billion, and between 1950 and 1987, the global population doubled from 2.5 to 5 billion (Figure 1). This increase—a doubling—in a period of less than 40 years, equalled the total increase in the world's population from the time the human species first emerged until the middle of this century.

Of the 5.3 billion people who now inhabit the Earth, over 40% are under the age of 15. The stage is thus set for a continued mushrooming of the world's population. According to the Population Reference Bureau, the current net rate of increase of the world's population—the birth rate minus the death rate—is more than 10,000 people per hour.

TODAY'S POPULATION

The world's population growth rate accelerated in the 1950s and 1960s to peak at slightly more than 2% a year from 1965 to 1970. By 1975 the rate of the world's population growth had slowed to about 1.7% per year and has held near that level ever since.

Although the population growth rate, expressed as *the percent increase per year*, has fallen from its 1965-70 peak, the net annual increase in the world's population—the absolute number of additional people per year—has continued to rise because of the continued growth in the population base. In other words, even though the percentage increase has declined, because it is taken on a larger base, the world's population continues to grow and is expected to reach about 97 million per year during the last years of this century.

Most countries in the world are expected to grow more slowly in the

The Ten Most Populous Countries in the World

Country	1988 Population (in Millions)
1. China	1,104.00
2. India	796.60
3. USSR	283.60
4. USA	246.33
5. Indonesia	174.95
6. Brazil	144.43
7. Japan	122.61
8. Pakistan	105.41
9. Nigeria	104.96
10. Bangladesh	104.53

Table 1

The Ten Fastest Growing Countries

Country	% Average Annual Population Increase 1983-1988
1. Macao	5.9
2. Burkina Faso	5.9
3. Saudi Arabia	5.6
4. Kenya	4.9
5. Bahrain	4.8
6. Kuwait	4.5
7. Côte D'Ivoire	4.5
8. United Arab Emirates	4.4
9. Liberia	4.2
10. Qatar	4.1

Table 2

Population of OECD Countries

Country	1988 Population (in Millions)
1. Australia	16.53
2. Austria	7.60
3. Belgium	9.92
4. Canada	25.95
5. Denmark	5.13
6. Finland	4.95
7. France	55.87
8. FRG	61.20
9. Greece	10.01
10. Iceland	0.25
11. Ireland	3.54
12. Italy	57.44
13. Japan	122.61
14. Luxembourg	0.37
15. Netherlands	14.76
16. New Zealand	3.29
17. Norway	4.20
18. Portugal	10.41
19. Spain	39.05
20. Sweden	8.44
21. Switzerland	6.62
22. Turkey	52.42
23. UK	57.08
24. USA	246.33
TOTAL	823.97

Table 3

next 20 years than during the past 10, because of wider availability of contraceptives, development of new, easier methods of contraception, and increased acceptance of limiting family size. But there are exceptions. Afghanistan, Bangladesh, and several African countries face a population doubling by the year 2010. In the next 20 years, the Philippines will increase from 59 to 92 million; Iran from 53 to 95 million; Mexico from 83 to 125 million; and Brazil from 144 to 207 million. The 10 most populous countries are listed in Table 1, and the 10 countries with the fastest growing populations are listed in Table 2.

Some of the world's highest population growth rates are found in Middle Eastern countries, including Saudi Arabia, Bahrain, Kuwait and the United Arab Emirates. This is due partly to the large numbers of immigrants lured by the region's oil wealth. But the wealth from oil has also brought up the level of health care in these countries, resulting in higher birth rates, lower infant mortality rates, and declining death rates because of longer life spans. The recent war in the Persian Gulf may affect the population growth rate, as immigration slows. A number of African countries—Burkina Faso, Ivory Coast, and Kenya—are not far behind the Middle East. Their population growth rates are out-running the growth rates of their economies.

Most of the world's developed countries belong to the Organization for Economic and Cooperative Development (OECD). Their populations are listed in Table 3. Except for Turkey and Australia, all OECD countries and Eastern European countries had low population growth rates during the 1980s. Over the next 20 years, the populations of many of these countries will barely rise, according to the OECD.

Somewhat faster growth rates characterize Asian countries, although the low overall figure for the Asian Planned Economies (Burma, Cambodia, China, North Korea, Laos, Mongolia, and Vietnam) is heavily influenced by China's efforts to keep its vast population under control. Since the 1980s, China has managed to maintain a relatively slow growth rate of 1.3%. But even if, as projected, China will maintain a 1.3% growth rate over the next decade, it would still take about 50 years to be able to detect a *decrease* in growth.

Cartoon by John Winsch

Countries with the Highest Percent of their Populations Living in Urban Areas

Country	% Population Living in Urban Areas
1. Macao	100.0
2. Singapore	100.0
3. Belgium	96.3
4. Kuwait	93.7
5. Hong Kong	92.4
6. United Kingdom	91.7
7. Israel	90.3
8. Iceland	89.4
9. Netherlands	88.4
10. Qatar	88.0

Table 4

Countries with the Highest Population Densities

Country	Number of People per square mile
1. Macao	66,365
2. Hong Kong	13,611
3. Singapore	10,995
4. Bermuda	2,903
5. Malta	2,759
6. Bangladesh	1,861
7. Bahrain	1,781
8. Mauritius	1,516
9. Barbados	1,487
10. Taiwan	1,417

Table 5

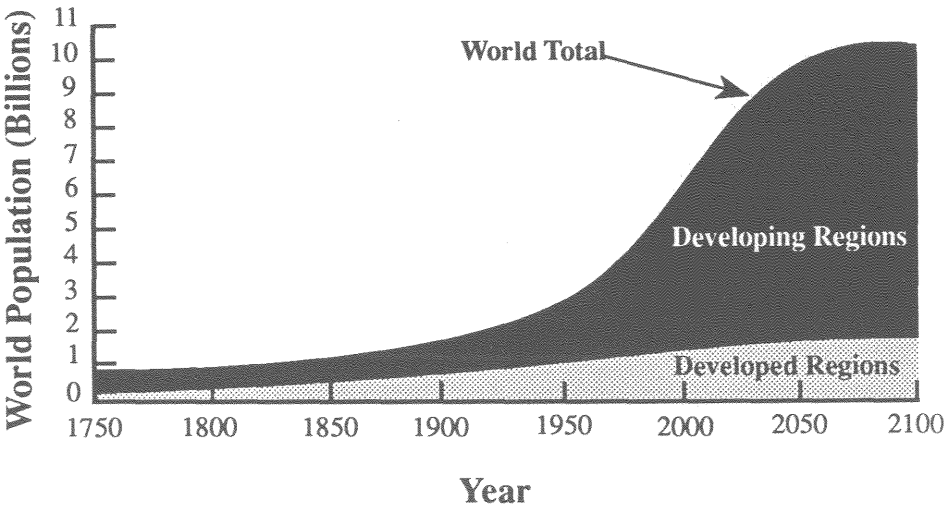

Figure 2

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Growth rates in many Latin American countries are also slowing substantially, although some, as well as many other developing countries, are still experiencing a lack of or antipathy to family planning programs.

Many cultures of the developing world maintain long-held traditions of having large families. These traditions are based on multiple reasons, one of which is economic, for example, the need for many hands to carry out family farming or other labor-intensive livelihoods where machinery and equipment do not exist. According to the National Academy of Sciences in their book, "One Earth, One Future: Our Changing Global Environment," when countries experience economic development, including employment and education opportunities, they also experience lower birth rates. The most developed countries (the U.S., most Europen countries, Canada, and the U.K., for example) have shown the most success with family planning.

Because the population growth rate is higher in developing countries than in developed countries, there has been a steady drop in the percentage of the total population accounted for by developed countries (Figure 2). The United Nations has estimated that by the year 2055, the world's population will increase to 8.5 billion —a 60% increase over the present population—before stabilizing at over 10 billion at the end of the coming century. Ninety-five percent of this increase will occur in developing countries.

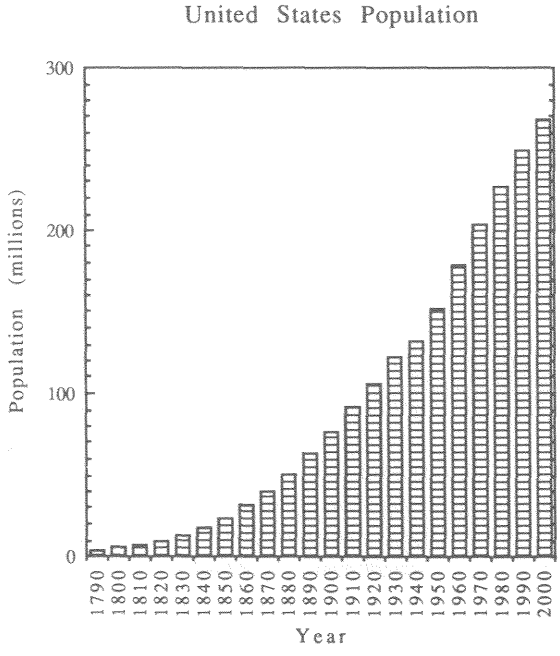

Figure 3

POPULATION DENSITY

Two other important measures of a country's population are the percent of the total population that lives in urban areas and the population density—the number of people per unit area (per square mile or per square kilometer). The 10 countries with the highest percentage of people living in urban areas are listed in Table 4. The 10 countries with the highest population densities are listed in Table 5.

TRENDS IN U.S. URBANIZATION

The growth in population of the United States from 1790 to 1990 is plotted in Figure 3. The U.S. population increased relatively rapidly from 1950 to 1970, but the growth rate now is beginning to flatten out. Although

Coastal development

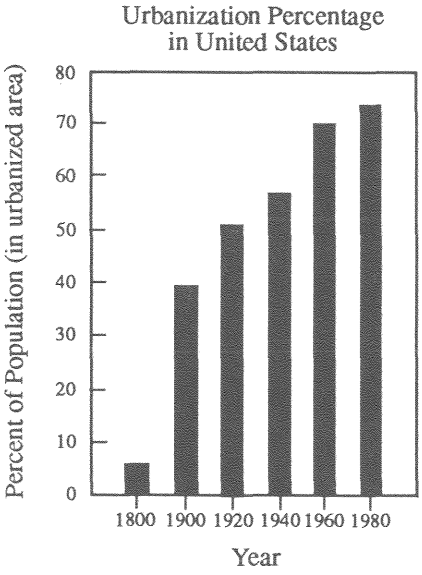

Figure 4

the U.S. is not expected to have a rate of population growth as high as many other regions of the world, the steady increase that will occur will be significant and will pose major challenges to the environment and to those who must plan for the delivery of public and social services.

It is not just the total population that must be considered, but how that population is distributed. Because of the special problems associated with densely populated regions, particularly with densely populated coastal regions, it is instructive to examine the trends in U.S. urbanization.

An increasing number of our citizens are leaving rural settings in favor of urban centers (Figure 4). In 1840 nearly 90% of the U.S. population lived on farms. By 1880, 28% lived in cities of over 8,000 people. Today more than 75% live in "urban areas." An urban area is defined by the U.S. Bureau of the Census as a central city and surrounding suburbs with a population of 50,000 or more. According to the 1990 census, even larger "metropolitan areas," (those with populations numbering one million or more) are home to the majority of Americans (50%), as compared to 1980, when 46% of Americans lived in metropolitan areas.

CLUSTERING AT THE COASTS

Even our urban and metropolitan clusters are not distributed uniformly throughout the country. They tend to be concentrated along the coastal margins (Figure 5). According to the U.S. Bureau of the Census, in 1988, 53% of the residents of the U.S. lived within 50 miles of the coasts of the oceans and Great Lakes. From 1960 to 2010, the U.S. population is projected to increase the most in coastal states—a pattern that has persisted for the past 30 years. Seventeen of the 20 states with the greatest statewide population increases are coastal states. Clearly, the population of the U.S. is growing and moving toward the continent's margins. And even there people are not uniformly distributed—they cluster along our estuaries.

The 1960s was the decade of maximum growth in coastal population. During the 1960s, coastal population increased by more than 13 million with California, Florida, and New York accounting for about 58% of the total increase. In New York, most of the increase occured on Long Island. As population in coastal areas increases, the stresses on our coastal environments increase.

In the U.S., between 1954 and 1980, the number of people living in counties directly adjacent to marine waters almost doubled and is continuing to increase. By the year 2010 the U.S. coastal population is expected to have grown from 80 million to more than 127 million—an increase of almost 60% nationwide, enough to populate 16 Long Islands.

The Northeast and Pacific regions have the largest coastal populations of the five coastal regions of the U.S. (Northeast, Southeast, Gulf of Mexico, Pacific, and Great Lakes). Together they account for 28% of the entire U.S. population. Coastal population will continue to grow over the next two decades, but more slowly than in the past several decades. This general slowing of growth will characterize the nation as a whole, and coastal areas will continue to grow more rapidly than non-coastal areas.

REGIONAL TRENDS IN CLUSTERING

The Northeast U.S.

The Northeast region, which extends from Virginia to Maine, is the most populous of the five U.S. regions. It accounts for more than 16% of the nation's total population and more than 33% of the nation's coastal population. Six of the nation's seven leading states in coastal county population are in the Northeast region. The Northeast is also the most *densely populated* region in the U.S., with more than 750 people per square mile. Eighteen of the 25 most densely populated counties in the entire U.S. and nine of the top 10 are in the Northeast region. The tenth is

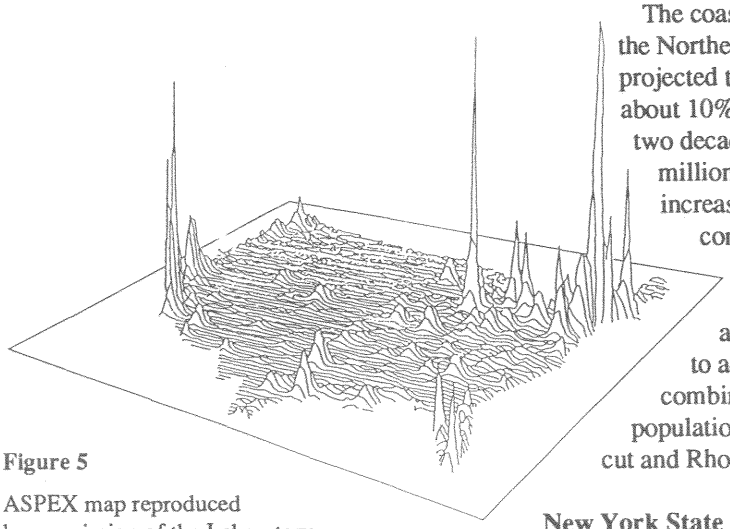

Figure 5

ASPEX map reproduced by permission of the Laboratory for Computer Graphics and Spatial Analysis, Harvard Graduate School of Design, Cambridge, MA.

San Francisco County, California.

The coastal population of the Northeast region is projected to increase by about 10% over the next two decades to almost 43 million in 2010. This increase, while modest compared to previous growth rates, is almost equivalent to adding the combined current populations of Connecticut and Rhode Island.

New York State

Seventy percent of New York State's total population lives in coastal counties. New York's coastal region has an average of 1,629 people per square mile, compared with 375 people per square mile for the state as a whole, and more than 6,700 people per linear mile of shoreline. The projected national average population density for the year 2010 is only about 80 people per square mile.

Metropolitan New York

As shown in the 1990 census, the New York metropolitan area remained the country's largest, with 18,087, 251 people. This is an increase of 3.1% from 1980.

"... in view of continuing growth of human populations, we fear that the marine environment could deteriorate significantly in the next decade unless strong coordinated national and international action is taken now."
— 1990 UN Report

IMPACTS OF POPULATION ON THE COASTAL OCEAN

More than half of the U.S. population and the world's population live in coastal regions. The impacts of society on the world ocean already are concentrated in coastal regions, particularly in bays and estuaries surrounded by large populations, and the impacts will continue to worsen. Much of the projected growth of the world's population will take place in coastal regions, most in developing countries.

A recent report (1990) by an advisory group to the United Nations concluded that the four greatest threats to the entire world ocean (not just the coastal ocean) in decreasing order of importance are (1) nutrient contamination; (2) microbial contamination of seafood; (3) disposal of debris, particularly plastics; and (4) occurrence of synthetic organic compounds in sediments and in predators at the top of the food web.

The UN report states that man's "fingerprints" are ubiquitous throughout the world ocean, but that the open ocean is still relatively clean, that the major problems are in coastal areas, and that actions should be taken now.

> "... in view of continuing growth of human populations, we fear that the marine environment could deteriorate significantly in the next decade unless strong coordinated national and international action is taken now."

The Executive Summary of the UN report closes with this observation:

> "In summary, at the end of the 1980s the major causes of concern in the marine environment on a global basis are coastal development and the attendant destruction of habitats, eutrophication, microbial contamination of seafood, fouling of seas by litter, continued build-up of chlorinated hydrocarbons, especially in the tropics and the sub-tropics, and accumulation of tar balls."

According to the UN, the most serious issue in coastal regions is contamination by nutrients, chiefly nitrogen, but sometimes also phosphorous. This is increasing, and areas of excessive nutrient enrichment are expanding, contributing to enhanced frequency and scale of unusual phytoplankton blooms, excessive seaweed growth, and problems of hypoxia (low dissolved oxygen) in coastal waters.

Where do Nutrients Come From?

The two major sources of nutrients are sewage and agricultural runoff — fertilizer from treated fields and intensive raising of livestock. Reducing these nutrient inputs will involve

large investments in sewage treatment plants and in sludge and effluent disposal, and major changes in agricultural practices. Lawn fertilizers, animal wastes, and the atmosphere also contribute nutrients to coastal waters.

CAUSES OF IMPAIRMENT OF ESTUARINE WATERS

Each year coastal states are required to report on the condition of their estuaries to the U.S. Environmental Protection Agency. In 1990, the 23 coastal states, jurisdictions, and interstate commissions reported to the E.P.A. the major causes of impairment of estuarine waters, such that they no longer support their designated activities. These were eutrophication (over enrichment by nutrients), which accounted for 80% of the total impaired area; high levels of bacteria, which accounted for 48% of the total impaired area; and low levels of dissolved oxygen (hypoxia), which accounted for 29% of the total impaired area[1].

The most extensive source of pollution cited by the states in their estuarine waters is municipal discharges, primarily sewage from sewage treatment plants, which affects 53% of the impaired area. This is a result of too many people clustering along our coastlines, discharging too many wastes— often improperly or incompletely treated— into our coastal waters. This is particularly true in our near-coastal waters: the estuaries, bays, lagoons, and other semi-enclosed coastal water bodies which are only slowly "flushed."

The impacts on the coastal ocean are more a function of what happens on the land than what happens at sea. The input of nutrients and contaminants and alterations in the input of freshwater are major contributors to coastal degradation[2].

[1] The total exceeds 100% because the effects of the three major sources of impairment are not independent.

[2] To be discussed in a future Bulletin on hypoxia.

THE OUTLOOK FOR THE FUTURE

It is clear that while every effort should be made to curb population growth, the Earth's population will continue to grow, at least over the next century. This growth will place increasing stress on the environment. Much of this stress will be in coastal areas where population growth rates and population densities will be highest. Most will occur in developing countries without the infrastructure and economic resources to implement environmental conservation strategies.

Coastal environments will be degraded and important habitats lost unless decisive actions are taken now. Degradation will not be restricted to the environment. Contamination of drinking water supplies and bathing and shellfishing areas by human wastes could lead to epidemics. Thus, governments in these threatened coastal areas, with the help of scientists and community leaders, should identify and take appropriate steps to minimize adverse impacts to the environment and to human health and welfare. If predictions—even the more conservative predictions—of the greenhouse effect and global change are correct, with the accompanying increased rate of sea level rise and frequency and severity of storms, there could be large losses of life in low-lying coastal areas such as Bangladesh. The recent cyclone there (May 1991) should leave little doubt about the potential casualties.

Access to the coast throughout the history of humans has been a right taken for granted. At one time, it was a necessity, to be able to take meals readily from bountiful coastal waters. Today, the extent of global coastal contamination may no longer permit taking for granted our right to populate the coast.■

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