POPULATION MATTERS
A RAND Program of Policy-Relevant Research Communication
Policy Brief

Population and Environment

A Complex Relationship

Between 1960 and 1999, Earth's population doubled from three billion to six billion people. In many ways, this reflected good news for humanity: child mortality rates plummeted, life expectancy increased, and people were on average healthier and better nourished than at any time in history. However, during the same period, changes in the global environment began to accelerate: pollution heightened, resource depletion continued, and the threat of rising sea levels increased. Does the simultaneous occurrence of population growth and environmental decline over the past century indicate that more people translate into greater environmental degradation?

In *The Environmental Implications of Population Dynamics*, Lori Hunter synthesizes current knowledge about the influence of population dynamics on the environment. Specifically, her report examines the following:

- The relationship between demographic factors—population size, distribution, and composition—and environmental change.
- The mediating factors that influence this relationship: technological, institutional, policy, and cultural forces.
- Two specific aspects of environmental change affected by population dynamics: climate change and land-use change.
- Implications for policy and further research.

Hunter concludes that population dynamics have important environmental implications but that the sheer size of population represents only one important variable in this complex relationship. Other demographic dynamics, including changes in population flows and densities, can also pose challenging environmental problems.

ENVIRONMENTAL IMPLICATIONS OF SPECIFIC POPULATION FACTORS

According to recent United Nations estimates, global population is increasing by approximately 80 million—the size of Germany—each year. Although fertility rates have declined in most areas of the world, population growth continues to be fueled by high levels of fertility, particularly in Asia and Africa. In numerous Middle Eastern and African nations, the average number of children a woman would be expected to have given current fertility levels remains above 6.0—for example, 6.4 in Saudi Arabia, 6.7 in Yemen, 6.9 in Uganda, and as high as 7.5 in Niger. Even in areas where fertility rates have declined to near replacement levels (2.1 children per couple), population continues to grow because of "population momentum," which occurs when a high proportion of the population is young.

Population Size

No simple relationship exists between population size and environmental change. However, as global population continues to grow, limits on such global resources as arable land, potable water, forests, and fisheries have come into sharper focus. In the second half of the twentieth century, decreasing farmland contributed to growing concern of the limits to global food production. Assuming constant rates of production, per capita land requirements for food production will near the limits of arable land over the course of the twenty-first century. Likewise, continued population growth occurs in the context of an accelerating demand for water: Global water consumption rose sixfold between 1900 and 1995, more than double the rate of population growth.

Population Distribution

The ways in which populations are distributed across the globe also affect the environment. Continued high fertility in many developing regions, coupled with low fertility in more-developed regions, means that 80 percent of the global population now lives in less-developed nations. Furthermore, human migration is at an all-time high: the net flow of international migrants is approximately 2 million to 4 million per year and, in 1996, 125 million people lived outside their country of birth. Much of this migration follows a rural-to-urban pattern, and, as a result, the

Earth's population is also increasingly urbanized. As recently as 1960, only one-third of the world's population lived in cities. By 1999, the percentage had increased to nearly half (47 percent). This trend is expected to continue well into the twenty-first century.

The distribution of people around the globe has three main implications for the environment. First, as less-developed regions cope with a growing share of population, pressures intensify on already dwindling resources within these areas. Second, migration shifts relative pressures exerted on local environments, easing the strain in some areas and increasing it in others. Finally, urbanization, particularly in less-developed regions, frequently outpaces the development of infrastructure and environmental regulations, often resulting in high levels of pollution.

Population Composition

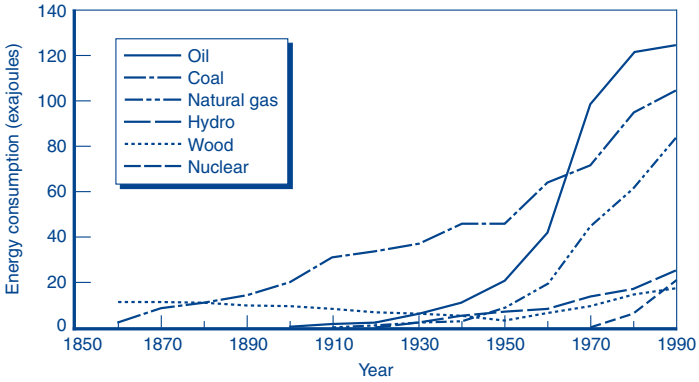
Composition can also have an effect on the environment because different population subgroups behave differently. For example, the global population has both the largest cohort of young people (age 24 and under) and the largest proportion of elderly in history. Migration propensities vary by age. Young people are more likely than their older counterparts to migrate, primarily as they leave the parental home in search of new opportunities. As a result, given the relatively large younger generation, we might anticipate increasing levels of migration and urbanization, and therefore, intensified urban environmental concerns.

Other aspects of population composition are also important: Income is especially relevant to environmental conditions. Across countries, the relationship between economic development and environmental pressure resembles an inverted U-shaped curve; nations with economies in the middle-development range are most likely to exert powerful pressures on the natural environment, mostly in the form of intensified resource consumption and the production of wastes. By contrast, the least-developed nations, because of low levels of industrial activity, are likely to exert relatively lower levels of environmental pressure. At highly advanced development stages, environmental pressures may subside because of improved technologies and energy efficiency.

Within countries and across households, however, the relationship between income and environmental pressure is different. Environmental pressures can be greatest at the lowest and highest income levels. Poverty can contribute to unsustainable levels of resource use as a means of meeting short-term subsistence needs. Furthermore, higher levels of income tend to correlate with disproportionate consumption of energy and production of waste.

MEDIATING FACTORS: TECHNOLOGY, POLICY CONTEXTS, AND CULTURAL FACTORS

Current technology, policies, and culture influence the relationship between human population dynamics and the natural environment. The technological changes that have most affected environmental conditions relate to energy use. The consumption of oil, natural gas, and coal increased dramatically during the twentieth century, as seen in Figure 1. Until about 1960, developed nations were responsible for most of this consumption. Since then, however, industrialization in the newly developing nations has resulted in greater reliance on resource-intensive and highly polluting production processes.



SOURCE: Weyant, John, and Yukio Yanigisawa, "Energy and Industry," in Steve Rayner and Elizabeth L. Malone, eds., *Human Choice & Climate Change*, Vol. 2, Columbus, Ohio: Battelle Press, 1998, p. 208.

Figure 1– World Energy Consumption, 1850–1990

Policy actions can ameliorate environmental decline—as in the case of emissions standards—or exacerbate degradationas in the case in Central Asia's Aral Sea basin, which has shrunk 40 percent since 1960 and has become increasingly contaminated, in large part because of the irrigation policies of the former Soviet Union.

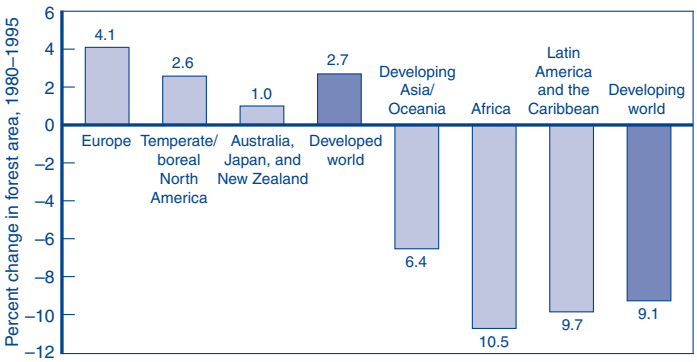
Cultural factors also influence how populations affect the environment. For example, cultural variations in attitudes toward wildlife and conservation influence environmental conservation strategies, because public support for various policy interventions will reflect societal values.

TWO SPECIFIC AREAS OF POPULATION-ENVIRONMENT INTERACTION: GLOBAL CLIMATE CHANGE AND LAND-USE PATTERNS

Two specific areas illustrate the challenges of understanding the complex influence of population dynamics on the environment: land-use patterns and global climate change.

Land Use

Fulfilling the resource requirements of a growing population ultimately requires some form of land-use change—to provide for the expansion of food production through forest clearing, to intensify production on already cultivated land, or to develop the infrastructure necessary to support increasing human numbers. During the past three centuries, the amount of Earth's cultivated land has grown by more than 450 percent, increasing from 2.65 million square kilometers to 15 million square kilometers. A related process, deforestation, is also critically apparent: A net decline in forest cover of 180 million acres took place during the 15-year interval 1980–1995, although changes in forest cover vary greatly across regions. Whereas developing countries experienced a net loss of 200 million acres, developed countries actually experienced a net increase, of 20 million acres (see Figure 2).



SOURCE: Food and Agricultural Organization (FAO), *The State of the World's Forests, 1999*, Rome, Italy: FAO, 1998.

NOTE: Data exclude the countries of the former Soviet Union.

Figure 2– Forest Area in 1995 Compared with 1980

These types of land-use changes have several ecological impacts. Converting land to agricultural use can lead to soil erosion, and the chemicals often used in fertilizers can also degrade soil. Deforestation is also associated with soil erosion and can lessen the ability of soil to hold water, thereby increasing the frequency and severity of floods. Human-induced changes in land use often result in habitat fragmentation and loss, the primary cause of species decline. In fact, if current rates of forest clearing continue, one-quarter of all species on Earth could be lost within the next 50 years.

Global Climate Change

Recent years have been among the warmest on record. Research suggests that temperatures have been influenced by growing concentrations of greenhouse gases, which absorb solar radiation and warm the atmosphere. Research also suggests that many changes in atmospheric gas are human-induced. The demographic influence appears primarily in three areas. First, contributions related to industrial production and energy consumption lead to carbon dioxide emissions from fossil fuel use; second, land-use changes, such as deforestation, affect the exchange of carbon dioxide between the Earth and the atmosphere; and third, some agricultural processes, such as paddy-rice cultivation and livestock production, are responsible for greenhouse gas releases into the atmosphere, especially methane. According to one estimate, population growth will account for 35 percent of the global increase in CO_2 emissions between 1985 and 2100 and 48 percent of the increase in developing nations during that period. As such, both attention to demographic issues and the development of sustainable production and consumption processes are central responses to the processes involved in global warming.

WHAT SHOULD POLICYMAKERS DO?

The policy implications of demographic influences on the environment are complicated and can sometimes be controversial. While some view large, rapidly growing populations in developing regions as the primary culprit in environmental decline, others focus on the costly environmental effects of overconsumption among the slowly increasing populations of the developed nations. These differing emphases naturally point to radically different solutions: slow population increase in less-developed nations or change destructive consumption and production patterns in the more-developed nations. This debate, however, presumes a one-step solution to the complex problems created by population pressures on the environment. Both population size and consumption influence environmental change and are among the many factors that need to be incorporated into realistic policy debate and prescriptions. Examples of policies that could address the environmental implications of demographic factors include policies to promote effective family planning, more effective rural development to slow migration to crowded urban centers, and incentives to encourage sustainable levels of consumption and the use of efficient, cleaner technologies.

WHAT SHOULD RESEARCHERS DO?

Disciplinary boundaries between social and natural scientists have hindered the study of the interrelationships between demographics and the environment. These barriers, however, are beginning to fall. The trend toward interdisciplinary environmental research must be encouraged, and researchers should continue to improve analytic approaches and collect new data that allow examination of the links between social and natural processes. The use of recent technology (e.g., satellite remote sensing) to study environmental change promises to contribute significantly to expanding knowledge in this area.

RAND policy briefs summarize research that has been more fully documented elsewhere. This policy brief describes work done for the Population Matters *project of RAND's Labor and Population Program and documented in* The Environmental Implications of Population Dynamics *by Lori Hunter, MR-1191-WFHF/DLPF/RF, 2000, 120 pp., ISBN: 0-8330-2901-0. Available free from* Population Matters. Population Matters *is sponsored by the William and Flora Hewlett Foundation, the David and Lucile Packard Foundation, and the Rockefeller Foundation.* Population Matters *publications and other project information are available at http://www.rand.org/popmatters. All RAND publications are available from RAND Distribution Services, P.O. Box 2138, Santa Monica, CA 90407-2138 (Telephone: 310-451-7002; FAX: 310-451-6915; email: order@rand.org; or the Web: http://www.rand.org/publications/ordering.html). RAND® is a registered trademark. RAND is a nonprofit institution that seeks to improve public policy through research and analysis; its publications do not necessarily reflect the opinions or policies of its research sponsors.*

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