Chapter Five

MEDIATING FACTORS: SCIENCE AND TECHNOLOGY, INSTITUTIONS AND POLICY, AND CULTURE

The previous chapters have reviewed several dimensions of the relationship between population and the environment, focusing on various demographic factors and offering examples of their relation to select aspects of the environment. The relationship between population and the environment is, however, even more complex than this focus would suggest. Aspects of society relating to technologies, institutions, and culture, alter the ways in which demographic and environmental factors interact. These “mediating factors” are reviewed here, with brief examples provided where useful. Again, the complexity of these relationships prohibits a comprehensive review in such limited space, so the following discussion is designed to illustrate the factors that shape the environmental implications of demographics.

SCIENTIFIC AND TECHNOLOGICAL FACTORS

Scientific and technological advancements have mediated the relationship between population and the environment since prehistoric time. The scope of their impacts can be demonstrated by four simple examples: the discovery of the usefulness of fire brought about more stable prehistoric societies; agricultural processes were greatly enhanced by the development of technology allowing the harnessing of draft animal energy; advancements allowing the use of wind for sea transport enabled new migration opportunities, and; technology harnessing the energy offered by coal and electricity allowed for the expansion of urban centers (Boserup, 1981; Colombo, 1996). In some cases, these scientific advancements and technological changes resulted in environmental modification beyond what would be anticipated stemming exclusively from demographic factors (e.g., the pace of land cover change was determined not only by population size, but also by agricultural technology). In other cases, these advancements allowed for shifts in the demographic factors that modified the environment (e.g., the scale of population redistribution afforded by advancements in travel).

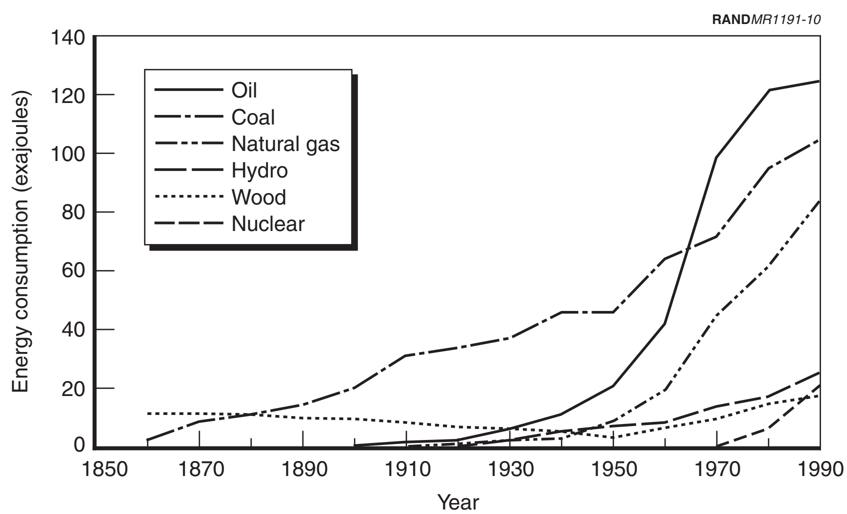
During the past 100 years, improvements in agricultural technology, such as mechanized cultivation, high-yield seed varieties, fertilizers, and pesticides, have increased the yield per acre by more than 100 percent (Rasmuson and Zetterstrom, 1992). These advancements enabled the sustenance of the world's growing population—a scenario not considered by Malthus (1798) in his predictions of widespread starvation. In fact, some argue that since humans bring about such innovation, population itself is not necessarily detrimental to the environment. Rather, humans may be the ultimate resource in coping with environmental change because greater numbers of people mean more creativity and innovation (Simon 1981, 1996).

Several studies support the perspective that high levels of demographic pressure may induce innovation or at least intensify the application of existing technologies. In northern Nigeria, population densities are high and the majority of land is already under cultivation. Those with small landholdings have made significant investments in land improvement through sustainable management of soil fertility and increased use of farm trees. In areas lacking intense population pressure, such innovations had not yet been adopted, suggesting that the resource pressure spurred changes in land management (Mortimore, 1993).[1] In another study conducted at the national level using data reflecting population and environmental conditions in 85 developing nations, a positive relationship was found between rural population growth and intensification of irrigation and fertilizer use (Bilsborrow, 1992).

[1]In this study of the association between demographic pressure and innovation (Mortimore 1993), causality is *inferred* as opposed to specifically tested.

The technological changes that have had the most effect on environmental conditions relate to the ways in which humans use energy. In fact, energy use is one of the primary links between population and the environment. Transitions in technologies related to energy represent an important aspect of the modernization process, as reflected in the change since 1850 in energy consumption (see Figure 5.1). In particular, the consumption of oil, coal, and natural gas has significantly increased during the past century.

Until about 1960, the developed nations were responsible for most of the increases in energy consumption. Prior to that time, consumption in the less-developed regions consisted of relatively small amounts of wood and traditional biomass materials such as cow dung (Weyant and Yanigisawa, 1998). Since the 1960s, however, many less-developed nations have experienced some level of industrial development, resulting in increased reliance on resource-intensive and highly polluting energy production processes. The People's Republic of China (PRC) provides an example of the links between population size, composition, and energy use. The PRC's population



SOURCE: Weyant and Yanigisawa, 1998, p. 208.

Figure 5.1—World Energy Consumption, 1850–1990

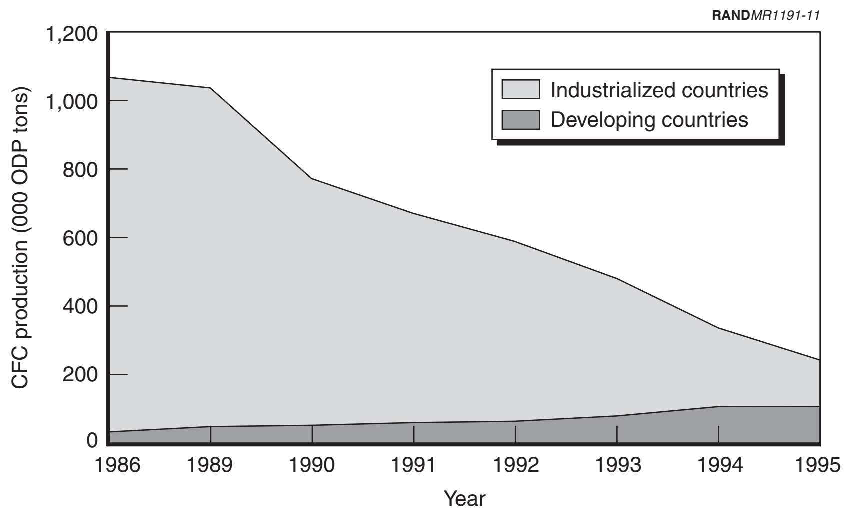
currently exceeds 1 billion, and as development proceeds, per capita income is expected to rise dramatically. Given the nation's large coal reserves and changing consumer aspirations arising from income increases, carbon emissions are expected to rise to the point that the PRC becomes the world's largest producer of emissions within the next 20–30 years (Weyant and Yanigisawa, 1998). Obviously, improved efficiencies in energy production could greatly diminish the environmental impact expected from the interaction between China's population size and changing consumption patterns.

INSTITUTIONAL FACTORS, THE POLICY CONTEXT

Institutional response represents a significant mechanism through which humans react to environmental change. In particular, policy plays a key role in determining the ultimate effect of humans on the environment. Following are four examples. The first represents a positive policy outcome operating at the global scale, and the other three demonstrate the potential negative effects of misguided policy.

Example 1, the Montreal Protocol of 1987

During the 1980s, evidence began to suggest that the Earth's protective atmospheric ozone layer was being significantly eroded. The ozone layer shields humans from potential eye damage and skin cancers caused by the sun's high-energy ultraviolet radiation. It also protects crops and livestock (Meyer, 1996). The primary culprit in ozone depletion appeared to be human-induced—the production of synthetic organic compounds, chlorofluorocarbons (CFCs), used in refrigeration, solvents, and propellants. Although ozone decline had human origins, the rate of ozone depletion was lessened during the 1990s, even in the face of continued world population increases. Here, the relationship between population and the environment was tempered by the ratification of the Montreal Protocol in 1987 (see Figure 5.2). As a result of aggressive campaigning by international nongovernmental organizations (NGOs), and political leadership from the United States, several European countries, and the United Nations Environment Program (UNEP), the unprecedented international agreement aimed to reduce and eventually eliminate the emissions of manufactured ozone-depleting substances (Jasanoff



NOTE: Ozone-depleting potential (ODP) tons is a measure by which ozone-depleting substances are weighted according to their ability to destroy ozone.
SOURCES: WRI, 1998, p. 1777; Oberthür, 1997, p. 30.

Figure 5.2—Annual Production of CFCs, 1986–1995

and Wynne, 1998). Under current agreements, CFC consumption has dropped more than 70 percent (WRI, 1998), with the ozone layer expected to return to normal by the middle of the next century (UNEP, 1998).

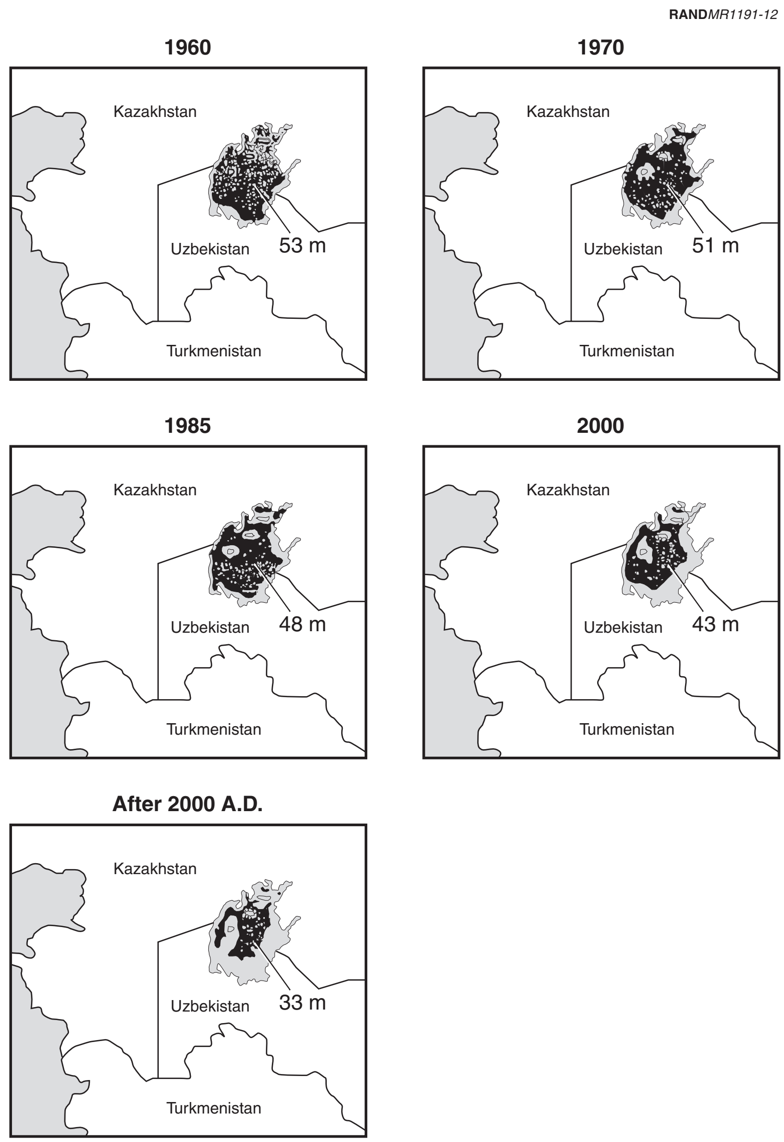
As demonstrated by this example, many factors have combined to determine the scale, scope, and intensity of ozone depletion. Yet demographic factors remain important. In particular, population influenced environmental conditions by providing a market for destructive technologies. To look at this relationship another way, the technology allowing CFC production operated as a mediating influence between population size and the environment. In this instance, however, it was the policy response that ultimately defined the relationship between technology, consumption, population, and environmental change.

Example 2, the Aral Sea Basin

Policy actions not only ameliorate environmental decline, but on occasion misguided policy may also become a powerful force behind degradation. The ecological and social dilemmas facing the Aral Sea basin offer an extreme example of the effects of policies regarding resource use. This basin in central Asia is shared by several nations, mainly Uzbekistan and Kazakhstan (Glazovsky, 1995; Micklin, 1997). Since 1960, the Aral Sea has shrunk 40 percent (see Figure 5.3) and, while a component of the decline stems from natural variations, research has demonstrated that human forces are the primary cause behind the ecological destruction. In particular, irrigation policies of the former Soviet Union appear to account for this trend. Canals were built to draw water from the Amu Darya and Syr Darya river basins to support agricultural development in the region. Today, the dried sea floor has changed the original coastline and altered the local precipitation cycle, 20 of 24 native fish species have disappeared, and the number of bird species has decreased from 319 to 168 (Goudie and Viles, 1997; Micklin, 1997). The expansion of agriculture has also heightened chemical pollution in the area. All of these factors combine to feed back into human processes—the vast majority of fisheries have closed resulting in a lack of local economic opportunity and infant mortality runs extremely high (110 infant deaths per 1,000 live births in some areas) (Goudie and Viles, 1997; Micklin, 1997).

Example 3, Mono Lake, California

The complex interactions between demographic pressures, environmental context, and institutional response have also played out in California. In 1941, the Los Angeles Department of Water and Power began diverting water from the Sierra Nevada's Mono Lake basin to meet the needs of southern California's burgeoning population. As a result of the diversion, the lake's surface began dropping by approximately one foot per year. By 1955, the lake's surface had dropped 12 feet; by 1995, more than 40 vertical feet had been lost. With the decline in water volume, sandy beaches became sticky mud, losing much of their recreational appeal. In addition, sediment flows were changed, lagoons and wetlands altered, and strange natural



SOURCE: Modified after Hollis (1978) as presented in Goudie and Viles, 1997.

Figure 5.3—Aral Sea, 1960–2000

sculptures known as tufas were exposed. Water plants vanished, affecting naturally occurring brine shrimp and alkali fly populations. This, in turn, resulted in a decline of migrating bird populations dependent on the lake's aquatic life. In sum, the lake's ecosystem was severely disrupted (Hart, 1996).

Litigation on behalf of Mono Lake began in 1979, initially promoted by the National Audubon Society and the grassroots Mono Lake Committee. Years of controversy preceded the landmark decision in 1994 by the State Water Resources Control Board, which amended Los Angeles Department of Water and Power's diversion rights in the Mono basin. The legislation calls for a lake level of 6,392 feet above sea level, which will take about 20 years to achieve but allowing limited diversions for municipal water supplies. Since 1994, additional agreements have been developed requiring stream and waterfowl habitat restoration (MLC, 1999).

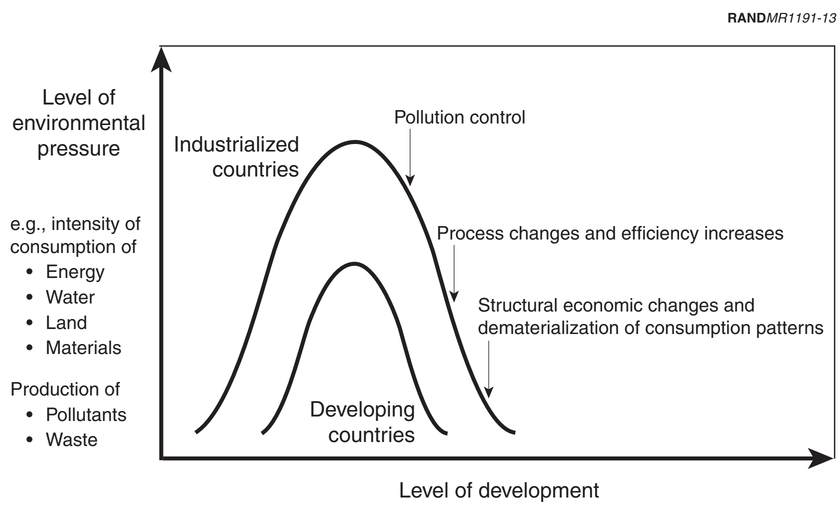
Example 4, Energy Policy in India

The critical importance of timely organizational response in mediating the relationship between population and the environment can also be seen in India, a nation whose population grew from 548 million to 846 million between 1971 and 1991, an increase of more than 50 percent in 20 years. A study examining population growth, poverty, and environment during this period concludes that some of the dilemmas facing India today are not specifically the result of population growth or resource shortages per se, but rather of the insufficient institutional and policy response necessary to mediate these relationships. For instance, persistent shortages of coal and coal-based electricity did not result from resource shortages or inadequate technologies but from a failed energy policy. Among other factors, inefficient public sector monopolies continued to operate, and prices were set too low to rein in demand (Repetto, 1997).

Many other examples of the important mediating influence of institutions and policy could be offered. Consider, for instance, the creation of the U.S. Environmental Protection Agency in 1970 and the subsequent implementation of the Clean Air Act (1970), the Safe Drinking Water Act (1984), and regulations regarding hazardous waste disposal (e.g., Resource Conservation and Recovery Act of 1976).

The mediating influences of both technology and policy vary in important ways across the development continuum (World Bank, 1992). The processes of industrialization and modernization that characterize the development of today's developed nations, entail environmentally unsound production processes. The development also often occurred in contexts lacking sound environmental regulation. As reflected in Figure 5.4, these early development stages brought increasing environmental pressures as a result of the adoption of energy-intense production and consumption patterns and the lack of pollution-control regulatory mechanisms. As economies move along the development continuum, however, pollution controls tend to be implemented, along with advances in production, and eventually the adoption of consumption patterns that yield less environmental pressure.

Concerns have arisen about the application of similar development processes to the world's expanding economies. Given that more than 90 percent of future population growth is expected to occur in



SOURCE: UNEP, 1997, p. 3.

Figure 5.4—Conceptual Representation of the Relationship Between Economic Development and Environmental Pressure

developing nations, consumption-driven environmental pressure in these regions could portend environmental disaster. However, some evidence suggests it is possible to reduce the environmental implications of economic development: the rate of degradation in some of today's developing nations has been slower than that experienced by industrial countries when they were at similar stages of economic development (UNEP, 1997).

CULTURAL FACTORS

Cultural factors encompass the meanings and ways of life that define a society, including beliefs, values, norms, traditions, and symbols (Mooney, Knox, and Schacht, 1997). Here we provide examples of how such cultural factors as gender roles and societal perceptions of natural environments influence the ways in which demographic factors are brought to bear on environmental context.

With regard to gender roles, in the social context of many developing nations, women are the managers of the daily living environment, responsible for the collection of resources necessary for household maintenance. And yet, while primarily responsible for resource collection, women often have less security in access to these resources compared to men. In Zimbabwe, for instance, girls have no rights of inheritance from their parents, and women acquire access to land only through their fathers, husbands, and brothers. This insecurity of tenure influences women's relationship with the environment. As a specific manifestation, women are significantly less likely to plant trees for food, medicine, and fuelwood in areas where future access is uncertain (Fortmann, Antinori, and Nabane, 1997). In societies where women are restricted access to land ownership, they tend to also be ineligible for credit, cooperative membership, and programs designed for innovative land management approaches. In both of these cases, gender roles mediate the relationship between population and the environment by influencing resource management strategies.

Nature-society relations offer another example of cultural factors' mediating influence. For example, distinctive patterns have been shown to exist with regard to attitudes, knowledge, and behavior toward wildlife and conservation across three industrial democracies: the United States, Japan, and Germany. While Americans and

Germans express a broad appreciation for a variety of animals, Japanese culture places greater emphasis on the experience of nature in controlled, confined, and highly idealized circumstances (e.g., bonsai, rock gardening, flower arranging) (Kellert, 1991, 1993). These cultural variations in perceptions of wildlife influence conservation strategies because public support for various policy interventions will reflect societal values (Kellert, 1985).