

# Environmental Change and Violent Conflict

*Growing scarcities of renewable  
resources can contribute to social  
instability and civil strife*

by Thomas F. Homer-Dixon, Jeffrey H. Boutwell and George W. Rathjens

Within the next 50 years, the human population is likely to exceed nine billion, and global economic output may quintuple. Largely as a result of these two trends, scarcities of renewable resources may increase sharply. The total area of highly productive agricultural land will drop, as will the extent of forests and the number of species they sustain. Future generations will also experience the ongoing depletion and degradation of aquifers, rivers and other bodies of water, the decline of fisheries, further stratospheric ozone loss and, perhaps, significant climatic change.

As such environmental problems become more severe, they may precipitate

civil or international strife. Some concerned scientists have warned of this prospect for several decades, but the debate has been constrained by lack of carefully compiled evidence. To address this shortfall of data, we assembled a team of 30 researchers to examine a set of specific cases. In studies commissioned by the University of Toronto and the American Academy of Arts and Sciences, these experts reported their initial findings.

The evidence that they gathered points to a disturbing conclusion: scarcities of renewable resources are already contributing to violent conflicts in many parts of the developing world. These conflicts may foreshadow a surge of similar violence in coming decades, particularly in poor countries where shortages of water, forests and, especially, fertile land, coupled with rapidly expanding populations, already cause great hardship.

Before we discuss the findings, it is important to note that the environment is but one variable in a series of political, economic and social factors that can bring about turmoil. Indeed, some skeptics claim that scarcities of renewable resources are merely a minor variable that sometimes links existing political and economic factors to subsequent social conflict.

The evidence we have assembled supports a different view [see illustration on page 40]. Such scarcity can be an important force behind changes in the poli-

tics and economics governing resource use. It can cause powerful actors to strengthen, in their favor, an inequitable distribution of resources. In addition, ecosystem vulnerability often contributes significantly to shortages of renewable resources. This vulnerability is, in part, a physical given: the depth of upland soils in the tropics, for example, is not a function of human social institutions or behavior. And finally, in many parts of the world, environmental degradation seems to have passed a threshold of irreversibility. In these situations, even if enlightened social change removes the original political, economic and cultural causes of the degradation, it may continue to contribute to social disruption. In other words, once irreversible, environmental degradation becomes an independent variable.

Skeptics often use a different argument. They state that conflict arising from resource scarcity is not particularly interesting, because it has been common throughout human history. We maintain, though, that renewable-resource scarcities of the next 50 years will probably occur with a speed, complexity and magnitude unprecedented in history. Entire countries can now be deforested in a few decades, most of a region's topsoil can disappear in a generation, and acute ozone depletion may take place in as few as 20 years.

Unlike nonrenewable resources—including fossil fuels and iron ore—renewable resources are linked in highly complex, interdependent systems with many

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**ARMY DETACHMENT** patrols village in Assam, India, where in 1983 local tribespeople attacked migrant Muslims from Bangladesh. Members of the tribe had long accused the mi-

grants of stealing some of the region's richest farmland. Before troops arrived to restore order, almost 1,700 Bengalis had been massacred in one incident alone.

nonlinear and feedback relations. The overextraction of one resource can lead to multiple, unanticipated environmental problems and sudden scarcities when the system passes critical thresholds.

Our research suggests that the social and political turbulence set in motion by changing environmental conditions will not follow the commonly perceived pattern of scarcity conflicts. There are many examples in the past of one group

or nation trying to seize the resources of another. For instance, during World War II, Japan sought to secure oil, minerals and other resources in China and Southeast Asia.

Currently, however, many threatened renewable resources are held in common—including the atmosphere and the oceans—which makes them unlikely to be the object of straightforward clashes. In addition, we have come to under-

stand that scarcities of renewable resources often produce insidious and cumulative social effects, such as population displacement and economic disruption. These events can, in turn, lead to clashes between ethnic groups as well as to civil strife and insurgency. Although such conflicts may not be as conspicuous or dramatic as wars over scarce resources, they may have serious repercussions for the security inter-

ests of the developed and the developing worlds.

Human actions bring about scarcities of renewable resources in three principal ways. First, people can reduce the quantity or degrade the quality of these resources faster than they are renewed. This phenomenon is often referred to as the consumption of the resource's "capital": the capital generates "income" that can be tapped for human consumption. A sustainable economy can therefore be defined as one that leaves the capital intact and undamaged so that future generations can enjoy undiminished income. Thus, if topsoil creation in a region of farmland is 0.25 millimeter per year, then average soil loss should not exceed that amount.

The second source of scarcity is population growth. Over time, for instance, a given flow of water might have to be divided among a greater number of people. The final cause is change in the distribution of a resource within a society.

Such a shift can concentrate supply in the hands of a few, subjecting the rest to extreme scarcity.

These three origins of scarcity can operate singly or in combination. In some cases, population growth by itself will set in motion social stress. Bangladesh, for example, does not suffer from debilitating soil degradation or from the erosion of agricultural land: the annual flooding of the Ganges and Brahmaputra rivers deposits a layer of silt that helps to maintain the fertility of the country's vast floodplains.

But the United Nations predicts that Bangladesh's current population of 120 million will reach 235 million by the year 2025. At about 0.08 hectare per capita, cropland is already desperately scarce. Population density is 785 people per square kilometer (in comparison, population density in the adjacent Indian state of Assam is 284 people per square kilometer). Because all the country's good agricultural land has been exploited, population growth will cut in half the amount of cropland available

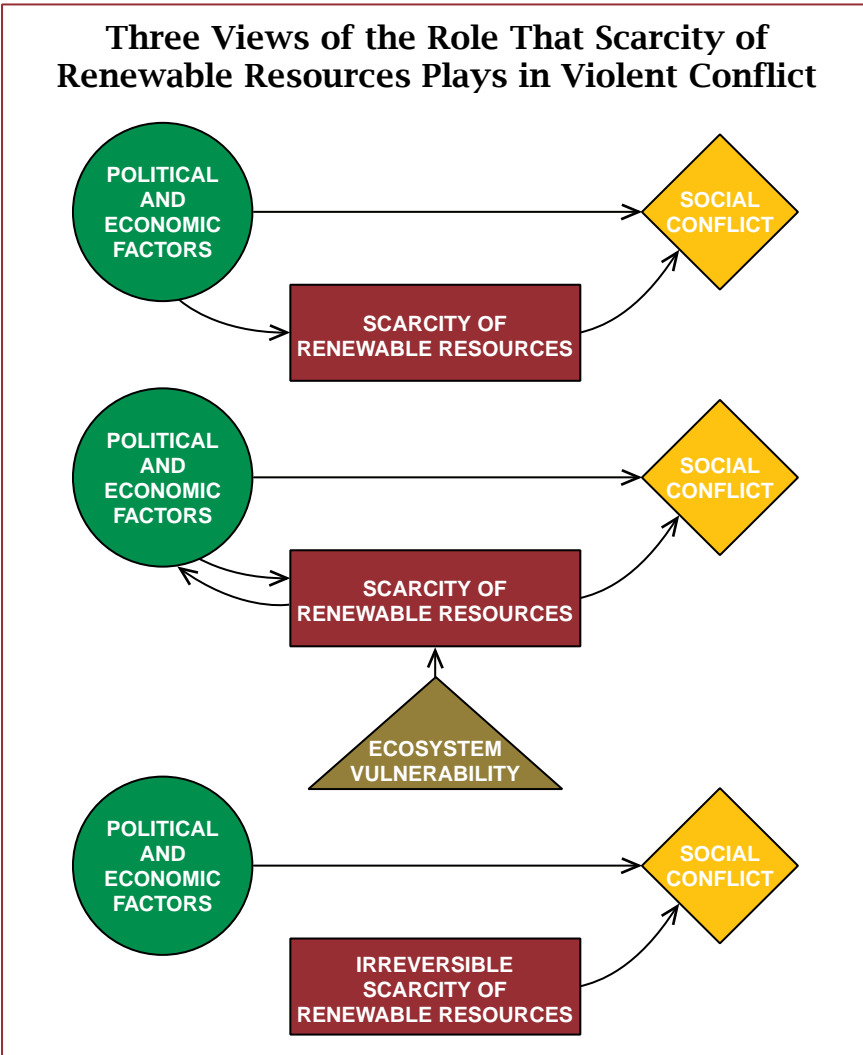
per capita by 2025. Flooding and inadequate national and community institutions for water control exacerbate the lack of land and the brutal poverty and turmoil it engenders.

Over the past 40 years, millions of people have migrated from Bangladesh to neighboring areas of India, where the standard of living is often better. Detailed data on the movements are few: the Bangladeshi government is reluctant to admit there is significant migration because the issue has become a major source of friction with India. Nevertheless, one of our researchers, Sanjoy Hazarika, an investigative journalist and reporter at the *New York Times* in New Delhi, pieced together demographic information and experts' estimates. He concludes that Bangladeshi migrants and their descendants have expanded the population of neighboring areas of India by 15 million. (Only one to two million of those people can be attributed to migrations during the 1971 war between India and Pakistan that resulted in the creation of Bangladesh.)

This enormous flux has produced pervasive social changes in the receiving Indian states. Conflict has been triggered by altered land distribution as well as by shifts in the balance of political and economic power between religious and ethnic groups. For instance, members of the Lalung tribe in Assam have long resented Bengali Muslim migrants: they accuse them of stealing the area's richest farmland. In early 1983, during a bitterly contested election for federal offices in the state, violence finally erupted. In the village of Nellie, Lalung tribespeople massacred nearly 1,700 Bengalis in one five-hour rampage.

In the state of Tripura the original Buddhist and Christian inhabitants now make up less than 30 percent of the population. The remaining percentage consists of Hindu migrants from either East Pakistan or Bangladesh. This shift in the ethnic balance precipitated a violent insurgency between 1980 and 1988 that was called off only after the government agreed to return land to dispossessed Tripuris and to stop the influx of Bangladeshis. As the migration has continued, however, this agreement is in jeopardy.

Population movements in this part of South Asia are, of course, hardly new. During the colonial period, the British imported Hindus from Calcutta to administer Assam, and Bengali was made the official language. As a result, the Assamese are particularly sensitive to the loss of political and cultural control in the state. And Indian politicians have often encouraged immigration in



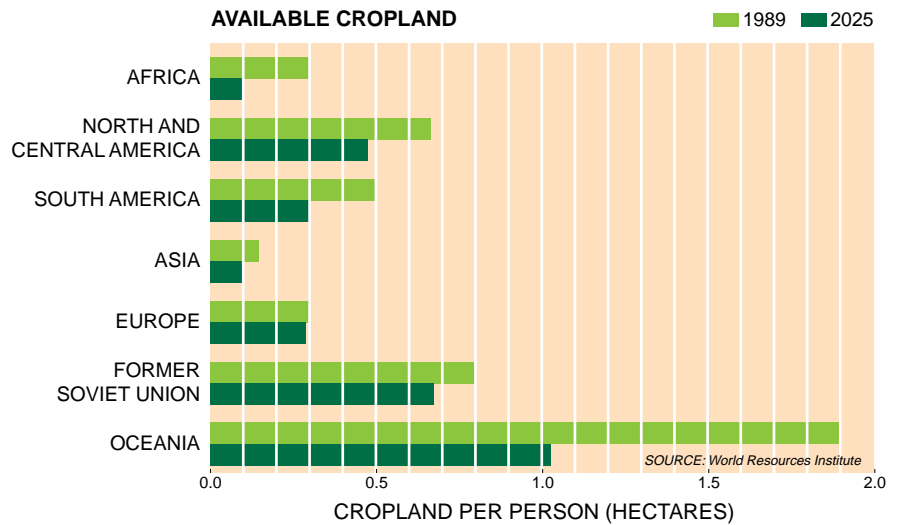


order to garner votes. Yet today changes in population density in Bangladesh are clearly contributing to the exodus. Although the contextual factors of religion and politics are important, they do not obscure the fact that a dearth of land in Bangladesh has been a force behind conflict.

In other parts of the world the three sources of scarcity interact to produce discord. Population growth and reductions in the quality and quantity of renewable resources can lead to large-scale development projects that can alter access to resources. Such a shift may lead to decreased supplies for poorer groups whose claims are violently opposed by powerful elites. A dispute that began in 1989 between Mauritians and Senegalese in the Senegal River valley, which demarcates the common border between these countries, provides an example of such causality.

Senegal has fairly abundant agricultural land, but much of it suffers from severe wind erosion, loss of nutrients, salinization because of overirrigation and soil compaction caused by the intensification of agriculture. The country has an overall population density of 380 people per square kilometer and a population growth rate of 2.7 percent; in 25 years the population may double. In contrast, except for the Senegal River valley along its southern border and a few oases, Mauritania is for the most part arid desert and semiarid grassland. Its population density is very low, about 20 people per square kilometer, and the growth rate is 2.8 percent a year. The U.N. Food and Agriculture Organization has included both Mauritania and Senegal in its list of countries whose croplands cannot support current or projected populations without a large increase in agricultural inputs, such as fertilizer and irrigation.

Normally, the broad floodplains fringing the Senegal River support productive farming, herding and fishing based on the river's annual floods. During the 1970s, however, the prospect of chronic food shortages and a serious drought encouraged the region's governments to seek international financing for the Manantali Dam on the Bafing River tributary in Mali and for the Diama salt-intrusion barrage near the mouth of the Senegal River between Senegal and Mauritania. The dams were designed to regulate the river's flow for hydropower, to expand irrigated agriculture and to raise water levels in the dry season, permitting year-round barge transport from the Atlantic Ocean to land-locked Mali, which lies to the east of Senegal and Mauritania.



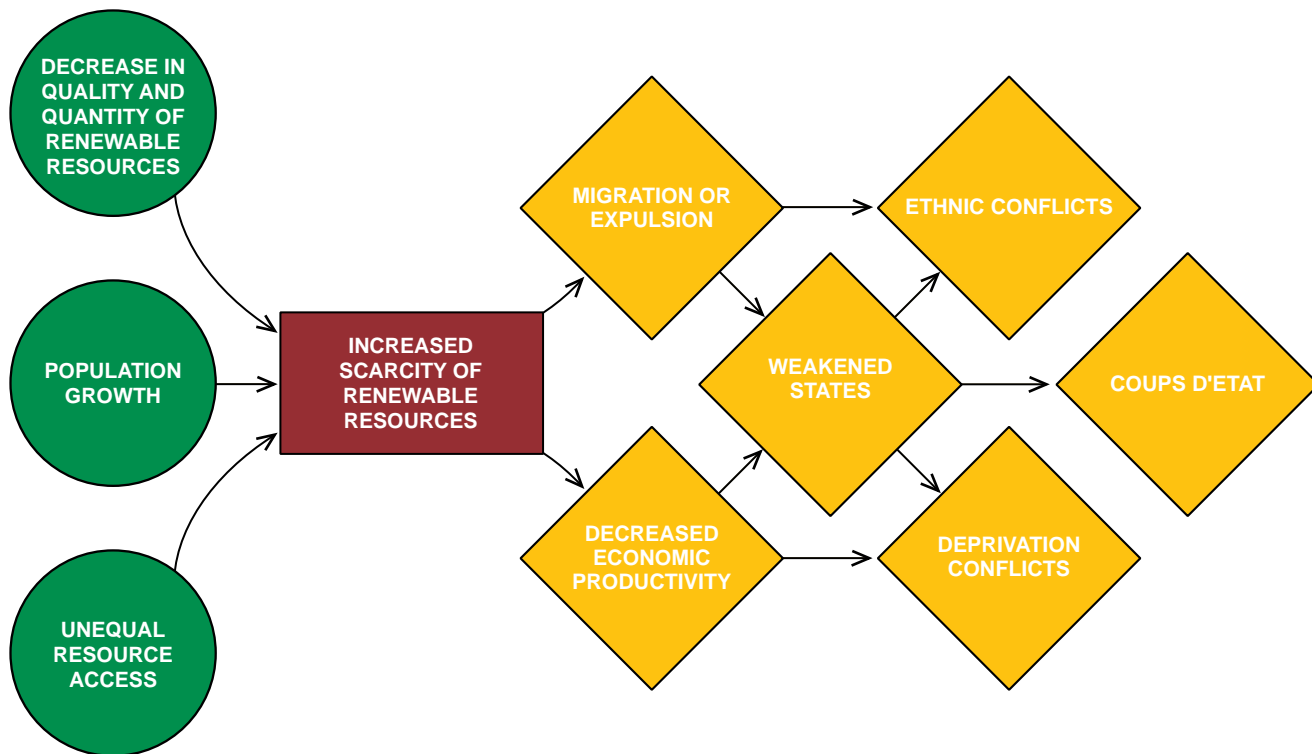
**AVAILABLE CROPLAND** is expected to decline in many parts of the world by 2025 (*top*) as a result of population growth and the degradation of fertile land. In the Philippines, lack of good land has pushed poor farmers onto steep hillsides (*bottom*). Unterraced farming on such terrain causes severe erosion, which can be seen in the earth-colored gashes on the slopes.

But the plan had unfortunate and unforeseen consequences. As anthropologist Michael M. Horowitz of the State University of New York at Binghamton has shown, anticipation of the new dams raised land values along the river in areas where high-intensity agriculture was to become feasible. The elite in Mauritania, which consists primarily of white Moors, then rewrote legislation governing land ownership, effectively abrogating the rights of black Africans to continue farming, herding and fishing along the Mauritanian riverbank.

There has been a long history of racism by white Moors in Mauritania toward their non-Arab, black compatri-

ots. In the spring of 1989 the killing of Senegalese farmers by Mauritians in the river basin triggered explosions of ethnic violence in the two countries. In Senegal almost all of the 17,000 shops owned by Moors were destroyed, and their owners were deported to Mauritania. In both countries several hundred people were killed, and the two nations nearly came to war. The Mauritanian regime used this occasion to activate the new land legislation, declaring the black Mauritians who lived alongside the river to be "Senegalese," thereby stripping them of their citizenship; their property was seized. Some 70,000 of the black Mauritians were forcibly ex-

## Some Sources and Consequences of Renewable Resource Scarcity



pelled to Senegal, from where some launched raids to retrieve expropriated cattle. Diplomatic relations between the two countries have now been restored, but neither has agreed to allow the expelled population to return or to compensate them for their losses.

We see a somewhat different causal process in many parts of the world: unequal access to resources combines with population growth to produce environmental damage. This phenomenon can contribute to economic deprivation that spurs insurgency and rebellion. In the Philippines, Spanish and American colonial policies left behind a grossly inequitable distribution of land. Since the 1960s, the introduction of green revolution technologies has permitted a dramatic increase in lowland production of grain for domestic consumption and of cash crops that has helped pay the country's massive external debt.

This modernization has raised demand for agricultural labor. Unfortunately, though, the gain has been overwhelmed by a population growth rate of 2.5 to 3.0 percent. Combined with the maldistribution of good cropland and an economic crisis in the first half of the 1980s, this growth produced a surge in agricultural unemployment.

With insufficient rural or urban industrialization to absorb excess labor, there has been unrelenting downward pressure on wages. Economically desperate, millions of poor agricultural laborers and landless peasants have migrated to shantytowns in already overburdened cities, such as Manila; millions of others have moved to the least productive—and often most ecologically vulnerable—territories, such as steep hillsides.

In these uplands, settlers use fire to clear forested or previously logged land. They bring with them little ability to protect the fragile ecosystem. Their small-scale logging, charcoal production and slash-and-burn farming often cause erosion, landslides and changes in hydrologic patterns. This behavior has initiated a cycle of falling food production, the clearing of new plots and further land degradation. Even marginally fertile land is becoming hard to find in many places, and economic conditions are critical for peasants.

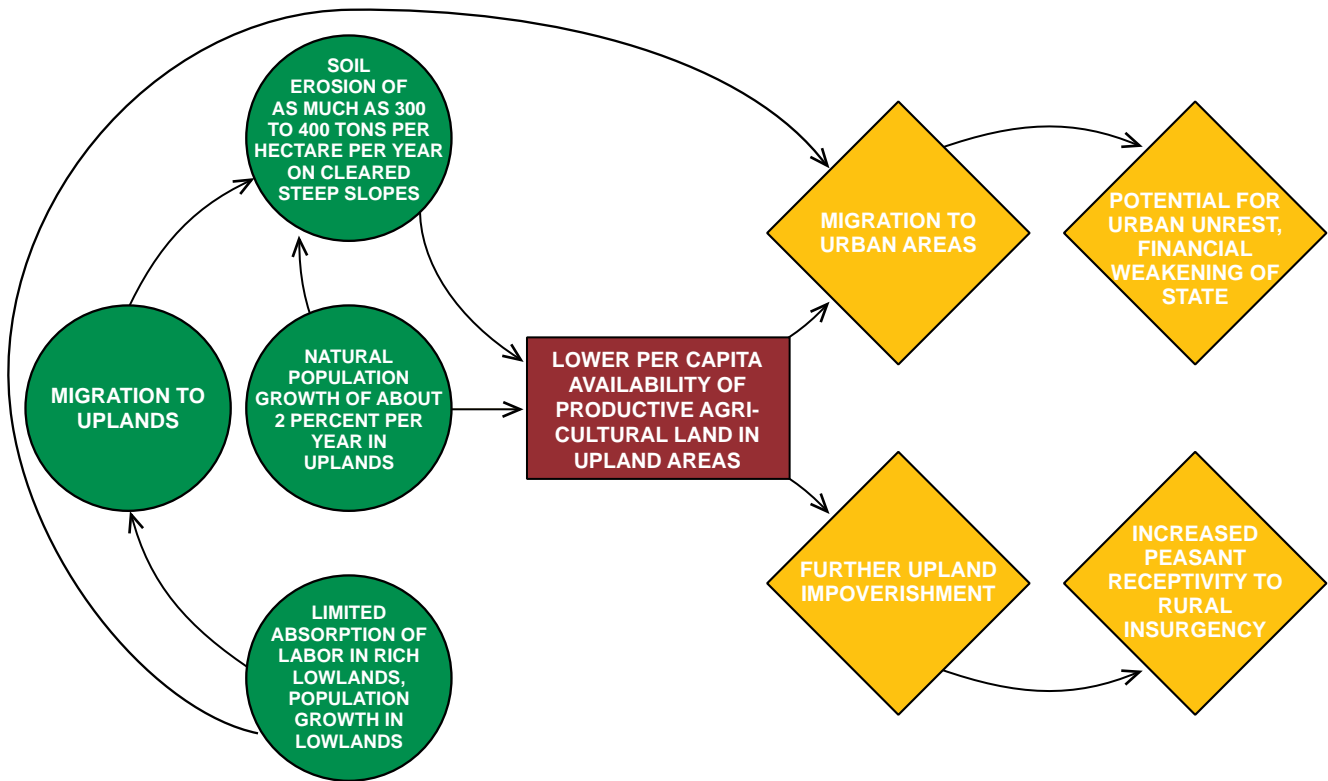
The country has suffered from serious internal strife for many decades. But two researchers, Celso R. Roque, the former undersecretary of the environment of the Philippines, and his colleague Maria I. Garcia, conclude that resource scarcity appears to be an increasingly powerful force behind the current communist-led insurgency. The

upland struggle—including guerrilla attacks and assaults on military stations—is motivated by the economic deprivation of the landless agricultural laborers and poor farmers displaced into the hills, areas that are largely beyond the control of the central government. During the 1970s and 1980s, the New People's Army and the National Democratic Front found upland peasants receptive to revolutionary ideology, especially where coercive landlords and local governments left them little choice but to rebel or starve. The revolutionaries have built on indigenous beliefs and social structures to help the peasants focus their discontent.

Causal processes similar to those in the Philippines can be seen in many other regions around the planet, including the Himalayas, the Sahel, Indonesia, Brazil and Costa Rica. Population growth and unequal access to good land force huge numbers of people into cities or onto marginal lands. In the latter case, they cause environmental damage and become chronically poor. Eventually these people may be the source of persistent upheaval, or they may migrate yet again, stimulating ethnic conflicts or urban unrest elsewhere.

The short but devastating "Soccer War" in 1969 between El Salvador and Honduras involved just such a combin-

AN EXAMPLE FROM THE PHILIPPINES



ation of factors. As William H. Durham of Stanford University has shown, changes in agriculture and land distribution beginning in the mid-19th century concentrated poor farmers in El Salvador's uplands. Although these peasants developed some understanding of land conservation, their growing numbers on very steep hillsides caused deforestation and erosion. A natural population growth rate of 3.5 percent further reduced land availability, and as a result many people moved to neighboring Honduras. Their eventual expulsion from Honduras precipitated a war in which several thousand people were killed in a few days. Durham notes that the competition for land in El Salvador leading to this conflict was not addressed in the war's aftermath and that it powerfully contributed to the country's subsequent, decade-long civil war.

In South Africa the white regime's past apartheid policies concentrated millions of blacks in the country's least productive and most ecologically sensitive territories. High natural birth rates exacerbated population densities. In 1980 rural areas of the Ciskei homeland supported 82 persons per square kilometer, whereas the surrounding Cape Province had a rural density of two. Homeland residents had, and have, little capital and few skills to manage re-

sources. They remain the victims of corrupt and abusive local governments.

Sustainable development in such a situation is impossible. Wide areas have been completely stripped of trees for fuelwood, grazed down to bare dirt and eroded of topsoil. A 1980 report concluded that nearly 50 percent of Ciskei's land was moderately or severely eroded; close to 40 percent of its pasture was overgrazed. This loss of resources, combined with the lack of alternative employment and the social trauma caused by apartheid, has created a subsistence crisis in the homelands. Thousands of people have migrated to South African cities. The result is the rapid growth of squatter settlements and illegal townships that are rife with discord and that threaten the country's move toward democratic stability.

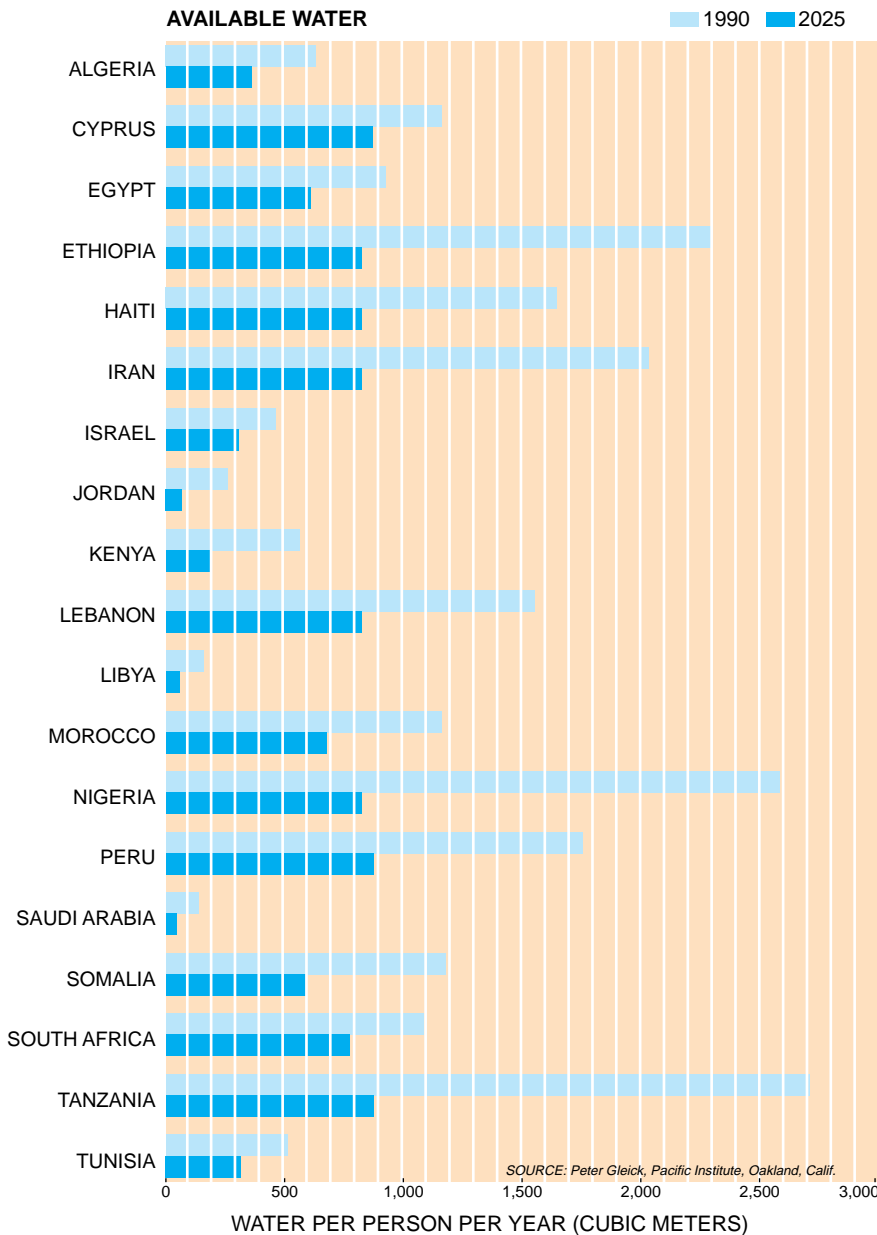
**D**windling natural resources can weaken the administrative capacity and authority of government, which may create opportunities for violent challenges to the state by political and military opponents. By contributing to rural poverty and rural-urban migration, scarcity of renewable resources expands the number of people needing assistance from the government. In response to growing city populations, states often introduce subsidies

that distort prices and cause misallocations of capital, hindering economic productivity.

Simultaneously, the loss of renewable resources can reduce the production of wealth, thereby constraining tax revenues. For some countries, this widening gap between demands on the state and its capabilities may aggravate popular grievances, erode the state's legitimacy and escalate competition between elite factions as they struggle to protect their prerogatives.

Logging for export markets, as in Southeast Asia and West Africa, produces short-term economic gain for parts of the elite and may alleviate external debt. But it also jeopardizes long-term productivity. Forest removal decreases the land's ability to retain water during rainy periods. Flash floods then damage roads, bridges, irrigation systems and other valuable infrastructure. Erosion of hillsides silts up rivers, reducing their navigability and their capacity to generate hydroelectric power. Deforestation can also hinder crop production by altering regional hydrologic cycles and by plugging reservoirs and irrigation channels with silt [see "Accounting for Environmental Assets," by Robert Repetto; *SCIENTIFIC AMERICAN*, June 1992].

In looking at China, Václav Smil of the University of Manitoba has estimated



**WATER SHORTAGES** may be severe in the future. In 2025 several nations (*top*) will have less than 1,000 cubic meters of water per person—the minimum amount considered necessary for an industrialized nation. In Ethiopia, water is already so scarce that some women walk miles to find it and lug it home (*bottom*).

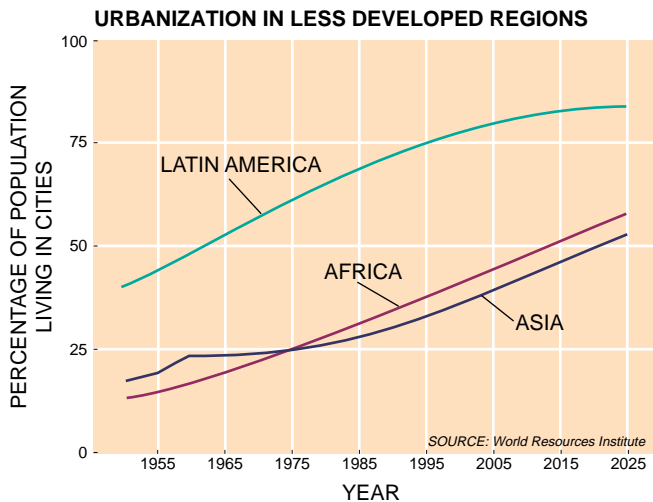
the combined effect of environmental problems on productivity. The main economic burdens he identifies are reduced crop yields caused by water, soil and air pollution; higher human morbidity resulting from air pollution; farmland loss because of construction and erosion; nutrient loss and flooding caused by erosion and deforestation; and timber loss arising from poor harvesting practices. Smil calculates the current annual cost to be at least 15 percent of China's gross domestic product; he is convinced the toll will rise steeply in the coming decades. Smil also estimates that tens of millions of Chinese will try to leave the country's impoverished interior and northern regions—where water and fuelwood are desperately scarce and the land often badly damaged—for the booming coastal cities. He anticipates bitter disputes among these regions over water sharing and migration. Taken together, these economic and political stresses may greatly weaken the Chinese state.

Water shortages in the Middle East will become worse in the future and may also contribute to political discord. Although figures vary, Miriam R. Lowi of Princeton University estimates that the average amount of renewable fresh water available annually to Israel is about 1,950 million cubic meters (mcm). Sixty percent comes from groundwater, the rest from river flow, floodwater and wastewater recycling. Current Israeli demand—including that of settlements in the occupied territories and the Golan Heights—is about 2,200 mcm. The annual deficit of about 200 mcm is met by overpumping aquifers.

As a result, the water table in some parts of Israel and the West Bank has been dropping significantly. This depletion can cause the salinization of wells and the infiltration of seawater from the Mediterranean. At the same time, Israel's population is expected to increase from the present 4.6 million to 6.5 million people in the year 2020, an estimate that does not include immigration from the former Soviet Union. Based on this projected expansion, the country's water demand could exceed 2,600 mcm by 2020.

Two of the three main aquifers on which Israel depends lie for the most part under the West Bank, although their waters drain into Israel. Thus, nearly 40 percent of the groundwater Israel uses originates in occupied territory. To protect this important source, the Israeli government has strictly limited water use on the West Bank. Of the 650 mcm of all forms of water annually available there, Arabs are allowed to use only 125 mcm. Israel restricts the num-





**GROWTH OF CITIES**, in part a result of increasing rural poverty and of migration, will be dramatic in the developing world (left). In Manila the “Smoky Mountains” squatter settlement is

home to poor peasants arriving by ship from the provinces (right). The Filipinos named the settlement after the perpetually smoldering garbage dump on which it is constructed.

ber of wells Arabs can drill in the territory, the amount of water Arabs are allowed to pump and the times at which they can draw irrigation water.

The differential in water access on the West Bank is marked: on a per capita basis, Jewish settlers consume about four times as much water as Arabs. Arabs are not permitted to drill new wells for agricultural purposes, although Mekorot (the Israeli water company) has drilled more than 30 for settlers. Arab agriculture in the region has suffered because some Arab wells have become saline as a result of deeper Israeli wells drilled nearby. The Israeli water policy, combined with the confiscation of agricultural land for settlers as well as other Israeli restrictions on Palestinian agriculture, has encouraged many West Bank Arabs to abandon farming. Those who have done so have become either unemployed or day laborers within Israel.

The entire Middle East faces increasingly grave and tangled problems of water scarcity, and many experts believe these will affect the region's stability. Concerns over water access contributed to tensions preceding the 1967 Arab-Israeli War; the war gave Israel control over most of the Jordan Basin's water resources. The current Middle East peace talks include multilateral meetings on water rights, motivated by concerns about impending scarcities.

Although “water wars” are possible in the future, they seem unlikely given the preponderance of Israeli military power. More probably, in the context of historical ethnic and political disputes, water shortages will aggravate tensions and unrest within societies in the Jor-

dan River basin. In recent U.S. congressional testimony, Thomas Naff of the University of Pennsylvania noted that “rather than warfare among riparians in the immediate future... what is more likely to ensue from water-related crises in this decade is internal civil disorder, changes in regimes, political radicalization and instability.”

Scarcities of renewable resources clearly can contribute to conflict, and the frequency of such unrest will probably grow in the future. Yet some analysts maintain that scarcities are not important in and of themselves. What is important, they contend, is whether people are harmed by them. Human suffering might be avoided if political and economic systems provide the incentives and wherewithal that enable people to alleviate the harmful effects of environmental problems.

Our research has not produced firm evidence for or against this argument. We need to know more about the variables that affect the supply of human ingenuity in response to environmental change. Technical ingenuity is needed for the development of, for example, new agricultural and forestry technologies that compensate for environmental deterioration. Social ingenuity is needed for the creation of institutions that buffer people from the effects of degradation and provide the right incentives for technological innovation.

The role of social ingenuity as a precursor to technical ingenuity is often overlooked. An intricate and stable system of markets, legal regimes, financial agencies and educational and research institutions is a prerequisite for the development and distribution

of many technologies—including new grains adapted to dry climates and eroded soils, alternative cooking technologies that compensate for the loss of firewood and water-conservation technologies. Not only are poor countries ill endowed with these social resources, but their ability to create and maintain them will be weakened by the very environmental woes such nations hope to address.

The evidence we have presented here suggests there are significant causal links between scarcities of renewable resources and violence. To prevent such turmoil, nations should put greater emphasis on reducing such scarcities. This means that rich and poor countries alike must cooperate to restrain population growth, to implement a more equitable distribution of wealth within and among their societies, and to provide for sustainable development.

**FURTHER READING**

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