from Lester R. Brown, *Eco-Economy: Building an Economy for the Earth*
(W. W. Norton & Co., NY: 2001)

8

Protecting Forest Products and Services

In the summer of 1998, the Yangtze River basin of China suffered some of the worst flooding in its history. An estimated 120 million people were driven from their homes by the floodwaters. A reported 3,656 people died. This near record flooding—with damages totaling $30 billion—came in a year when rainfall, though well above average, was not close to being a record. What was different from earlier years of comparable rainfall was the loss of forests. By 1998, the Yangtze River basin had lost fully 85 percent of its original forest cover, leaving little to hold the above-normal monsoon rainfall.[1]

Although it was too late to prevent massive deforestation, in August 1998 Chinese officials announced that they were imposing a total ban on tree cutting in the upper reaches of the Yangtze River basin. A senior official observed that trees standing were worth three times as much as trees cut. The state logging firms that had been cutting the trees were converted into tree planting organizations. As one employee noted, "It's now time to put down the ax and pick up the shovel."[2]

Because deforestation increases flooding, accelerates soil erosion, inhibits aquifer recharge, and decimates plant and animal life,

it directly affects several other trends that are shaping our future. Although we do not rely as universally on forests for fuelwood as we once did, forests still provide material for building our homes and for manufacturing the paper that remains the principal medium for communicating information. In addition, 2 billion people depend on forests for fuel.[3]

Since the beginning of agriculture, the world has lost nearly half of its forests. Much of the loss occurred during the last century. Although some individual countries have reversed the tide of forest loss, the world's forested area continues to shrink. As this area diminishes, so does the human prospect.[4]

Fuel, Lumber, and Paper

As of 2000, the forested area of the earth covered some 3.9 billion hectares, or roughly 30 percent of the earth's land surface, but each year world tree cover is shrinking. Between 1990 and 2000, the U.N. Food and Agriculture Organization (FAO) reported a net loss of 94 million hectares. The developing countries lost 130 million hectares and the industrial countries gained 36 million hectares. The gains were largely from the conversion of abandoned agricultural land to forest.[5]

While farmland was returning to forests in industrial countries, forests in developing countries were being turned into farmland, grazing land, and wasteland. The 13 million hectares of forested area lost in developing countries each year is equal to 0.65 percent of their forested area. Stated otherwise, every three years, developing countries lose 2 percent of their forestland.[6]

These FAO estimates of forest loss are substantial, yet even they fall short of conveying the full extent of deforestation. The FAO definition of forest is tree crown cover of more than 10 percent of an area—a threshold that includes as forest land what is otherwise sometimes classified as tundra, savanna, scrubland, or even desert. Another shortcoming of the FAO data is that harvested areas count as forest until they have been permanently converted to another use. Thus it may appear that the global rate of deforestation is slowing, but recent satellite images and country reports reveal that the opposite is true.[7]

Historically, forests were managed by cutting selectively, removing only mature, highly valued trees. Under this system the forested area was remarkably stable, shrinking only when land was

converted to agriculture or other nonforest uses. In recent decades, with new logging technologies and massive machines that can mow forests the way farmers mow hay, clearcutting has become much more economical as a harvesting technique, particularly when environmental costs are ignored.[8]

The world wood harvest in 1999 totaled 3.28 billion cubic meters, or just over 0.5 cubic meters for each person worldwide. Some 53 percent of this was used for fuel, supplying the 2 billion people who rely on wood for cooking. In developing countries, wood used for fuel accounted for 80 percent of all the wood harvested.[9]

Worldwide, wood accounts for 7 percent of the energy supply. In developing countries, it accounts for 15 percent of the total, compared with just 3 percent in industrial countries. Of the roughly 1.5 billion cubic meters of wood harvested that is not used for fuel, close to one third is used to make paper and paperboard. And over one fourth is sawed into lumber. Wood-based panels, often made with reconstituted wood, account for roughly a tenth of the non-fuelwood total.[10]

The paper sector of the world wood economy is the fastest growing of all. Between 1980 and 1999, world paper use climbed 86 percent, or 3.3 percent a year. At a total of nearly 317 million tons in 1999, this amounted to 52 kilograms, or more than 110 pounds, per person worldwide. (See Table 8–1.)[11]

Worldwatch researchers Janet Abramovitz and Ashley Mattoon note that nearly half of this paper was used for packaging. An estimated 30 percent was used for printing and writing paper, while 12 percent was used for newsprint. Paper towels and tissue account for most of the remainder.[12]

Looking ahead, the latest FAO projections show fuelwood consumption climbing to 2.35 billion cubic meters in 2015 and then leveling off as increased efficiency in wood burning offsets growth in fuelwood demand. For non-fuelwood use, FAO estimates that consumption will reach 2 billion cubic meters in 2015 and 2.4 billion cubic meters in 2030.[13]

In the decades ahead, the growing demand for wood products and the demand to convert forestland to both crop production and cattle ranching will continue to intensify pressures on the earth's forests. If recent deforestation trends continue, both the loss of forest productive capacity and, perhaps more important, the loss

Table 8–1. *World Paper Consumption by Country, 1999*

Country	Consumption (thousand tons)	Consumption Per Person (kilograms)
United States	95,829	338
China	44,677	35
Japan	30,482	240
Germany	17,592	214
United Kingdom	11,871	200
France	10,844	183
Italy	10,236	178
Canada	7,960	259
Brazil	7,044	41
South Korea	6,642	142
Top 10 Consumers	243,177	111
Others	73,499	19
World Total	316,676	52

Source: FAO, *FAOSTAT Statistics Database*, <apps.fao.org>, forest data updated 7 February 2001.

of key services that forests provide could disrupt local economies in some countries.

Forest Services

We are all familiar with the goods that forests supply, as just described. We are less familiar with the services they provide. Prominent among these are climate regulation, flood control, soil conservation, water cycling, nutrient storage and recycling, and recreation—all of which are a basic part of any economy's support systems.

In a landmark article in *Nature* in May 1997, Robert Costanza and 12 collaborators estimated that the earth's ecosystems provide $33 trillion worth of services per year—only slightly less than the $43 trillion worth of goods and services provided by the global economy. Of this total, Costanza and his coauthers estimated that the earth's forestland provides $4.7 trillion worth of services, or $969 of services per hectare per year. (See Table 8–2.) This can be compared with roughly $800 worth of corn produced per hectare

Table 8–2. *Principal Services Provided by Forests*

Service	Annual Value per Hectare (dollars)
Climate regulation	141
Erosion control	96
Nutrient storage and recycling	361
Recreation	66
Other	305
Total	969

Source: See endnote 14.

a year in the U.S. Corn Belt, one of the world's most productive farming regions.[14]

Impressive though the Costanza team's analysis is, it omits one of the most valuable services provided by forests—namely, their role in the recycling of rainfall inland that makes the interior of continents productive and habitable. If we continue to destroy coastal forests, the interior deserts of continents will continue expanding, squeezing humanity into an ever smaller area.

We often discover the services that forests provide when it is too late, after the trees have been cut. This is perhaps most true of flood control, as China, Thailand, and Mozambique have belatedly discovered.[15]

Forests also store nutrients. This is particularly important in the tropics, where almost all nutrients in forest ecosystems are stored in the vegetation itself. Many tropical soils have little organic matter and almost no nutrient storage capacity. If a forest is burned off to plant grass for cattle ranching or crops, whatever is planted can do relatively well in the first few years because of the nutrients remaining in the ashes. But once the ash washes away, as it soon does, the nutrients are gone. This is why much of the land cleared in the tropics quickly becomes wasteland and is abandoned.

Tropical rainforests are highly productive ecosystems, efficiently converting sunlight into plant material. But they can do this only as long as they are intact. Once they are destroyed, they can take centuries to regenerate. And some may never recover—simply because the conditions that existed at the time of their original for-

mation may no longer exist.

Forests help control soil erosion by adding organic matter to the soil and by slowing the flow of water runoff. Leaf litter on the floor protects the soil from being loosened by raindrops, creating a tight link between the vegetation and the soils. The forest vegetation permits soil to accumulate and keeps it from washing away. The accumulated soil in turn provides a healthy medium for the forest to develop. In this symbiotic relationship, losing the forests sometimes means losing the soil, which may in turn prevent the return of the forest.

The ability of forests to slow rainfall runoff and let it percolate downward also means forests play a central role in the hydrological cycle. They recharge aquifers, the underground rivers that supply water for the wells downstream. The more water that runs off when it is raining, the less there is to recharge aquifers. Thus the loss of forest cover leads to a double loss—more damage from flooding and a reduced recharge of aquifers.

Forests can purify drinking water as well. Walt Reid, who works with the Millennium Ecosystem Assessment, notes that "within the United States more than 60 million people in 3,400 communities rely on National Forest lands for their drinking water, a service estimated to be worth $3.7 billion per year." He then notes that this single service, one among many provided by national forests, is worth more than the annual value of timber harvested from these lands.[16]

New York City, with its population of nearly 17 million, recently discovered just how valuable nature's services are. Faced with the residential and industrial development of the Catskill forest region, the basin that is the source of its water, the city was told it needed a water purification plant that would cost $8 billion to build and $300 million a year to operate. The bill for this would reach $11 billion over 10 years. After analyzing the situation, city officials realized that they could restore the watershed to its natural condition for only $2 billion, thus avoiding the need for the purification plant and saving taxpayers $9 billion.[17]

As mentioned in Chapter 3, forests also help carry water to the interior of continents. Reduced recycling of rainfall inland is already evident in China. Deforestation in southern and eastern parts of the country is reducing the moisture transported inland from the Bay of Bengal, the South China Sea, the East China Sea, and

the Yellow Sea, notes Wang Hongchang, a Fellow at the Chinese Academy of Social Sciences. Rainfall in the northwestern interior is declining, contributing to the dust bowl conditions that are developing there. The Central Asian desert region extends from northwestern China north and west across Kazakhstan. The desert is expanding outward from the interior of the continent, moving northwest in Kazakhstan and southward and eastward in China. Indeed, Kazakhstan has lost the southern half of its croplands since 1980.[18]

A similar phenomenon is evident in Africa, as noted earlier. Both rangeland and cropland are turning to desert on the northern fringe of the Sahara Desert. Algeria is now working to convert the southernmost 20 percent of its grainland into orchards and vineyards in an effort to check the northward spread of desertification. And in Nigeria, the desert is moving southward, encroaching on the country's rangeland and cropland.[19]

A study as part of NASA's Earth Observing System reports that Lake Chad in Africa has shrunk from 25,000 square kilometers in 1963 to 1,350 square kilometers today. Declining rainfall in the central Sahelian region of Africa is primarily responsible for the shrinkage, although higher temperatures and the growth in irrigation, which diverts water from the rivers feeding the lake, are also contributing. As deforestation in Africa's high rainfall coastal regions and in the southern Sahel itself progresses, the capacity of the land to recycle water to the continent's interior is diminishing.[20]

Forests also have a stabilizing effect on local climate, modulating the more extreme day-to-night temperature fluctuations, such as those found in deserts. They store huge amounts of carbon that otherwise would be in the atmosphere in the form of carbon dioxide, contributing to climate change. When forests are cleared, this carbon storage capacity is lost not only in the vegetation above ground but also in the organic matter in the soil from roots and the leaf litter on the forest floor.[21]

Another service provided by forests is protection of streams and rivers from silting. In the U.S. Northwest, for example, the clearcutting of forests has destroyed nearby salmon fisheries because of increased muddy runoff. Mismanagement of one natural asset is decimating another.[22]

Silting also affects the productivity of dams, whether they are built for power generation or for irrigation. As they silt up, they

lose their storage capacity and hence their ability to generate electricity and provide water for irrigation. In extreme cases, reservoirs fill with silt and the investment in the dam is lost.[23]

Sustainable Forestry

There are many definitions of sustainable forestry, most having to do with the sustainable yield of timber. A more appropriate definition, a broader and more relevant one, includes the capacity of the forest to supply both products and services sustainably. In many situations, the latter is now far more important than the former.

Despite the high value of intact forests, only about 290 million hectares of global forest area are legally protected from logging (See Table 8–3.) An additional 1.4 billion hectares are unavailable for harvesting because of economic deterrents. Of the remaining area available for exploitation, 665 million hectares are undisturbed by humans and nearly 900 million hectares are seminatural and not in plantations.[24]

One type of forest that is marginal in economic terms is that supporting only low-quality wood, with few, if any, commercial species. Protected from timber harvesting by their poor quality, such forests continue to provide services. In other forests, logging is precluded solely because of physical or infrastructure constraints.

Table 8–3. *Area of World Forestland Available and Unavailable for Wood Supply*

Classification	Area (million hectares)
Available for wood supply	1,563
Semi-natural	898
Undisturbed	665
Unavailable for wood supply	1,657
Legal restrictions	290
Economic restriction	
Physical reasons	256
Transport or infrastructure constraints	365
Other	746
Total forested area	3,221

Source: See endnote 24.

Unfortunately, these areas can quickly become accessible to the chainsaw if the forest products industry or a government invests in transportation or other infrastructure.[25]

A large share of the forests that are protected by national decree are safeguarded not so much to preserve the long-term wood supply capacity as to ensure that the forest can continue to provide services. Countries that take this step often have been heavily deforested. The Philippines, for example, has banned all logging in old-growth and virgin forests largely because the country has become so vulnerable to flooding, erosion, and landslides. Once covered by rich stands of tropical hardwood forests, the Philippines was a major exporter of forest products. But after years of massive clearcutting, the country became a net importer of forest products. It lost both the goods and the services provided by its forests.[26]

Although some nongovernmental organizations (NGOs) have been working for years to protect forests or restrict their exploitation, public institutions such as the World Bank have only recently begun to consider sustainable forestry systematically. The Bank's current goal is to have 200 million hectares of forestland in its client countries under sustainable management by 2005. It proposes to have 50 million hectares of natural forest that is high in biological diversity under protection by 2005.[27]

For many landowners in the tropics who lack access to timber markets, trees are seen simply as an obstacle to agriculture or ranching—something to be burned or cut down. They are not interested in either the goods or the services provided. These forests are difficult to protect.

Where forest products are exported, access to timber markets can often be used to ensure that forests are managed sustainably. NGOs and governments in many importing countries are requiring that all timber marketed, including both domestically produced and imported timber, be certified as coming from sustainably managed forests. (For further discussion of forest certification, see Chapter 11.)

There are several forest products certification programs, which have varying success in promoting sustainable forestry. These link environmentally conscious consumers with the management of the forest where the product originates. Some certification programs are national while others are international. Some of the latter originate with the importing countries and others with exporters.

The most rigorous international program that is certified by a number of NGOs worldwide is the Forest Stewardship Council (FSC). Some 24 million hectares of forests in 45 countries are certified by FSC-accredited bodies as responsibly managed. Among the leaders in certified forest area are Sweden, with 10 million hectares; the United States, with nearly 3 million hectares; Bolivia, with over 1 million hectares; and South Africa and Brazil with just under 1 million hectares each.[28]

On the export end of the sustainable forest products industry, Brazil has also developed a national certification program. It is called Cerflor, a System for the Certification of Origin of Forest Raw Materials. This initiative was economically motivated so that Brazilian pulp and paper products would have an ecolabel to ensure access to the European Union market. The label aimed to distinguish Brazilian forestry products from those of other countries that might not be managing their forests sustainably. In the case of Brazil, this was a relatively easy goal to reach simply because so much of its paper comes from plantations.[29]

Although the world is far from managing its forests well, the concept of sustainable forest management is taking root to some degree in many parts of the world. It at least holds out the hope that the annual forest loss of 13 million hectares in developing countries can be reduced and eventually eliminated as balance is restored between the production and harvesting of forestry products. Arresting the deforestation would also help protect the services that forests currently provide.[30]

Lightening the Load

There is enormous potential in all countries to lessen the demand pressure that is shrinking the earth's forest cover. In industrial nations the greatest opportunity lies in reducing the amount of wood used to manufacture paper. In developing countries it also depends on reducing that used as fuel.

An examination of paper recycling in the top 10 paper-producing countries shows a wide variation. (See Table 8–4.) On the low end are China, which recycles 27 percent of its paper, and Italy, at 31 percent. At the high end are Germany at 72 percent and South Korea at 66 percent. The rate in Germany is high because the government has consistently emphasized the recycling of paper in order to reduce the flow to landfills. If every country recycled as much

Table 8–4. *Paper Recycling Rates, 10 Leading Paper-Producing Countries and World, 1997*

Country	Recycling Rate (percent)
Germany	72
South Korea	66
Sweden	55
Japan	53
Canada	47
United States	46
France	41
Finland	35
Italy	31
China	27
World	43

Source: Janet N. Abramovitz, "Paper Recycling Remains Strong," in Lester R. Brown et al., *Vital Signs 2000* (New York: W.W. Norton & Company, 2000), pp. 132–33.

as Germany does, nearly one third less wood would be needed worldwide to produce paper.

The United States, the world's largest producer and consumer of paper, is far behind Germany but making progress. Twenty years ago, roughly one fourth of the paper used in the United States was recycled. By 1997, the figure had reached 46 percent. Contributing to this were the introduction of convenient curbside recycling, the banning of paper in many landfills, and mandates imposed by both the federal and state governments on recycled content in purchased paper, such as the one adopted by the Clinton administration in 1993.[31]

Some countries not among the top 10 producers are also making impressive progress. The Netherlands, for example, has set a goal of recycling 72 percent of all the paper used within its borders by 2001. This goal, which will put it on a par with Germany, seems likely to be reached.[32]

The use of paper, perhaps more than any other single product, still reflects the throwaway mentality that evolved during the second half of the last century. There are enormous possibilities for reducing paper use, including replacing facial tissues, paper nap-

kins, disposable diapers, and paper shopping bags with cloth alternatives.

The Japanese have a special problem since their wooden chopsticks are often discarded after one use. As a result, some 25 billion chopsticks a year end up in the garbage in Japan. In attempts to solve a comparable problem, China is launching a program to reduce the use of throwaway chopsticks.[33]

In the electronic era, some uses of paper could be phased out almost entirely. Among these is the use of paper telephone directories, which can be replaced by online phone directories available on the Internet. Not all residences have access to the Internet, but it may now make sense to discontinue automatic distribution of phone directories and give them out only on request. This could save millions of tons of paper each year.

Newspapers devote most of their space to advertising. For example, a typical city newspaper in the United States will carry two pages of used car ads each day for 365 days a year. Although some people never buy a car, much less a used one, they nonetheless automatically get these pages with their daily newspaper. An online electronic directory of used cars in each city could largely dispense with this use of newsprint. Indeed, electronic directories for cars, apartment rentals, and various services such as home repair and plumbing will undoubtedly reduce newspaper ads and save paper.

The *International Herald Tribune*, published in Paris and printed at several different locations around the world, is a model of a paper-efficient newspaper. Owned jointly by the *New York Times* and the *Washington Post*, it carries material from both newspapers. It is trim and easy to read, with few ads. Within the United States, *USA Today* also has an unusually high rate of news to advertising. These newspapers are also available on the Internet.[34]

The largest single demand on our trees—the need for fuelwood—accounts for just over half of all wood removed from forests. One way of reducing the pressure of fuelwood demand is to use wood more efficiently. While attention in the industrial world focuses on increasing the fuel efficiency of automobiles, much less attention has been given to the efficiency of cook stoves, the leading use of energy in many developing countries. A number of international aid agencies, including the U.S. Agency for International Development, have begun to sponsor projects in this area, and with some success. One of its more promising projects undertaken in Kenya

has involved the distribution of new cook stoves to 780,000 people. Investing public resources in replacing outmoded cook stoves could earn handsome dividends in forest protection and regeneration, including the restoration of forest services.[35]

Over the longer term, the key to reducing pressure on forests is to develop alternative sources of energy for cooking in the Third World. As the world shifts from an energy economy based on fossil fuels to one based on wind, solar, or geothermal energy (see Chapter 5), it will be much easier for developing countries without fossil fuels to develop indigenous sources of renewable energy. Although we do not know exactly what form the substitution will take as the world moves toward a hydrogen-based economy, we do know there is an abundance of locally available renewable energy in the developing world.

As the energy transition accelerates, the potential for replacing fuelwood with other local energy sources will become more evident. Whether countries replace firewood with electric hotplates fed by wind-generated electricity, solar thermal cookers, or some other source of energy, it will lighten the load on forests.

The Role of Plantations

As of 2000, the world had 113 million hectares in forest plantations, less than 3 percent of the total 3.9 billion hectares in forest. By comparison, this area is roughly one sixth of the 700 million hectares planted in grain each year worldwide.[36]

These plantations produce mostly wood either for pulp mills to make paper or for mills to reconstitute wood. Increasingly, reconstituted wood is substituting for natural wood in the world lumber market as industry adapts to a shrinking supply of large logs from natural forests.[37]

Production of wood on plantations is estimated at 331 million cubic meters, or 10 percent of world wood production. Stated otherwise, nine tenths of the world timber harvest came from natural forest stands, while one tenth came from plantations.[38]

Five countries account for two thirds of the 113 million hectares of plantations. (See Table 8–5.) China, which has little original forest remaining, is the largest, and Russia and the United States follow. U.S. plantations are concentrated in the southeastern part of the country. India and Japan are fourth and fifth. Brazil is further back, but expanding fast.[39]

Table 8–5. *Forest Plantations in Key Countries, 2000*

Country	Area
	(million hectares)
China	39.9
Russia	17.3
United States	16.2
India	12.4
Japan	10.7
All other	16.3
World Total	112.8

Source: See endnote 39.

The average productivity of existing plantations worldwide is estimated at 6.6 cubic meters per hectare a year. This figure could easily go to 10 cubic meters with more sophisticated management and the use of fast-growing tree species. New Zealand, for example, harvests 18 or more cubic meters per hectare a year. Brazil was averaging 14 cubic meters per hectare in 1990 and could go to 33 cubic meters with advanced management, according to FAO.[40]

As the industry expands, it is also undergoing a geographic shift, with more and more of the new plantations located in the moist tropical or subtropical regions. In contrast to grain yields, which tend to rise with distance from the equator and the longer growing days of summer, tree plantation yields rise with proximity to the equator and the year-round growing conditions. For example, in the southeastern United States, it takes 15 years for fast-growing pines to reach harvestable size. Brazilian plantation managers can have eucalyptus trees ready for harvest in 7 years—less than half the time.[41]

In eastern Canada, the average hectare of forest plantation produces 4 cubic meters per year. In the southeastern United States, it is 10 cubic meters. But in Indonesia, it is 25 cubic meters, and in Brazil, newer plantations may be close to 30 cubic meters. While corn yields in the United States average almost 9 tons per hectare, Brazil's are less than 3 tons. So while the ratio of corn yields between the United States and Brazil is nearly 3 to 1, timber yields favor Brazil by nearly 3 to 1. To satisfy a given demand for wood, Brazil requires only one third as much land as the United States.

This tree-growing advantage of tropical countries helps explain why growth in pulp capacity from 1995 to 2000 was estimated at 1.5 percent for the United States, 3.5 percent for Canada, 166 percent for Thailand, and 123 percent for Indonesia.[42]

In addition to warm, year-round temperatures and abundant moisture in the tropics, land and labor are cheaper in developing countries. As a result, for example, Chile's exports of forest products, largely from plantations, increased from $334 million in 1985 to $2 billion in 1995, expanding employment and boosting export earnings.[43]

Many northern firms are investing in countries in the South. Japanese firms are investing in the Western Pacific, and U.S. firms are investing in the western hemisphere, especially Brazil. Some U.S. firms are buying into forest plantations in Brazil to supply wood chips for their pulp mills in the southern United States. Brazil, now with 5 million hectares of forest plantations, gets 60 percent of its industrial wood from plantations.[44]

Projections of future growth show that plantations are constrained by land scarcity. An increase in land in plantations can come on deforested land, but it is more likely to come at the expense of existing natural stands of forests. There is also competition with agriculture, since land that is suitable for growing trees is often suitable for crop production too. Water scarcity is yet another constraint. Fast-growing plantations require an abundance of moisture.

Nonetheless, FAO projects that the current 113 million hectares of plantations could easily increase to 145 million hectares in 2030. Meanwhile, as yields rise, the harvest could more than double, climbing from 331 million cubic meters to 766 million. This assumes that this growth will be concentrated in the tropics and subtropics, where the yields are high.[45]

It is entirely conceivable that plantations could one day satisfy most of the world's demand for industrial wood. While part of the modest projected growth in plantation area will undoubtedly come at the expense of existing forests, the area of forests that would be protected is several times greater.

Reclaiming the Earth

Reforestation is essential to restoring the earth's health, a cornerstone of the eco-economy. Reducing flooding and soil erosion, re-

cycling rainfall inland, and restoring aquifer recharge depend not merely on slowing deforestation or arresting it, but on reforesting the earth. Planting trees helps to reduce topsoil loss caused by erosion to or below the level of new soil formation.

Historically, some highly erodible agricultural lands have been reforested by natural regrowth. New England, a geographically rugged region of the United States, was reforested beginning a century or so ago. Settled early by Europeans, this mountainous region was having difficulty sustaining cropland productivity because soils were thin and vulnerable to erosion. As highly productive farmland opened up in the Midwest and the Great Plains during the nineteenth century, pressures on New England farmland lessened, permitting much of the land that was cropped to return to forest. Although the share of New England covered by forest has increased from a low of roughly one third two centuries ago to perhaps over three fourths today, this reforested area still has not regained its original health and diversity.[46]

A somewhat similar situation exists now in the republics of the former Soviet Union and in several East European countries. After the economic reforms in the early 1990s, which replaced central planning with market-based agriculture, farmers on marginal land simply could not make ends meet and were forced to seek their livelihoods elsewhere. Precise figures are difficult to come by, but millions of hectares of farmland are now returning to forest, much as happened in New England.[47]

Perhaps the most successful national reforestation effort is the one undertaken in South Korea beginning more than a generation ago. By the end of the Korean War, South Korea was almost totally deforested by a combination of heavy logging and reliance on fuelwood during the Japanese occupation. Despite being one of the world's poorest countries, it launched a national reforestation program. Trees were planted on mountainsides throughout the country. While driving across South Korea in November 2000, I was thrilled to see the luxuriant stand of trees on mountains that a generation ago were bare. It made me even more confident that we can reforest the earth.

This model reforestation program helps explain why North Korea regularly has floods and droughts, while South Korea does not. South Korea benefits from the flood control services of reforested mountains, and with the forests' capacity to store water and

recharge aquifers, the nation rarely faces serious drought. Environmental degradation is contributing to chronic famine in one country while environmental restoration helped set the stage for economic success in an adjacent nation.

In Turkey, a mountainous country largely deforested over the millennia, one leading environmental group, TEMA (Turkiye Erozyonia Mucadele, Agaclandima), has made reforestation its principal activity. Founded by two prominent Turkish businessmen, Hayrettin Karuca and Nihat Gokyigit, TEMA has launched a 10-billion-acorn campaign to restore tree cover and reduce runoff and soil erosion. In 1998, it mobilized forestry ministry staff, army units, and volunteers to plant 45 million acorns, 15 million of which were expected to emerge as seedlings. Aside from the planting of acorns, this program is raising national awareness of the services that forests provide.[48]

China also is engaging in a reforestation effort. In addition to planting trees in the recently deforested upper reaches of the Yangtze River basin to control flooding, China is planting a belt of trees across its northwest to protect land from the expanding Gobi Desert. This green wall, a modern version of the Great Wall, is some 4,480 kilometers (2,800 miles) long. An ambitious, long-term plan, it is projected to take 70 years. One local village leader said, "We'll plant trees every day for five years. And if that doesn't work, we'll plant for five more. That's what they tell us." Residents in this region are no longer permitted to burn wood for heating or cooking. The raising of animals, other than for household use, is also banned.[49]

But this green wall treats the symptoms of declining rainfall and desertification in the northwest, not the need to restore rainfall in the region by restoring the forests in the southern and eastern provinces that help recycle rainfall inland. An official within the Ministry of Agriculture's ecology section worries that Beijing lacks a cohesive, comprehensive plan. He sees tree planting as a positive step, but thinks grasses need to be planted first to stabilize the soil. He says, "But everything is going fast now and there is no master plan."[50]

In response to water shortages in the north, China is now planning to construct two major south-north water diversions, each of which will cost tens of billions of dollars. If completed, they will bring water from the south to the north, but they will not restore

the rainfall that is desperately needed in the northwest if the vegetation and ecological health of the region is to be restored.[51]

Wang Honchang of the Chinese Academy of Social Sciences has proposed reforestation and tree planting wherever possible to recycle more water to the interior. This might well carry more water from south to north than the diversion canals that are being planned, and at a lower cost.[52]

Shifting subsidies from building logging roads to tree planting would increase tree cover worldwide. The World Bank has the administrative capacity to lead an international program that would emulate South Korea's success in blanketing mountains and hills with trees.

In addition, FAO and the bilateral aid agencies can work with individual farmers in national agroforestry programs to integrate trees wherever possible into agricultural operations. Aptly chosen and well-placed trees provide shade, serve as windbreaks to check soil erosion, and fix nitrogen, which reduces the need for fertilizer. The only forest policy that is environmentally acceptable is one that expands the earth's tree cover.

A successful effort to reclaim the earth calls for a global reforestation effort, coordinated country by country, integrated with population planning and improved efficiency of fuelwood burning. Reducing wood use by developing alternative energy sources as well as systematically recycling paper and using fewer forest products are integral components of the campaign to lighten pressure on the land. With such an integrated plan, humanity can arrest the spread of deserts that threatens agriculture and human settlements in so many countries.