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Restoring the Economy's Natural Support Systems

Pakistan's record flooding in the late summer of 2010 was the most devastating natural disaster in the country's history. The media coverage reported torrential rains as the cause, but there is much more to the story. When Pakistan was created in 1947, some 30 percent of the landscape was covered by forests. Now it is 4 percent. Pakistan's livestock herd outnumbers that of the United States. With little forest still standing and the countryside grazed bare, there was scant vegetation to retain the rainfall.[1]

Pakistan, with 185 million people squeezed into an area only slightly larger than Texas, is an ecological basket case. If it cannot restore its forests and grazing lands, it will only suffer more "natural" disasters in the future. Pakistan's experience demonstrates all too vividly why restoration of the world's forests, grasslands, and soils is an integral part of Plan B. In this chapter we lay out both a plan for saving these natural support systems and a budget for doing so.[2]

Restoring the earth will take an enormous international effort, one far more demanding than the Marshall Plan that helped rebuild war-torn Europe and Japan after World War II. And such an initiative must be undertaken at wartime speed before environmental deterioration translates into economic decline, just as it did for the

Sumerians, the Mayans, and many other early civilizations whose archeological sites we study today.

Protecting the 10 billion acres of remaining forests on earth and replanting many of those already lost, for example, are both essential for restoring the earth's health. Since 2000, the earth's forest cover has shrunk by 13 million acres each year, with annual losses of 32 million acres far exceeding the regrowth of 19 million acres.[3]

Global deforestation is concentrated in the developing world. Tropical deforestation in Asia is driven primarily by the fast-growing demand for timber and increasingly by the expansion of oil palm plantations for fuel. In Latin America, in contrast, the fast-growing markets for soybeans and beef are together squeezing the Amazon. In Africa, the culprit is mostly fuelwood gathering and land clearing for agriculture.[4]

Fortunately, there is a vast unrealized potential in all countries to lessen the various demands that are shrinking the earth's forest cover. In industrial nations, the greatest opportunity lies in reducing the amount of wood used to make paper. The use of paper, perhaps more than any other single product, reflects the throwaway mentality that evolved during the last century. The challenge is to replace facial tissues, paper napkins, and paper shopping bags with reusable cloth alternatives.

The goal is first to reduce paper use and then to recycle as much as possible. The rates of paper recycling in the top 10 paper-producing countries range widely—from China and Finland on the low end, recycling less than 40 percent of the paper they use, to Japan and Germany on the higher end, each between 70 and 80 percent, and South Korea, which recycles an impressive 91 percent. The United States, the world's largest paper consumer, is far behind the leaders, but it has raised the share of paper recycled from roughly 20 percent in 1980 to 59 percent in 2009. If every country recycled as much of its

paper as South Korea does, the amount of wood pulp used to produce paper worldwide would drop by more than one third.[5]

In developing countries, the focus needs to be on reducing fuelwood use. Indeed, fuelwood accounts for just over half of all wood removed from the world's forests. Some international aid agencies, including the U.S. Agency for International Development, are sponsoring fuelwood efficiency projects. In September 2010, the United Nations Foundation, leading a coalition of groups, announced plans to get 100 million more-efficient stoves into homes by 2020. Highly efficient cookstoves not only use far less wood than traditional stoves, they also pollute less. Over the longer term, pressure on forests can be reduced by replacing firewood with solar thermal cookers or even with electric hotplates powered with renewable energy.[6]

Another challenge is to harvest forests responsibly. There are two basic approaches to timber harvesting. One is clearcutting. This practice is environmentally devastating, leaving eroded soil and silted streams, rivers, and irrigation reservoirs in its wake. The alternative is simply to cut only mature trees on a selective basis, leaving the forest largely intact. This ensures that forest productivity can be maintained in perpetuity.

Forest plantations can reduce pressures on the earth's remaining forests as long as they do not replace old-growth forest. As of 2010, the world had 652 million acres in planted forests, more than one third as much land as is planted in grain. Tree plantations produce mostly wood for paper mills or for wood reconstitution mills. Increasingly, reconstituted wood is substituted for natural wood as lumber and construction industries adapt to a shrinking supply of large logs from natural forests.[7]

Six countries account for 60 percent of productive tree plantations. China, which has little original forest

remaining, is by far the largest, with 134 million acres. India and the United States follow, with 42 million acres each. Russia, Canada, and Sweden are close behind. As tree farming expands, it is starting to shift geographically to the moist tropics, where yields are much higher. In eastern Canada, one hectare (2.47 acres) of forest plantation produces 4 cubic meters of wood per year. In the southeastern United States, the yield is 10 cubic meters. But in Brazil, newer plantations are getting close to 40 cubic meters.[8]

The U.N. Food and Agriculture Organization projects that as plantation area expands and yields rise, the harvest could more than triple between 2005 and 2030. It is entirely conceivable that plantations could one day satisfy most of the world's demand for industrial wood, thus helping protect the world's remaining natural forests.[9]

Planting trees on degraded or disturbed land not only reduces soil erosion, it also helps pull carbon dioxide (CO_2) out of the atmosphere. In recent years, the shrinkage of forests in tropical regions has released 2.2 billion tons of carbon into the atmosphere annually. Meanwhile, expanding forests in the temperate regions are absorbing close to 700 million tons of carbon. On balance, therefore, some 1.5 billion tons of carbon are released into the atmosphere each year from forest loss, roughly one fourth as much as from fossil fuel burning.[10]

The Plan B goals are to end net deforestation worldwide and to sequester carbon through a variety of tree planting initiatives and the adoption of improved agricultural land management practices. Although banning deforestation may seem far-fetched, environmental damage has pushed Thailand, the Philippines, and China to implement partial or complete bans on logging. All three bans followed devastating floods and mudslides resulting from the loss of forest cover.[11]

In China, after suffering record losses from weeks of

nonstop flooding in the Yangtze River basin in 1998, the government noted that when forest policy was viewed not through the eyes of the individual logger but through those of society as a whole, it simply did not make economic sense to continue deforesting. The flood control service of trees standing, they said, was three times as valuable as the timber from trees cut.[12]

Protecting the earth's soil also warrants a worldwide ban on the clearcutting of forests in favor of selective harvesting, simply because each successive clearcut brings heavy soil loss and eventual forest degeneration. Restoring the earth's tree and grass cover, as well as practicing conservation agriculture, protects soil from erosion, reduces flooding, and sequesters carbon.

International environmental groups such as Greenpeace and WWF have negotiated agreements to halt deforestation in the Brazilian Amazon and in parts of Canada's boreal forests. Daniel Nepstad and colleagues reported in *Science* in 2009 on two recent developments that together may halt deforestation in the Amazon basin. One is Brazil's Amazon deforestation reduction target that was announced in 2008, which prompted Norway to commit $1 billion if there is progress toward this goal. The second is a marketplace transition in the beef and soy industries to avoid Amazon deforesters in their supply chains.[13]

If Brazil's Amazon rainforest continues to shrink, it may also continue to dry out, becoming vulnerable to fire. If this rainforest were to disappear, it would likely be replaced largely by desert and scrub forestland. The reduced capacity of the rainforest to cycle water to the interior of the continent would threaten the agricultural areas in the west and south.

Recognizing the central role of forests in modulating climate, the Intergovernmental Panel on Climate Change has examined the potential for tree planting and

improved forest management to sequester CO_2. Since every newly planted tree seedling in the tropics removes an average of 50 kilograms of CO_2 from the atmosphere each year during its growth period of 20–50 years, compared with 13 kilograms of CO_2 per year for a tree in the temperate regions, much of the afforestation and reforestation opportunity is found in tropical countries.[14]

What is needed is a tree planting effort to both conserve soil and sequester carbon. To achieve these goals, billions of trees need to be planted on millions of acres of degraded lands that have lost their tree cover and on marginal croplands and pasturelands that are no longer productive.

This global forestation plan to remove atmospheric CO_2 would need to be funded by the industrial countries that put most of it there. In comparison with other mitigation strategies, stopping deforestation and planting trees are relatively inexpensive. They pay for themselves many times over. An independent body could be set up to administer and monitor the vast tree planting initiative. The key is moving quickly to stabilize climate before temperature rises too high, thus giving these trees the best possible chance of survival.[15]

There are already many tree planting initiatives proposed or under way. Kenya's Nobel laureate, Wangari Maathai, who years ago organized women in Kenya and several nearby countries to plant 30 million trees, inspired the Billion Tree Campaign that is managed by the U.N. Environment Programme. The initial goal in 2006 was to plant 1 billion trees. If half of those trees survive, they will sequester 5.6 million tons of carbon per year. By the end of 2009, over 10 billion trees had been planted.[16]

Some state and provincial governments have also joined in. Uttar Pradesh, India's most populous state, mobilized 600,000 people to plant 10.5 million trees in a

single day in July 2007, putting the trees on farmland, in state forests, and on school grounds. Since then, India has planted 2 billion additional trees. China, which has planted 2.9 billion trees, is now the leader in the Billion Tree Campaign. Among the other leaders in this initiative are Ethiopia, with 1.5 billion trees, and Turkey, with over 700 million trees planted.[17]

Some countries reforest on their own. South Korea is in many ways a reforestation model for the rest of the world in this respect. When the Korean War ended half a century ago, the mountainous country was largely deforested, much as Haiti is today. Beginning around 1960, under the dedicated leadership of President Park Chung Hee, the South Korean government launched a national reforestation effort. Hundreds of thousands of people were mobilized in village cooperatives to dig trenches and to create terraces for supporting trees on barren mountains. Se-Kyung Chong, a researcher at the Korea Forest Research Institute, notes that "the result was a seemingly miraculous rebirth of forests from barren land."[18]

Today forests cover nearly 65 percent of the country, an area of more than 15 million acres. While driving across South Korea in November 2000, it was gratifying to see the luxuriant stands of trees on mountains that a generation earlier were bare. We can reforest the earth![19]

Planting trees is just one of many activities that will remove meaningful quantities of carbon from the atmosphere. Improved grazing and land management practices that increase the organic matter content in soil also sequester carbon.

The 1930s Dust Bowl that threatened to turn the U.S. Great Plains into a vast desert was a traumatic experience that led to revolutionary changes in American agricultural practices, including the planting of tree shelterbelts (rows of trees planted beside fields to slow wind and thus reduce wind erosion) and strip cropping (the planting of

wheat on alternate strips with fallowed land each year). Strip cropping permits soil moisture to accumulate on the fallowed strips, while the alternating planted strips reduce wind speed and hence erosion on the idled land.[20]

In 1985, the U.S. Department of Agriculture, with strong support from the environmental community, created the Conservation Reserve Program (CRP) to reduce soil erosion and control overproduction of basic commodities. By 1990 there were some 35 million acres of highly erodible land with permanent vegetative cover under 10-year contracts. Under this program, farmers were paid to plant fragile cropland in grass or trees. The retirement of those 35 million acres under the CRP, together with the use of conservation practices on 37 percent of all cropland, reduced annual U.S. soil erosion from 3.1 billion tons to 1.9 billion tons between 1982 and 1997. The U.S. approach offers a model for the rest of the world.[21]

Another tool in the soil conservation toolkit is conservation tillage, which includes both no-till and minimum tillage. Instead of the traditional cultural practices of plowing land and discing or harrowing it to prepare the seedbed, and then using a mechanical cultivator to control weeds in row crops, farmers simply drill seeds directly through crop residues into undisturbed soil, controlling weeds with herbicides. The only soil disturbance is the narrow slit in the soil surface where the seeds are inserted, leaving the remainder of the soil covered with crop residue and thus resistant to both water and wind erosion. In addition to reducing erosion, this practice retains water, raises soil carbon content, and greatly reduces energy use for tillage.[22]

In the United States, the no-till area went from 17 million acres in 1990 to 65 million acres in 2007. Now widely used in the production of corn and soybeans, no-till has spread rapidly, covering 63 million acres in Brazil and

Argentina and 42 million in Australia. Canada, not far behind, rounds out the five leading no-till countries. Farming practices that reduce soil erosion and raise cropland productivity such as minimum-till, no-till, and mixed crop-livestock farming usually also lead to higher soil carbon content and soil moisture. In Kazakhstan, the 3 million acres in no-till seemed to fare better than land in conventional farming during the great Russian heat wave and drought of 2010.[23]

In sub-Saharan Africa, where the Sahara is moving southward all across the Sahel, countries are concerned about the growing displacement of people as grasslands and croplands turn to desert. As a result, the African Union has launched the Green Wall Sahara Initiative. This plan, originally proposed in 2005 by Olusegun Obasanjo when he was president of Nigeria, calls for planting a 4,300-mile band of trees, 9 miles wide, stretching across Africa from Senegal to Djibouti. Senegal, which is losing 124,000 acres of productive land each year and which would anchor the green wall on the western end, has planted 326 miles of the band. A $119-million grant from the Global Environment Facility in June 2010 gave the project a big boost. Senegal's Environment Minister, Modou Fada Diagne, says, "Instead of waiting for the desert to come to us, we need to attack it." One key to the success of this initiative is improving management practices, such as rotational grazing.[24]

In the end, the only viable way to eliminate overgrazing on the two fifths of the earth's land surface classified as rangelands is to reduce the size of flocks and herds. Not only do the excessive numbers of cattle, sheep, and goats remove the vegetation, but their hoofs pulverize the protective crust of soil that is formed by rainfall and that naturally checks wind erosion. In some situations, the preferred option is to keep the animals in restricted areas, bringing the forage to them. India, which has successfully adopted this practice to build the world's largest dairy industry, is a model for other countries.[25]

Oceanic fisheries, another major source of animal protein, are also under intense pressure. For decades, governments have tried to save specific fisheries by restricting the catch of individual species. Sometimes this worked; sometimes it failed and fisheries collapsed. In recent years, support for another approach—the creation of marine reserves or marine parks—has been gaining momentum. These reserves, where fishing is banned, serve as natural hatcheries, helping to repopulate the surrounding area.[26]

In 2002, at the World Summit on Sustainable Development in Johannesburg, coastal nations pledged to create national networks of marine reserves or parks that would cover 10 percent of the world's oceans by 2012. Together these could constitute a global network of such parks.

Progress is slow. Today some 5,000 marine protected areas cover less than 1 percent of the world's oceans. Even more distressing, fishing is banned in only 12.8 percent of those areas. And a survey of 255 marine reserves reported that only 12 were routinely patrolled to enforce the ban.[27]

In 2001 Jane Lubchenco, former President of the American Association for the Advancement of Science and now head of the National Oceanic and Atmospheric Administration, released a statement signed by 161 leading marine scientists calling for urgent action to create the global network of marine reserves. Drawing on the research on scores of marine parks, she said: "All around the world there are different experiences, but the basic message is the same: marine reserves work, and they work fast. It is no longer a question of whether to set aside fully protected areas in the ocean, but where to establish them."[28]

Sea life improves quickly once the reserves are established. A case study of a snapper fishery off the coast of New England showed that fishers, though they violently opposed the establishment of the reserve, now champion it because they have seen the local population of snapper increase 40-fold. In the Gulf of Maine, all fishing methods that put groundfish at risk were banned within three marine reserves totaling 6,600 square miles. Unexpectedly, scallops flourished in this undisturbed environment, and their populations increased by up to 14-fold within five years. This buildup within the reserves also greatly increased the scallop population outside the reserves. Within a year or two of establishing a marine reserve, population densities increased 91 percent, average fish size went up 31 percent, and species diversity rose 20 percent.[29]

But the challenges we face are changing, and so must the response. The traditional approach to protecting biological diversity by building a fence around an area and calling it a park or nature preserve is no longer sufficient. If we cannot also stabilize population and climate, there is not an ecosystem on earth that we can save, no matter how high the fence.

We can roughly estimate how much it will cost to reforest the earth, protect topsoil, restore rangelands and fisheries, stabilize water tables, and protect biological diversity. The goal is not to offer a set of precise numbers but rather to provide a set of reasonable estimates for an earth restoration budget.[30]

In calculating reforestation costs, the focus is on developing countries, since forested area is already expanding in the northern hemisphere's industrial countries. Meeting the growing fuelwood demand in developing countries will require an estimated 140 million additional acres of forested area. Conserving soils and restoring hydrological stability would require another 250 million acres in thousands of watersheds in developing countries. Recognizing some overlap between these two, we will reduce the total to 380 million acres. Beyond this, an additional 75 million acres will be needed to produce lumber, paper, and other forest products.[31]

Only a small share of the tree planting will likely come from plantations. Much of it will be on the outskirts of villages, along field boundaries and roads, on small plots of marginal land, and on denuded hillsides. The labor for this will be local; some will be paid labor, some volunteer. Much of it will be rural off-season labor.

If seedlings cost $40 per thousand, as the World Bank estimates, and if the typical planting density is roughly 800 per acre, then seedlings cost $32 per acre. Labor costs for planting trees are high, but since much of the labor would consist of locally mobilized volunteers, we are assuming a total of $160 per acre, including both seedlings and labor. With a total of 380 million acres to be planted over the next decade, this will come to roughly 38 million acres per year at $160 each for an annual expenditure of $6 billion.[32]

Planting trees to conserve soil, reduce flooding, and provide firewood sequesters carbon. But because climate stabilization is essential, we tally the cost of planting trees for carbon sequestration separately. Doing so would reforest or afforest hundreds of millions of acres of marginal lands over 10 years. Because it would be a more commercialized undertaking focused exclusively on wasteland reclamation and carbon sequestration, it would be more costly. Assuming a value of sequestered carbon of $200 per ton, it would cost close to $17 billion per year.[33]

Conserving the earth's topsoil by reducing erosion to the rate of new soil formation or below has two parts. One is to retire the highly erodible land that cannot sustain cultivation—the estimated one tenth of the world's cropland that accounts for perhaps half of all excess erosion. For the United States, that has meant retiring nearly 35 million acres. The cost of keeping this land out of

production is close to $50 per acre. In total, annual payments to farmers to plant this land in grass or trees under 10-year contracts approaches $2 billion.[34]

In expanding these estimates to cover the world, it is assumed that roughly 10 percent of the world's cropland is highly erodible, as in the United States, and should be planted in grass or trees before the topsoil is lost and it becomes barren land. In both the United States and China, which together account for 40 percent of the world grain harvest, the official goal is to retire one tenth of all cropland. For the world as a whole, converting 10 percent of cropland that is highly erodible to grass or trees seems like a reasonable goal. Since this costs roughly $2 billion in the United States, which has one eighth of the world's cropland, the total for the world would be $16 billion annually.[35]

The second initiative on topsoil consists of adopting conservation practices on the remaining land that is subject to excessive erosion—that is, erosion that exceeds the natural rate of new soil formation. This initiative includes incentives to encourage farmers to adopt conservation practices such as contour farming, strip cropping, and, increasingly, minimum-till or no-till farming. These expenditures in the United States total roughly $1 billion per year.[36]

Assuming that the need for erosion control practices elsewhere is similar to that in the United States, we again multiply the U.S. expenditure by eight to get a total of $8 billion for the world as a whole. The two components together—$16 billion for retiring highly erodible land and $8 billion for adopting conservation practices—give an annual total for the world of $24 billion.[37]

For cost data on rangeland protection and restoration, we turn to the U.N. Plan of Action to Combat Desertification. This plan, which focuses on the world's dryland regions, containing nearly 90 percent of all rangeland,

estimates that it would cost roughly $183 billion over a 20-year restoration period—or $9 billion per year. The key restoration measures include improved rangeland management, financial incentives to eliminate overstocking, and revegetation with appropriate rest periods, during which grazing would be banned.[38]

This is a costly undertaking, but every $1 invested in rangeland restoration yields a return of $2.50 in income from the increased productivity of the earth's rangeland ecosystem. From a societal point of view, countries with large pastoral populations where the rangeland deterioration is concentrated are invariably among the world's poorest. The alternative to action—ignoring the deterioration—brings a loss not only of land productivity but also of livelihood, and ultimately leads to millions of refugees. Restoring vulnerable land will also have carbon sequestration benefits.[39]

For restoring fisheries, a U.K. team of scientists led by Andrew Balmford of the Conservation Science Group at Cambridge University has analyzed the costs of operating marine reserves on a large scale based on data from 83 relatively small, well-managed reserves. They concluded that managing reserves that covered 30 percent of the world's oceans would cost $12–14 billion a year. But this did not take into account the likely additional income from recovering fisheries, which would reduce the actual cost.[40]

At stake in the creation of a global network of marine reserves is not just the protection of fisheries but also a possible increase in the annual oceanic fish catch worth $70–80 billion. Balmford said, "Our study suggests that we could afford to conserve the seas and their resources in perpetuity, and for less than we are now spending on subsidies to exploit them unsustainably." The creation of the global network of marine reserves—"Serengetis of the seas," as some have dubbed them—would also create more than 1 million jobs.[41]

In many countries, the capital needed to fund a program to raise water productivity can come from eliminating subsidies that often encourage the wasteful use of irrigation water. Sometimes these are energy subsidies for irrigation, as in India; other times they are subsidies that provide water at prices well below costs, as in the United States. Removing these subsidies will effectively raise the price of water, thus encouraging its more efficient use. In terms of additional resources needed worldwide, including research needs and the economic incentives for farmers, cities, and industries to use more water-efficient practices and technologies, we assume it will take an additional annual expenditure of $10 billion.[42]

For wildlife protection, the World Parks Congress estimates that the annual shortfall in funding needed to manage and protect existing areas designated as parks comes to roughly $25 billion a year. Additional areas needed, including those encompassing the biologically diverse hotspots not yet included in designated parks, would cost perhaps another $6 billion a year, yielding a total of $31 billion.[43]

Altogether, then, restoring the economy's natural support systems—reforesting the earth, protecting topsoil, restoring rangelands and fisheries, stabilizing water tables, and protecting biological diversity—will require additional expenditures of just $110 billion per year. Many will ask, Can the world afford these investments? But the only appropriate question is, Can the world afford the consequences of not making these investments?

Data, endnotes, and additional resources can be found on Earth Policy's Web site, at www.earth-policy.org.