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9. ABSTRACT

Agricultural practices are destroying the soil in developing nations where population pressures result in conversion of hilly land to crop production. The emphasis in this paper is on new technical information that will help save hillsides and valley lands from being rendered incapable of growing future crops. Five policy implications based on current knowledge are offered: (1) If the legal framework existed to assure a tenant who invests in terraces or forests that he could retain the land for the number of years required to attain a reasonable rate of return, he might invest in soil-preserving measures; (2) If hillside squatters' tenure rights could be made secure, they would be more apt to attempt conservation practices; (3) If hillside-farmer organizations were set up and incentives provided, grass-roots leadership potential could be developed; (4) If soil conservation techniques were made available and emphasized, as much as seeds and fertilizer, in a package of follow-up inputs to land reform, steeper gradients might be saved; (5) If zoning procedures could be set up so that industry and transportation systems would have to use unproductive hillsides, with basins reserved for agriculture, there would be more time to allow for curtailment of the rapid rise in population. In many countries, land deterioration will not halt until governments make basic changes in land tenure laws and national economic priorities.

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HILL LAND FARMING: AN INTERNATIONAL DIMENSION\*

by

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## HILL LAND FARMING: AN INTERNATIONAL DIMENSION\*

William C. Thiesenhusen\*\*

. . . even the battles to purify the noxious clouds over Tokyo and São Paulo, and to restore life to Lake Erie are but skirmishes compared to the uncontested routs being suffered in the hills of Nepal and Java, and on the rangelands of Chad and northwest India. A far deadlier toll, and perhaps an even greater threat to future human welfare than that of the pollution of our air and water is that exacted by the undermining of the productivity of the land itself. . . . Not surprisingly, the principal victims of these trends are the world's poor who, in their quest for food and fuel, are often forced by circumstances and institutions beyond their control to serve as the agents of their own undoing. Though poverty is often associated with a pristine environment, and affluence with despoliation, in some important ways the poor are damaging the environment even more than the rich. . . . Today the human species has the knowledge of past mistakes, and the analytical skills, to halt destructive trends and to provide an adequate diet for all using lands well-suited for agriculture. The mounting destruction of the earth's life-supporting capacity is not the product of a preordained, inescapable human predicament, nor does the reversal of the downward slide depend upon magical scientific breakthroughs. Political and economic factors, not scientific research, will determine whether or not the wisdom accumulating in our libraries will be put into practice.

- Erik P. Eckholm  
Losing Ground  
1976

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I.

Contemporary economists are interested in hill farming because of the inescapable fact that all over the Third World, and at an ever-increasing pace, slopes and hillsides are yielding to the pressure of population growth. The phenomenon is hardly new; in every thickly populated region most fertile valley soils have long since been developed and exploited. In some established farming areas near the equator, public efforts to control such diseases as malaria and sleeping sickness, together with road construction, have permitted population to move from the highlands to the hot, humid lowlands. Governmental programs of irrigation and reclamation have allowed new or more intensive use of some other lowland areas. But most of the new land coming into agriculture through the efforts of individual farmers has been steep or sloping land, and population growth has relentlessly speeded its exploitation.

If economic implications were examined by themselves, some complex interconnections among social, biological, and physical factors would be overlooked. A simple description of what typically happens as hill lands are converted to farming may help to keep them in focus. Where hills are a predominant topographical feature, the trees in the valleys are first removed to make way for sedentary agriculture (often row crops). Forests in the highlands continue to protect life in the lowlands, providing ground cover for easily erodible slopes and also furnishing firewood for the valley dwellers.

As population grows, young people establish new farms or enlarge their holdings by pushing on to foothills and even steeper gradients, necessarily cutting the trees that grow there. When trees at these levels have been removed for farming, rural families begin to take firewood from even higher slopes. As the forest border recedes, more and more hillside soils (which are often of lower quality) and forest litter wash down into the valleys, covering prime fields. As forests become increasingly distant, cow dung becomes a reasonable substitute for firewood as fuel. (Kerosene is usually much too costly for day-to-day use in farming communities of the kind I have been describing.) Every unit of dung burned as fuel means one less unit available to restore the natural fertility of the soil.

In the humid tropics, the picture involves additional complexities. Because rainfall there is so intense, the destruction of ground cover for row crops is a questionable practice even in the valleys. When hillsides are laid bare, rivers and irrigation canals become clogged and valleys silted with startling swiftness.

The consequences I have described are dramatic, but their coming is so gradual (and, once begun, so inexorable) that little has been done to modify their impact on the livelihood of people in the immediate area or other areas linked to it by ecology, products sold, or labor exported.

This simple case is repeated, with infinite variations, in dozens of poor countries today. For many of them it has been translated into the dominant issue of the food-population-environment controversy.

Growing consciousness of the breadth and seriousness of this problem, is sure to bring insistent demands for economists to contribute to policy analyses. To do so, they will need many of the traditional economist's tools and kinds of data: costs, returns, and feasibilities for this steady movement up the slopes compared to the alternatives of using existing land more intensively, moving people elsewhere, or generating nonagricultural employment, costs and availability of firewood, kerosene, electricity, and other fuels. But an economist's policy prescriptions will be grossly misleading if he does not also utilize data on soil and weather in evaluating the capability to sustain human enterprises at successively higher locations and the feasibility of such soil conservation procedures as contouring and terracing. How do different kinds of soils react when ground cover is broken and they are exposed to intense heat and driving rainfall? (If heat is intense enough, nutrient sources may be destroyed; if water movement is rapid enough, nutrients themselves may be washed away.) How do new crops or new varieties respond to soils and water or fertilizer treatments to which they have not before been exposed? What constraints of imagination and action do the people face when they have no off-farm employment opportunities, uncertain or insecure rights to the land they farm, no experience (or bad experience) with group action to solve their problems, and little community leadership or group identity? What problems are posed when this process results in a face-off between two cultures, one from the mainstream and the other for centuries closed off from it? Issues like these remind us of the futility of studying problems of humans as if they were packaged as disciplinary units. Although I will try to extract some of the socio-economic problems from questions like this, it should be obvious that they cannot be treated adequately without the expertise of the agronomist, the soil scientist, the engineer, and the botanist.

## II.

Economists who study hill lands in the context of the contemporary international food problem tend to focus on marginality of agricultural production, an issue best formulated in an earlier epoch by Ricardo, one of the first true economists. In 1817 he provided a theoretical framework linking capital, labor, and land which posited the centrality of the population-agriculture issue. He saw land as the factor which ultimately would limit economic expansion. In meeting larger demands for food, he reasoned, successive employment of units of either labor or capital on a land supply that is essentially fixed will bring diminishing returns of agricultural output to those factors.

As poorer lands are brought under cultivation (the idea that the supply of land is fixed was modified only by the fact that less agriculturally appropriate land could be added), competition among those who farm for the better grades of land causes a portion of the produce of the land to be transferred to landowners. This return is "rent," or that portion of the produce which is paid to the landlord for the use of the "original and indestructable powers of the soil."

Ricardo's views were in marked contrast to the philosophical optimism of many thinkers of his time; his theoretical constructs at the same time brought some rigor to Malthus' pessimism. William Godwin in 1793 had excoriated the present but had seen a future in which "there would no longer be a handful of rich and a multitude of poor. . . . [T]here will be no disease, anguish, melancholy, or resentment." It was inevitable that such optimism would bring a reaction, and Malthus, in providing it, formulated the raw material for Ricardo's ideas. Malthus wrote in 1798 that population would outstrip all possible means of subsistence. Far from ascending to higher levels, mankind was caught in a hopeless trap in which it would be driven to the brink of existence, condemned to a losing battle between population growth and the insufficiency of nature's larder.

Ricardo was responsible for casting Malthus' ideas into a theory--now we would call it a model. His early eighteenth century economic world was a dynamic one, but the stationary state was right around the corner. As capitalists reinvested, new shops and factories would appear. Demand for laborers would increase, but their temporarily higher wages, he prognosticated, would simply mean that workers would multiply faster. As they did, more food would be needed, and poorer and poorer lands would be required to feed the now expanded labor force. In Ricardo's formulation, the capitalist makes growth possible because he reinvests. Since food supply couldn't expand fast enough, the selling price of agricultural produce would rise and, naturally, so would the returns (rent) to landlords. But the landlord's rent is not reinvested and, in order for Ricardo's construct to make sense, the landlord and the capitalist are never the same person. The process of growth squeezes the capitalist doubly: first, by an increased number of workers, to whom he must pay at least a subsistence wage; and second, by the landlord--a most pernicious character--whose rents rise as less productive land is pushed into cultivation. If capitalist and worker are the active participants in the economic process, the landlord is at best a passive beneficiary. When wages rise to reduce all profits to zero, the growth process stops, for the capitalist has no more incentive to invest.

For most of humanity, the nineteenth century did not bring the dreary outcome presaged by Ricardo, nor has the first three quarters of the twentieth. Some believe his ideas to be hopelessly dated; I believe that to avoid their implications will take positive planning. When wheatfields began creeping up the hillsides of England in the last century, they were stopped by a rather simple mechanism: imports of grain. Industrialists lobbied hard for freer international trade and cheap food for workers, and they got it. Also, Malthus and Ricardo were wrong about population growth for their era: it did not proceed on the rampant course they had forecast. Another limitation, perhaps the most decisive, in Ricardian theory was its lack of recognition that there are more ways to increase agricultural production than by simply bringing more land into production. The unprecedented innovations of the last century and a half made it possible to keep food production up with population growth without moving to successively poorer land. Indeed, applying technology to produce a surplus in areas naturally suited to agriculture has been the cheapest way to add to the indigenous food supply.

There is another side to this coin. Just as Ricardo didn't foresee land-saving technology, neither did he, writing in England where rainfall is gentle and hills are slightly rolling (and at the time quite amply covered with natural grass and trees), imagine the havoc that man could wreak by despoiling natural resources.

But the food-population issue is again before us, about a century and a half after Ricardo set down his thoughts in orderly form. Now, the setting is different: the contemporary less developed countries--which were then underpopulated and entered into no one's calculus--are the problem. Today the ideas of these four first social scientists look less preposterous than they did even a decade ago:

1. Population is growing at a rate unprecedented in human history and it is more than simple tautology to observe that this growth is greatest where agricultural land is under the most pressure. Most demographers think that the current population of the world will not quite double by the end of the century, but exactly how fast it is growing is a moot point--growth is quick enough to cause alarm to every thinking human being. Even now the experts are having a difficult time figuring out how more can be produced in some areas, or, where there are bumper crops, how they can be distributed from those who have too much to those who don't have enough.<sup>1</sup>

2. The margins for sustaining less developed countries through international trade are not so large as in the recent past.<sup>2</sup> The United States is the largest exporter of grain, but most must be paid for in hard currency. The prospect is that, if events continue on their present course, less developed countries will become increasingly dependent on the United States, an unsatisfactory solution for both us and them.

3. Most dramatic increases in rates of population growth are occurring in tropical areas where we know least about producing more from a fixed land base: most of our agricultural technology comes from the

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1. With a number of provisos, the tone of one recent compendium of articles on the world food problem is more optimistic than most. See "Food and Agriculture," Scientific American (September 1976).

2. Of course, there are resources that, at a substantial cost, can be pressed into use in developed countries to produce what less developed countries need. "The best arable land in the United States is already in production. . . . To feed a growing U.S. population or increase the world per capita diet (or both), the amount of cropland under cultivation can be increased or the productivity of the land already cultivated can be increased. Either course would require enormous amounts of energy and could not be continued indefinitely. Major reclamation projects would be required to drain, grade, and irrigate the estimated 75 million acres [30.36 million hectares] in the United States that are potentially arable." D. Pimentel, et al., "Land Degradation: Effects on Food and Energy Resources," Science 194 (8 October 1976): 153. Currently about 154 million hectares of the arable land in the United States are under cultivation.

temperate zone. It is one irony of soils in the tropics that somewhat sloping lands may be more attractive for farming purposes than flat land because the hills receive nutrients from the underlay of parent rock. Some combination of heat, moving water, and rock results in soil formation. Flatlands may have little mineral base or minerals are leached out. Of course, if hills are too steep, soils may be formed and quickly made inaccessible because of erosion. So life becomes an important balance between such factors as degree of slope, speed of water, depth of mineral source, and temperature. Finding that balance is a researchable matter.

4. Despoliation of the environment due to overgrazing, erosion, and leaching is rampant. While it has been so for years, it is more serious now and has been recognized as a critical worldwide problem only in the last decade or so. (Of course, it was considered serious in the United States, beginning with the dust-bowl days of the 1930s, but an international problem wasn't recognized.)

So in addition to curbing population growth and increasing production, some attention needs to be given to the preservation of marginal areas such as hillsides, which are increasingly being inhabited and expected to provide the sustenance for growing populations.

### III.

Of course, there are reasons other than the sheer pressure of population why people live on hillsides, and have done so for centuries, which have little or nothing to do with these exigencies of the modern day.

1. In some areas of the world, hills serve either as enclaves of cultural identity, as refuges from the discrimination of the lowlanders, or as convenient strongholds for those who are considered by the majority as the least desirable members of society (who would presumably otherwise have to be dealt with in more meaningful, probably integrative, ways). This depends on the country in question and the analyst's political philosophy.<sup>3</sup>

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3. "Each of the modern nations of Southeast Asia includes a nucleus of plains people who form, in each case, a relatively homogeneous and dense population. Each of these peoples speaks a single dominant language, is characterized by adherence to one of the world's great religions, and is subsistence based upon intensive 'wet rice' agriculture. But each of the countries also includes a minority of hill people, who are always far more heterogeneous. They speak a multitude of languages, have no political unity among themselves, and until the last century have never had more than tenuous political ties with the plains. The hill people usually practice shifting agriculture and have been much slower to become Buddhists, Hindus, or Muslims than have their neighbors on the plains." Robbins Burling, Hill Farms and Padi Fields: Life in the Mainland Southeast Asia (Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1965), p. 4. For a more dynamic approach which shows acculturation, see Ben J. Wallace, Hill and Valley

2. In some tropical areas of the world, less productive hills were occupied to escape the malarial lowlands. With the disappearing threat of malaria, there is movement in some countries to the as yet uncharted lowland areas. But the temperate climate, the familiarity of the environment, and the religious overtones which attend some ancestral lands hinder depopulation.

3. Some tropical hillsides are farmed to provide a more diversified cropping pattern, more work throughout the year, or for a more adequate, well-balanced supply of life's necessities than would be possible in their absence. In the tropics, small-acreage farmers may have sugarcane in the lowlands, temperate vegetables and row crops at, say, 3,000 meters, and pasturage further up.<sup>4</sup> In some Central American countries, large-scale

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Farmers (Cambridge, Mass., and London, Eng.: Schenkman Publishing Company, 1970).

4. "Agriculture is the principal activity of the residents of Uchumarca [a village located east of the Marañon River in northern Peru]. Here, the Andes provide a complex mosaic of micro-environments within a limited radius. The Uchumarquiños use land which ranges from 800 to 4300 meters in altitude. They divide this area into seven zones (moving from lowest to highest altitude) . . . .

"Temple (1280-1500 meters in altitude). This is the lowest and hottest zone, the smallest in area, and the most intensively cultivated. Irrigation accompanies all cultivation. The major crops are sugar cane, coca, maize, sweet potatoes, and bananas. They are grown principally for cash sale.

"Kichwa Fuerte (1500-1900 meters). This is a steeply sloped zone which contains the least amount of level land. It is extremely susceptible to drought and because of this was largely abandoned between 1965 and 1970. Given sufficient rainfall, wheat and maize can be grown successfully, as can alfalfa for cattle feed. Some households specialize in raising guinea pigs (cuyes) and chickens for trade in the upper valley. Fairly dense stands of shrubs and trees provide firewood for the village.

"Kichwa (1900-2450 meters). Rainfall is more dependable here so there is no irrigation and both the amount of cultivable land and the size of plots are greater than in the two lower zones. This is the primary grain-producing zone. Major crops are wheat and maize; secondary crops are beans, alfalfa, maguey, barley, and some fruits. Wheat grown in this zone is the single most important crop in the diet of the valley in terms of both calories and proteins.

"Templado (2450-2800 meters). This is an intermediate zone, sharing some characteristics with those above and below. It is marked by fairly steep slopes and hence a reduced area for cultivation. In the lower part of the zone wheat, maize, and barley are grown. In the upper part some varieties of potato, kidney beans, and broad beans are grown. Two crops--lentajas (lentils) and arvejas (peas--a principal subsistence crop)--are grown only in this zone.

"Jalka (2800-3500 meters). This is the highest agricultural zone of the valley; above its limits the threat of frost is too constant. The

farmers may have cotton at sea level, corn a little higher, and coffee on the steeper slopes. In parts of China, hill land provided fuel and green manure for the rice farmer whose main fields were in the plain. In certain low-lying rice areas, which are liable to severe flooding, it is advantageous to have a small patch of higher land to use as a seed nursery, even though the two plots are not contiguous.<sup>5</sup> In Sri Lanka, comparative advantage for the export market was in coffee and later tea, both grown on hillsides.

4. Some hillsides are occupied by small-scale farmers because it is their historic legacy. Colonial settlement may have created a land tenure pattern of latifundia estates in the rich valley land which left the vast

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valley widens here and the hillsides become less steep. Potatoes are the major crop. Other Andean tubers are also grown as are barley and broad beans. Some animals are pastured here.

"Jalka Fuerte (3500-4300 meters). The most important use of this zone is grazing of animals on communally owned pastures. These animals are kept largely for their natural increase, which is sold, rather than as sources of milk, cheese, and meat. Sheep are also valued for their wool.

"Ceja de Montaña (2500 meters and below). The largest portion of this zone lies on the east side of the Andean cordillera. Heavy vegetation, rainfall, moisture, low soil fertility, and rugged terrain make cultivation virtually impossible. Lumber is cut here and wild animals are hunted. A limited amount of slash-and-burn agriculture (producing maize and beans) is practiced on the lower portions of this zone.

"It is difficult to state the number of regions in which the villagers have access to plots. The ideal, of course, is all seven. My impression is that almost every household has access to plots in an average of four to five zones--as owner, sharecropper, or day laborer whose wages are paid in the produce cultivated. It appears that the resources of land and labor are adequate for the village as a whole. There are, however, differences in resource distribution among households. Land and labor are distributed by a number of reciprocal relationships which are established primarily through kinship links. The most important of these is sharecropping, and others include exchange of labor and exchange of food."

Stephen Brush, "A Study of Subsistence Activities in Uchucmarca, Peru," Land Tenure Center Newsletter no. 40 (April-June 1973), p. 10. See also Stephen Brush, "Subsistence Strategies and Vertical Ecology in an Andean Community: Uchucmarca, Peru" (Ph.D. diss., University of Wisconsin-Madison, 1973); Emil Haney, "Possibilities for the Economic Reorganization of Minifundia in a Highland Region of Colombia," Land Tenure Center Research Paper no. 43 (November 1971).

5. Fragmentation may be a problem in farming patterns like this. See Sir Bernard O. Binns, "The Consolidation of Fragmented Agricultural Holdings," FAO Agricultural Studies no. 11 (Washington: United Nations Food and Agriculture Organization, 1950.) As intimated in the last footnote, fragmentation is not always bad: the small pieces that are farmed may be intricately combined to allow a subsistence farmer to minimize his risk by taking advantage of different slope, soil, or even climate.

majority of those in agriculture in a marginal position. In order for peasants to obtain subsistence, hillsides were the only possibility. In times when their estates were in danger from a rebellious group of nonowner peasants, the owners may have parceled out some of their hillsides in order to placate the land-hungry poor. If there had been a dynamic labor market (if, for example, unskilled labor was needed in cities), these mini-plot farmers would have sold out long ago. If there had been a dynamic land market, any large holdings not intensively farmed might be available to make better use of their labor source. When such is not the case--and in most less developed countries it has not been--historic patterns become congealed.<sup>6</sup> The origin of some upland farms is a temporarily improved urban labor market which caused landlords to give out some nearby, but marginal, plots to assure a seasonal labor supply at times of peak labor needs, like seeding and harvest.

Nadel has described the contemporary results of such a historic phenomenon in one setting:

A Guatemalan campesino needs total concentration, all his ingenuity, to raise enough food for his family. The best land was long ago seized by the latifundistas [sic], the landowners on the great plantations on the lowland and Pacific coast who grew coffee, bananas, and sugar. The Indians were forced into the mountains. They plant on slopes as steep as sixty-five degrees. Every year, there are Indians who fall to their death from the cornfields.<sup>7</sup>

5. Some farms in the tropics are located on hillsides because clearing of vegetation may be easier there than in the more humid valleys: fire usually burns more intensively and kills unwanted vegetation more surely there than on level land. Fire control there is often easier because fire only burns up a hill, never down, and tree trunks that are felled can be easily pushed down a slope and out of the way. Thus hill land farms may be sought out by those with little capital and having only fire power and brawn, regardless of the fertility of that land.<sup>8</sup>

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6. No one who has observed the rebuilding of a community--whether rural or urban--after, say, a devastating earthquake or a raging flood, even when community members have full knowledge that such natural catastrophe is likely to occur again, ceases to marvel at the persistence of some settlement patterns.

7. Gerry Nadel, "Guatemala," The Atlantic Monthly (July 1976), p. 19. A variant on this theme is provided by Mario Góngora, Origen de los Inquilinos de Chile Central (Santiago: Editorial Universitaria, 1960).

8. Homer Aschmann, "Hillside Farms, Valley Ranches," Landscape (Winter 1955-56): 18-24.

IV.

Given the fact that more of the world is hilly than flat, it is rather remarkable that little direct attention has been given to the economics of hillside agriculture. That this will not be true over the long run is probably due to a number of interrelated reasons:

1. Population has been growing so rapidly that it necessitates the use of severely sloping land in some countries. Every ecological area seems to have its own problem related to soil conservation to which a certain amount of research has been given.<sup>9</sup> In some countries of East Asia, where population is particularly dense, the art of terracing developed with the growth of that population. In nations where population was not so dense, there was always another hill to move to, so that a conservation ethic did not develop. With the decline of the Inca Empire and the drop in Indian population in the Andes, the art of terracing was lost in the New World. In part of Nepal, terraces are now extremely necessary, but many have been constructed with an outward and not an inward slope, so the monsoon deluges weaken them more each year. And terracing isn't always the answer. Soil experts in the Uluguru mountains of Tanzania found that strategic tree planting and farming on the contour are better than terracing, which exposes too much infertile subsoil and encourages landslides.<sup>10</sup> Perhaps a good engineer would have solved the terracing problem in Tanzania, but even so, ways of conservation which work well in one area may not be as effective elsewhere.

The upper part of the northern temperate zone, which is the center of agricultural research and its dissemination, contributes few answers for the hill problems in the southern temperate or torrid zones. Since lands in the northern temperate zone are relatively sparsely populated, new technology was developed for management of relatively flat land. The Alps and the Rockies were not subjected to attempts at intensive cultivation. From them, only transhumance was expected. This distinguishes them from the Andes, the Himalayas, and the Ethiopian Highlands, which have supported great civilizations and population pressures for generations.

2. Shifting cultivation (the most primitive kind of agriculture, but the type many observers feel conserves energy best) seems to be becoming more destructive. This is often also related to the population issue; fallow periods become shorter because the land must support more people. This type of farming may be briefly defined as an economy of which the main characteristics are rotation of fields rather than of crops; clearing by

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9. See, for example, W. B. Manipura, "Soil Erosion and Conservation in Ceylon with Special Reference to Tea Land," Tea Quarterly 42 (1971): 206-211.

10. P. H. Temple, in Studies of Soil Erosion and Sedimentation in Tanzania, A. Rapp, L. Berry, P. H. Temple, eds. (University of Dar es Salaam, Bureau of Resource Assessment and Land Use Planning, and Dept. of Physical Geography, University of Uppsala, 1972), pp. 110-115.

fertility of the hills stems from another problem: the scarcity of animal manure which, prior to the contemporary period, the Nepalese have always assiduously applied to their fields. Now, when dung is available, it must increasingly be used for fuel; wood is increasingly far away. Also, there is less manure available because herd size is not growing, since hillsides must be used for field crops. The Nepalese hills must now support 22 people per hectare, roughly the man-to-land ratio of Java or Bangladesh, countries blessed with far better resources.

Eckholm notes that "if Nepal's borders ended at the base of the Himalayan foothills, the country would now be in the throes of a total economic and ecological collapse. Luckily the borders extend farther south to include a strip of relatively unexploited plains known as the Terai, which is an extension of the productive Indo-Gangetic Plain of northern India."<sup>14</sup> He notes that this region suffers seasonal flooding, is heavily vegetated, and was historically plagued with malaria. With malaria eradication, there was a rush to colonize the area. In the 1964 to 1974 decade, 31,200 hectares of Terai forest land were officially distributed by the government to settlers, but more than three times that amount was illegally cleared by migrants from the hills and, perhaps more significantly, from India. The Terai provides some reprieve for Nepal, but there seems to be no end to the problem. Satellite reconnaissance indicates that there are another 111,750 hectares that might be suitable for settlement; but if migration continues at present rates, the land will be filled in another decade. Meanwhile, something must be done about the hills which are causing the problem--especially since degradation of the mountains is causing rivers to swell and is cutting away at the fertility of the Terai. Nepalese government sources, reported by Eckholm, show Terai rivers rising at from 15 cm. to 30 cm. each year, probably because of stream-bed silting. This is causing rivers to wander about aimlessly, taking prime farmland as they go. The Nepalese National Planning Commission fears that the situation is almost at a point of no return, and feels that the hilly regions may develop into a semi-desert environment if nothing is done. Should the situation be allowed to continue along its present course, a predicament may exist in Nepal (and in Northern India and Northern Pakistan, for that matter) like that in most of Afghanistan and by the barren Zagros and Elburz mountains farther west in Iran.<sup>15</sup>

4. Closely related to the former point is the explicit problem of the disappearing forest, which not only is relied upon to hold upland soils in place, but to maintain the hydrological cycle intact and provide lumber and firewood. Once tree cover is cut, average temperatures in the area may rise and already arid soils not far distant may become deserts.

Eckholm states it well:

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14. Erik P. Eckholm, "The Deterioration of Mountain Environments," Science 189 (5 September 1975): 764-65. See also Claire Sterling, "Nepal," The Atlantic Monthly (October 1976): 14-25.

15. *Ibid.*

Forests influence the wind, temperature, humidity, soil, and water in ways often discovered only after the trees are cut, and these functions--usually beneficial to people--are sabotaged. Forests assist in the global recycling of water, oxygen, carbon, and nitrogen--and without any expenditure of irreplaceable fossil fuels. Rainwater falling on tree-covered land tends to soak into the ground rather than to run off; erosion and flooding are thus reduced, and more water is likely to seep into underground pools and springs.<sup>16</sup>

Then there is the problem of adequate lumber and firewood:

Peasants in the uplands of South Korea have adopted a different, but also destructive way to cope with the lumber shortage. A United Nations forestry team visiting [Korea] in the late 1960's found not only that live tree branches, shrubs, seedlings, and grasses were cut for fuel; worse, many hillsides were raked clean of all leaves, litter and bramble materials. Raking in this fashion, to meet the needs for home fuel and farm compost, robs the soil of both a protective cover and organic matter, and the practice was cited by the UN experts as 'one of the principal causes of soil erosion in Korea.'<sup>17</sup>

5. Land reforms are becoming somewhat more commonplace than previously and can be expected to open up more land which in more pristine days was tied up in large estates. Where peasants could gather only firewood before, they are in some areas able now to have small farms of their own and cultivate them pretty much as they see fit.

With land reform must come some basic ideas of conservation. Here, China may provide an example. At one time half of its territory was forested. By the time of the new government in 1949, it was said to have the greatest number of barren hills in the world; rehabilitating most of them is entirely beyond the realm of possibility:

In the 1950's, ambitious though probably unrealistic plans were made for mass reforestation, to be implemented mainly by the rural communes. The leadership hoped to raise the forested area to 20 percent of the country by the late 1960's, and 25 percent by the 1980's. . . .

Tens of millions of workers have since been mobilized to plant trees each year in the slack seasons between crop harvesting and sowing. The effort has been stupendous, though the results have sometimes been disappointing. By 1973, according to Chinese officials, about seventy million hectares --nearly 7 percent of the country--had been replanted, but

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16. Eckholm, Losing Ground, p. 27.

17. Ibid., pp. 105-6.

in many areas the survival rate of the newly planted trees was, in this early period, below 10 percent. Untrained labor, poor maintenance, mutilation or even uprooting of newly-planted trees for fuel, and frequently inhospitable growing conditions combined to corrode the efficiency of the mass planting efforts. By the mid-sixties, official emphasis had been shifted away from massive annual new plantings to careful maintenance within planted areas.<sup>18</sup>

V.

Just because a field is located in the mountains is no indication that its use will involve hillside farming, just as valley areas may well require at least modest conservation techniques. Some highland plains in the torrid zone have been centers of thriving civilizations, especially in days before men had learned to cope with either the seasonal extremes of the temperate zones or the exigencies of the humid tropics.

In Wisconsin, a 10-12 percent slope is considered suitable for row-crop farming only one year in five, and then with the strictest of soil conservation practices such as contour farming and terracing. To prevent water erosion the U.S. Soil Conservation Service recommends approved practices for slopes over 2 percent, and those over 12 percent are almost never put to row crops.<sup>19</sup>

But Wisconsin, with about 34 persons per square kilometer, and the United States, with about 23, do not need to use land that is exceptionally steep; better put, it makes no economic sense to do so. On the other hand, countries like India (173 persons per square kilometer), Pakistan (121), Nepal (80), Japan (289), Nigeria (61), and the Philippines (130), to use some examples, must farm slopes that are far steeper and often less fertile than those in the United States Midwest.

Many of the most densely populated areas of the world are also those with a precipitation pattern that makes hillside farming especially difficult. Wisconsin can expect somewhat over 760 millimeters per year, but

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18. Ibid., p. 44. See also Sterling Wortman, "Agriculture in China," Scientific American 232 (June 1975) and W. C. Lowdermilk, Conquest of the Land Through Seven Thousand Years, Agriculture Information Bulletin no. 99, USDA Soil Conservation Service, undated, cited in Don Schwennesen, "The Environmental Beat," Montana Journalism Review, no. 19 (1976): 55.

19. Personal conversation with James Enlow, U.S. Soil Conservation Service, Madison, Wis., 15 July 1976, and USDA, SCS, What Is a Farm Conservation Plan?, PA-629, Leaflet 249 (January 1973). See the Japanese perspective in Fukuo Ueno, "Problems in the Agricultural Utilization of Sloping Land," Rural Economic Problems 1 (November 1964): 22-36.

some areas of the world can expect up to 10,200 mm., and some of these have, in turn, a six-month dry period. Imagining the consequences of a 50 mm. daily rainfall falling on a steep hill where there is dense settlement gives one an idea of the difficulties facing those who are responsible for conserving soil required to at least assure minimal subsistence.

It is technically possible to farm the steepest of slopes. In the Wet Zone of Sri Lanka, I have seen a fruit crop adaptable to poor soil, grown on a 75 percent slope, using stones for terracing hauled--one by one and by human brawn alone--from the valley below. In some rice areas of East Asia, not only the terracing rock but also the topsoil have been hauled up the steep gradient to form a 2 percent mini-field from a 90 percent slope. But the effort required technical expertise, community cooperation and organization, and capital. Indeed, whether hillsides can be saved seems to depend more on the will of the people to do so, on food to sustain the workers while they are terracing, and on wise technical help, than on steepness of slope, amount of rainfall concentrated in a period of time, and population density. Many areas in Japan and China do an exceptional job against formidable odds. This seems to teach us that the solution to the problem depends as much or more on social organization and on economics than on a new technology. For the most part the technology of saving soil exists; when it is not applied, what is almost invariably lacking is an appropriate combination of economic incentives and opportunities for doing so. The case is the classic one of physical and biological expertise being highly developed in comparison to the politics and economics of the situation, which do not translate expertise into human action. There are alternative ways of farming any piece of agricultural land that provide maximum immediate yield, that maintain potential for future production, or that satisfy a combination of these two goals. When people choose alternatives that allow their only means of livelihood literally to wash from under their feet, the personal characteristics or traits of those who make the choice ("indolence" or "stupidity" or "sloth") are often cited as a reason. Much more plausible are explanations that rest on land tenure rights and custom, together with the accompanying system of lack of incentives, barriers to the spread of technical information, and tradition, which they imply and about which we understand so little. It may be perfectly rational for peasants to make little effort to engage in long-term investments of contour farming, terracing, tree planting, etc., for they know that once land is improved it will revert to another, perhaps a landlord. Or maybe they simply do not have financing for this long-term investment. If the hillsides of the world are to be saved, such problems as monopolistic control of land and short-term leasing will have to be dealt with explicitly. And when agrarian reform becomes an accomplished fact, conservation techniques won't simply come naturally to beneficiaries. New owners must be suffused with an ecological ethic as well as with the technical knowledge which has for so long been the domain of a few who have the wherewithal to use it.

What agricultural laborer with a year-to-year lease on a farm will go to great lengths to save hillside soil if he knows that his back-breaking efforts at terracing will merely conserve the resource for the landowner, who may dispossess him as soon as his laborious work is complete? What squatter will practice contour farming or reforestation if his occupancy rights are so tenuous that it is cheaper for him to move on to another

hillside patch next year (and by moving he may be less visible besides)? How many hillside farmers will be able to afford the time and money necessary to terrace if they own a mini-plot on hilly terrain and rely for the bulk of their incomes on work for large valley farmers below?

And, in an area of freehold mini-plot farming, the issue is somewhat different--having to do with organization, esprit de corps in the neighborhood, and leadership. What small-plot owner on the hillside can afford terraced farming (and what is its efficacy, anyhow?) if he alone wishes to practice it while his neighbors do not? How many soil-conservation experts are there who are available to work with, say, 500 small farmers who crowd onto one 10-hectare hillside on which the minimal slope is 25 percent?

The issue also centers upon education or, at least, on effective transmission of technical information. How much does a recent beneficiary of a land reform know about row cropping on slopes, something that he may now have to do to earn his living, when prior to the reform he saw it used only for grazing? How much does he know about reforesting land that his former landlord left barren?

The emphasis of this paper is on new technical information that will help save the hillsides; this is to be applauded. But what is even more important for millions of the world's peasants--the bulk of those who are engaged in agriculture in all less developed countries--is using what is now known about soil conservation. And what is now known and what is yet to be discovered will not be applied if the social, political, and economic organization is not appropriate for the task. From this observation one could extrapolate many policy implications, but I will list only five:

1. If the legal framework were in place to assure a tenant who invests in terraces, contours, or forests that he could retain the land after certain minimal conservation standards were met (or at the very least that he could retain it for the number of years required to attain a respectable rate of return--which would probably have to be the lifetime of the cultivator), he might do so.
2. If hillside squatters' tenure rights could be made secure, they might be more apt than otherwise to attempt conservation practices.
3. If hillside-farmer organizations could be set up, conservation and grass-roots leadership potential could be developed if incentives were provided. Of course, governments will also have to be committed, at the very least, to providing subsistence for workers while they are constructing terraces or planting trees.
4. If soil conservation techniques were made as important as the seeds and fertilizer that are available as part of the package of inputs that follow up a land reform, steeper gradients might be saved.
5. If zoning procedures could be set up so that industry and transportation systems would have to use the unproductive hillsides and the basins were reserved for agriculture, several generations of time might be bought to allow for the rapid rate of population growth to be curtailed.

A certain amount of government intervention and even subsidy would be involved, since short-term private establishment costs would be raised over what they might be otherwise, in exchange for long-term benefits to the nation.<sup>20</sup>

The price of negligence is desolation of both hillsides and valleys, increased influx into the already glutted cities, and human degradation and starvation. In controlling the contemporary over-rapid population growth and rationalizing the presently chaotic way in which available land is used, the ultimate problem with which humanity must deal is how to achieve an appropriate balance between man and land.

I close this paper as I opened it with a quotation for emphasis from Erik Eckholm's Losing Ground, from which I have quoted liberally throughout:

Land-use patterns are an expression of deep political, economic, and cultural structures; they do not change overnight when an ecologist or forester sounds the alarm that a country is losing its resource base. In many countries, the deterioration of the land will not be halted until basic changes in land tenure and national economic priorities occur.<sup>21</sup>

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20. This suggestion is one of those that Bryant Kears made upon reading a draft of this paper.

21. Eckholm, Losing Ground, p. 167.