



Some of the losses that the world has sustained are the following:

The first has been the extinction of species and varietal forms. The extinction of large predators and grazing animals may perhaps be checked off as failure to survive in environments altered by economic needs. This does not apply, however, to a long list of other animals. The seas and their margins have been wantonly devastated of many mammals and birds without compensating substitutions. The killing off of sea otters, for instance, has simply removed from our coasts the most valuable of all fur-bearing animals, whose presence would not diminish in the least any fishing or other maritime activity of man.

The removal of species, moreover, reduces the possible future range of utility of organic evolution. This may be illustrated by the domesticated plants. Primitive plant breeders developed a very wide range of useful plant forms from a great number of wild ancestors. Our commercial plants are only a small fraction of the primitive domesticated species and varieties. Commercial corn growing, for instance, utilizes only two subspecies of maize; and of them only a small part of the range of genes that have been fixed by primitive plant breeding. Yet the qualities we have standardized for present-day commercial corn growing may not be the same as will be desired a century from now.

Meanwhile, the extension of commercial agriculture is causing a rapid extinction of the primitive domestic forms. Many species and far more numerous genetically fixed varieties have been lost irrevocably in late years. Of the great varietal range of upland cotton only a few enter into the commercial forms. The extension of cotton in the United States, Egypt and India has resulted in its disappearance over much of its primitive area of cultivation in Mexico and Central America, where the full range of varietal forms was developed. Yet these primitive forms hold by far the greater range of plant breeding possibilities for future, as yet unrecognized needs. Some years ago we secured from Southern Mexico seeds of a type of cotton called *Acala*, that made possible the current development of cotton growing in the San Joaquin Valley. Had the plant explorer missed this particular spot in the state of Chiapas or come a few years later, there might not be a successful cotton industry in California. No one knows how many domestic varieties of cotton survive or have been lost.

In most domesticated plants and animals the greatest range of genes lies in noncommercial varieties. Until the late extension of commercial production the age-long tendency of the native husbandry was to continue and expand this range. Primitive husbandry was engaged in enlarging steadily the evolutionary process. Commercial production has caused and is causing a steady and great shrinking of forms, because suddenly restricted standards of utility are introduced. Unfortunately, immediate and prospective utility may be very different things. This applies equally in criticism of the effect of our commercial civilization on wild and on domesticated forms of life: in both cases we have drastically impoverished the results of biological evolution.

The second major loss to the world has been the restriction of useful species. Often we have affected local rather than total extermination. There are still fur seals of one species on the Pribilof Islands, but we know no means of repopulating the many island rookeries from which they are gone. The eastern white pine is not extinct in the Great Lakes region, but it has been removed entirely from large areas where it once flourished. Its reestablishment may cause uneconomic costs of seeding or replanting, or may be economically impossible because its place has been taken by inferior species that filled in the cut-over pine lands. Also ecologic associations, once seriously disturbed, may be difficult or impossible to reestablish. Overgrazing has caused sagebrush to increase hugely in the cooler steppes of the West, and the equally unpalatable yucca and sotol on the hot steppes of the Southwest. If overgrazing were stopped at once on such lands, an indefinitely long time would still be required for the grass to replace the useless brush even if no damage to the soil has been done. Ecologic successions often are slow; and once a degenerative plant succession has set in, a restoration is uncertain. Fires, for instance, may reduce for a long period of years the utility of a site by altering the quality of the soil.

Soil destruction is the most widespread and serious debit to be entered against colonial commercial exploitation. Only a brief statement is made of this dreadful problem, for which there is never an easy solution, and often none at all. Under natural conditions — given a specific climate, vegetation, relief and rock structure — there will be a characteristic soil as to depth and profile for any position on a slope. Soil and slope are in genetic relationship. Neither is static. Both are changing naturally and slowly. In the majority of cases the slope gradually grows less, and the soil on it weathers more deeply because it forms a bit more rapidly than it is removed at the surface. Soil formation and removal are either balanced or formation exceeds removal; or more rarely, removal exceeds formation. Soils develop slowly by weathering. The mechanically committed rock flour of our glacial lands has acquired approximately optimum characteristics in the course of about 25,000 years. This does not include weathering that starts from solid rock, but from the crushed materials of the glacial mill.

The Old World peasant agriculture, by placing animal products first, has maintained an adequate absorptive cover on the soil, as has the general farming/animal husbandry of northwestern Europe and the northeastern United States.

Row crops and bare fields in the off season have resulted in the diminution of absorptive organic matter in the soil. The surface is exposed to sluicing of rains. Film after film is stripped by rain, diminishing steadily the depth of the topsoil, which is normally the most productive and absorptive part of the soil, in some soils the only part that is fertile. Full soil sections are almost impossible to find in the South. The red color of southern uplands and of their streams is derived from the subsoil, which is now widely exposed at the surface. Southern farming is in large measure farming of the subsoil, made to yield crops only by liberal dosages of commercial fertilizer. The Ohio and Mississippi are becoming yellow rivers, which indicates that the yellow subsoils of that part of the country are now widely exposed. It is in the gradual and too commonly unnoticed loss of the true soil that the greatest damage is effected. The product of uncounted centuries of weathering and soil development is removed by a few decades of farming. The much publicized destruction of the land by gullying is only the final dramatic removal of the surface. The major and irreparable damage is done beforehand.

The loss of the soil horizon by rain wash is not confined to steep slopes, nor is it even most characteristic of the hillier lands. It has reduced many gentle uplands of the Piedmont and the Coast Plain to briar-brown pastures. It has destroyed, in the main, the old Black Belt of Alabama for cotton growing, with minimal slopes, many of less than one-degree. It is invading the Black Prairies of Texas, and has made amazing headway in the past ten years on the smooth plains of central Oklahoma. All that is needed is a slope sufficient for muddy water to run on. Even the great Corn Belt is becoming badly frayed about the edges. The once rich counties of northwestern Missouri have been reduced to widespread distress. Serious damage is claimed for one-fourth of the area of Iowa.

Wind erosion is not bound to slope at all; it operates best, in fact, on level land. The baring by the plow of the dry margins of our farming land has resulted in rapidly accelerated wind transport there whenever there is a marked dry spell.

These losses are in many cases irreparable. Engineering devices are in the main palliatives that reduce the rate of loss, but which under extreme weather conditions may increase the risk. The saving of worn land requires more labor, more skill, and more capital than the farming of good land, and then is of uncertain results. If one could place the best farmers on the worst-used land, some headway could be made. The cycle of degeneration is extremely difficult to break, and there is no salvation by any brilliant device.

To this summary review of the suicidal qualities of our current commercial economy the retort may be made that these are problems of the physical rather than of the social scientist. But the causative element is economic; only the pathologic processes released or involved are physical. The interaction of physical and social processes illustrates that the social scientist cannot restrict himself to social data alone. We cannot assume, as we are prone to do, an indefinitely elastic power of mind over matter. We are too much impressed by the large achievement of applied science. It suits our thinking to rely on a continuing adequacy on the part of the technician to meet our demands for production of goods. Our ideology is that of an indefinitely expanding universe, for we are the children of frontiersmen. We are prone to think of an ever ample world created for our benefit, by optimistic anthropocentric habits of thinking.

Let us admit for the moment that the supplying of the world with primary goods is simply a matter of the expenditure of energy, and that there is no lack of energy and no loss thereof. Even this optimistic assumption encounters the difficulty of the geography of population. Two billion inhabitants of the world have an unequally localized distribution. It is going to be bitterly hard to arrest the declining capacity of many well populated areas, for instance, our Old South.

It is going to be difficult to find the means of shifting large numbers of people from crisis areas into areas of opportunity. Our Resettlement Administration had no trouble discovering crisis areas, but it had slight success finding areas that were ready to receive immigrants in number. The current national


attitudes toward foreign immigration proceed in large part from a lately hardened conclusion that the resident populations are adequate to make use of the national opportunities. This attitude has become well-nigh worldwide. Decline in productivity is becoming characteristic of larger and larger areas. The generalization that the total productivity of the world might be maintained or raised gives no comfort to the increasingly large numbers of people who are trapped in lands of fading economic resource. India may be suggested as an example, on a huge scale, of a country in which occidental political economy stimulated population growth and in which an overdraft on land resources will develop a major population crisis. What is to be done about such specific maldistributions?

Let us accept once more the view that the physical scientist will be able to make the requisite synthesis of matter to provide laboratory-made substitutes for the exhausted natural resources. There still remains the problem of the cost of distribution imposed by the geography of land and sea and climate. Freight must continue to be hauled, and costs incurred in the movement of goods. The dream of the growth of staggeringly great laboratories to give us synthetic products will require also great changes in comparative advantage of location. If we appeal to the sun for our salvation, we must build our visionary factories in deserts, along mountain fronts, and in great tidal bays, which fail to coincide with present distributions of dense and advanced populations, and which introduce additional changes in transport of power and goods.

The easy denial of our dilemma by referring it to the technologists is in large measure wishful thinking. It derives mainly from the successful, and relatively easy, experience in synthesis of hydrocarbons. We expect a lot from the laboratory technicians when we ask them to supply the great range of biochemical compounds for which we are destroying the natural plant and animal laboratories, or even if we expect them to come near to meeting their cost of production from natural sources. But we demand a good deal more. Actually we ask that chemistry become alchemy, that it achieve the transmutation of elements. The classical but far from singular illustration is the problem of phosphates. Phosphorous is well known to be a minor constituent of the Earth's crust, too rare as a primary mineral to be recoverable in quantity. The loss of accumulated and available phosphorous from soils by destructive cropping is enormous and forms one of our most acute problems. We are getting along by cleaning up the last of the guano deposits, which have been under exploitation for a century, and by using up the secondary mineral phosphates. The latter are highly localized fossil accumulations in certain ancient marine graveyards. These are pretty well known as to occurrence, and the reserves are not large. What then? The question, sharply asked by Cyril Hopkins, as to how civilization will survive the dissipation of this element critical to animal life, remains unanswered.

The doctrine of a passing frontier of nature replaced by a permanently and sufficiently expanding frontier of technology is a contemporary and characteristic expression of occidental culture, itself a historical/geographic product. This "frontier" attitude has the recklessness of an optimism that has become habitual, but which is residual from the brave days when North European freebooters overran the world and put it under tribute. We have not yet learned the difference between yield and loot. We do not like to be economic realists.

Carl Ortwin Sauer (1889-1975) was the head of the geography department at the University of California at Berkeley for more than 30 years. He was one of the world's foremost historical geographers, combining research into several sciences to present an ecological history of the human race. Humanity, he said, determines its own destiny; the understanding of the agency of 'Man on Earth' is a principle obligation and opportunity of geographic scholarship. He pointed the way toward a land ethic, "a responsible stewardship of the sustaining Earth." At his death he was considered the "unchallenged dean of American environment and cultural geography," and his insights into the human and humane use of landscape had long been a vital part of the modern environmental movement. He was said to be "a man so routinely correct about matters so fundamental that a popular movement never caught up with him." His last book, *Seventeenth Century North America: French & Spanish Accounts*, published by Turtle Press just before his death, completed a 50 year study of early American land and life relationships.



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