THE IMPACT OF HUMAN POPULATIONS ON NATURAL RESOURCES

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To an ecologist,[1] the present situation of mankind is preposterous. Here we are, organisms with unique powers of manipulation, physical and mental, the ability to acquire, store, retrieve, and transmit information, and to convert raw materials into goods faster than they can be absorbed without the aid of destructive wars. We have improved the production of food and fiber while rendering great expanses of land and water biologically unproductive. Our machines save labor, at the same time displacing it, driving refugees into cities that cannot assimilate them.

Although we can channel and control energy and material changes, we have disrupted the great cycles of renewal which, by governing the flow of water, purifying the air, and converting the wastes of life into form for reuse, have sustained life since it began. Our planet, as Fairfield Osborn has noted, is not only plundered (Osborn, 1948), but finite and crowded (Osborn, 1953). The question now before us is: is environmental disruption a simple and direct function of our increase in numbers, or is it more involved than this?

There must have been long periods during which birth and death rates were almost in balance. Otherwise world population in the year 1 A.D. would have been far greater than the 300 million reckoned by our best estimates. Seventeen centuries were required for that figure to double. Since 1700 it has doubled twice again, with millions to spare. At the present rate, it is expected to double once more, to 6 billion in 35 years.

No other species has ever been known to continue such a rapid rate of increase without finally coming to terms with the limitations of its environment. This idea is beginning to register with a public that has long since recognized the necessity to control the numbers of its domestic animals by what has been called one of the greatest biological inventions. Overpopulation in the Orient and in Latin America speaks for itself; that it exists in the United States is persuasively set forth by the Days (1964).

It is easier to count noses than to measure resources. With a 1968 dollar buying one fourth of a 1936 dollar, there must be better units than money to use in evaluating resources—square miles for space, cubic feet for water, barrels for oil, tons for copper and iron, and so on. Nor is sheer quantity enough. Quality,

[1]Ecology, dealing with the interrelations of life and environment, seeks to establish general principles through the accumulation of precise and quantitative knowledge. Though regarded as a special phase of biology, it must draw upon a wide spectrum of the sciences; and since it involves man as an organism, its search for data transcends the experimental controls of conventional science. For this reason I prefer to regard it rather as a point of view than a science in the usual sense. To meet its obligation, it must take account of the most reliable information it can get that is pertinent to this point of view, whatever the source.

To a peculiar degree it must combine exact analytical procedure with constant scrutiny of complex relationships in search of patterns, hoping for mutual adjustment between these two approaches. This, of course, is the dual procedure of breaking up a complicated problem into small components that can be handled easily, while keeping an eye on the whole for the sake of perspective. This empirical practice, essential to artist and prudent administrator, is also evident in many of the great advances of science.

It is interesting to note that while the scientist tends to distinguish between "empirical" and "scientific" procedures, many philosophers tend to classify science as an empirical activity. Scientists themselves, in conceding that "laws" are actually rules of experience, subject to constant refinement and without absolute finality, seem to me to strengthen this philosophical judgment.

THE OHIO JOURNAL OF SCIENCE 69(1): 11, January, 1969.

location, and availability, the effect of one resource upon another (coal and iron for instance), plus what may loosely be called "the state of the arts," must all be taken into account.

Space, measured by area, would seem simple enough to be used as a dividend, using population as divisor. There are about ten acres per capita in the contiguous United States, but only about five of crop land. We must also remember that it may take thirty acres in Montana to produce as much pasture as one acre in Pennsylvania. A square yard in Manhattan would certainly buy a square mile in many other places. As long as the high-grade ore of the Mesabi Range lasted, taconite was not considered worth the trouble; today it is being developed by methods improved under economic pressure.

At this point we begin to suspect that something more than a simple ratio of resources to people is involved. To clarify matters, let us consider briefly four prime resources: Water, Space, Protein, and Electricity.

Water. The few quarts of water a day necessary to keep an individual alive do not measure the need, let alone the demand, for this resource. *Per capita* consumption is by no means a stable quotient. Within the United States it has continued to rise to at least 150 gallons a day for urban domestic use only and to some 1800 gallons a day for all types of use, including industry and agriculture.

Domestic needs with top priority, food production, industrial use, waste removal and various amenities, are conspicuous—often interwoven—functions of water. In earlier generations these were all served in home and village by well and running stream, bucket and hand pump. Today the majority of our citizens are supplied with running water available through systems of taps, baths, washers, sprinklers, drains, and, increasingly, swimming pools and garbage grinders. The mathematical relationship of numbers to consumption is not simply a linear one.

Space, a basic resource, is seldom listed as such except by inference. Even the word itself has come to be associated with regions far beyond the earth, while we lump together as "underdeveloped" those countries that, like Brazil, have room to spare with those which, like other parts of Latin America, the Near East, and Orient, are overpopulated and actually overdeveloped.

Within the two billion acres of the forty-eight states, it is estimated that the Indian population did not exceed one million at the time of Columbus—or one person for each two thousand acres. Yet this network of cultures was under such tension that, within a few decades of European settlement along the Atlantic coast, it snapped, with profound displacements in the interior of the continent, accelerating with the introduction of horses and firearms. Within four centuries, the acreage per individual has shrunk from two thousand to ten and is expected to halve within a generation.

Less than a century ago nine tenths of our people were rural. They not only produced their own food and that of the ten percent living in cities, but grew a surplus of food and fiber for export. Today eighty percent of us live in cities, crowded into less than ten percent of our area and creating problems which need no elaboration here. We speak of people being drawn to the cities by greater opportunity, when actually they have been driven there because technology has overshot its mark. The unemployed are refugees just as truly as if they were Arabs or Vietnamese. In ecological language they, and worse still their children, are without niche or rôle. While these refugees have had little choice about leaving their former homes, disparities in relief programs have given them options as to destination. Where these programs have been most liberal, the effect has been to intensify slum conditions.

With all allowance for humane motives behind the more generous relief provisions, one cannot overlook the tendency of some politicians to secure captive votes at public expense. The real issue, of course, is justice and opportunity for the victims of overpopulation and rapid technological change.

Here, as in the case of water, what is happening is not due solely to numbers, but to the way people are being distributed in relation to space, and this in turn to the way we have chosen to use space. This is taking place at a time when all the resources of technology are directed towards "labor-saving."

Protein in sufficient amount and of proper quality is essential to the development of healthy human bodies. Hunger, of which we have tragic examples south of the Rio Grande, and in Asia and Africa, is the companion of malnutrition. We have reason to believe, although the figures are uncertain, that there are serious degrees of both in our own country.

Protein, as with most consumer items, has become a matter of mass production. Aside from faulty distribution due to the inability of many to pay for their share, there are some interesting side effects.

Whatever its faults, the traditional farm was in many respects a functioning ecosystem, involving both plant and animal production and the recycling of wastes. Today large areas of rural United States are given over solely to field crops, while meat is being produced in concentrated feed-lots associated with processing establishments. These systems are developing a degree of computerized perfection that rivals other branches of industry.

Passing over the inferior flavor of battery-grown poultry, the effluvia from large-scale duck farms on Long Island and in the interior have become a serious source of pollution of adjacent waters. So throughout the Midwest are the wastes from major cattle feed-lots. Meanwhile manure essential to maintaining fertility in farm and garden is simply not available at many places where it is needed. As one market gardener who helps feed a city said recently, "I couldn't get it if I was able to pay a hundred dollars a ton for it."

Electricity. This secondary resource represents energy converted from fossil fuel, water power, and, hopefully, atomic power. No one can question its marvelous utility or the ingenuity and enterprise that have gone into making it available, however he may feel about some of the uses to which it is put. During the seven-year period that began in 1960, population in two New England states increased eight percent, while the demand for electricity increased fifty-five percent. Here again the increase in human numbers is not a direct measure of their impact upon resources.

The human ecosystem does not operate like the feed-yards just mentioned, where the necessary amount of space, water, and balanced feed is supplied, so much per head. One could try to explain the difference by Walter Cronkite's sign-off: "That's the way it is." Or he could attribute it to the form of our society, to economic necessity, or to the way people think or feel, what they know or believe.

For a professional judgment that takes account of all these possibilities, we go to the anthropologist. He tells us tersely that human societies are linked to their environments by the patterns of their cultures. Japan, with about 650 people per square mile, has efficient agriculture, high literacy rate, full employment, and population control. India, with about 500 people per square mile, has none of these advantages. Yet there is no reason to suppose that the difference is a matter of inherent ability. India has produced many able and distinguished individuals, but when it comes to improving conditions, her leaders, as well as foreign friends, find themselves stymied by the inertia of belief and custom—in other words, by the pattern of Indian culture.

The same principle applies to us, as we compare the condition of our landscape with those of the small democracies of western Europe. Our system of enterprise has developed in a spacious and abounding land, theirs has evolved where space and other resources are strictly limited. No less committed to freedom than are we, they practice frugality, neatness, and order. We waste resources and the things made from them, and live in the midst of disorder. I have heard economists,

decent fellows, defend waste with the chill assurance we attribute to ruthless entrepreneurs.

Murphy (1967), a legal scholar, asserts, correctly I believe, that the impact of our culture upon renewable resources (soil, water, air, and organic material) holds greater danger to our future than does our handling of the nonrenewable resources, about whose depletion we have been so concerned. The supply of fossil fuels, metals, and other minerals is due to events in the geological past over which we have no control. All we can do is to practice economy in the use and reuse of these resources, or to find substitutes. Scarcity and high cost become evident at once, compelling action by industry or government.

In contrast, the supply of renewable resources is maintained by physical and biological processes now going on. These are quite sensitive to our treatment, but their deterioration is often so subtle that it escapes notice until too late. Responsibility, for example, as to the way a farmer manages his land or a city disposes of its waste is diffused throughout society. Remedies are costly and offer no promise of immediate return. To complicate matters, much disruption of the processes involving soil, water, pure air, forests, and wildlife is due to the desire for quick returns, regardless of ultimate costs to society.

Imagine conditions at the end of the present century, should population be doubled by its present rate of increase, with automobiles being produced even faster than people, as they now are (Higbee, 1960)! Certainly the human race must apply the brakes to its own multiplication. But, to survive, it must accept a profound revolution in values. The idea that whatever can be done, made, and sold at a profit is automatically right must be examined and rejected.

However important sheer numbers are in their effect on environment, accepted standards of behavior largely determine their impact. A relatively small group of invaders wrecked the economy of what is now Iraq in the 13th century by destroying irrigation works that had functioned for thousands of years. A handful of conquerors devastated the Valley of Mexico in the 16th century. Irreparable damage was done to our forests, grasslands, soils, streams, and wildlife, when our population was less than half what it is now.

No, the protection of our resources for their fullest benefits, both now and in the future, and the health of the ecosystem of which we are a part, will depend not only upon our numbers, but upon what we know, believe, think, and feel. The outcome will be determined by the values that shape our culture. I cannot improve upon what John Kenneth Galbraith told a congressional committee—"I am not quite sure what the advantage is in having a few more dollars if the air is too dirty to breathe or the water too polluted to drink."

Hopefully, leaders in political and business life are not indifferent to the general welfare. Politicians must have campaign money from those who can afford it, but they must also have votes. Businessmen have to satisfy stockholders, but they cannot do this without customers. Meanwhile we are blessed with many effective voluntary organizations dedicated to getting the American people to cherish their ecosystem. In these organizations lies our greatest hope if they act promptly and remember the saying, "There is no limit to the good a man can do if he doesn't care who gets the credit."

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