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AN ECOLOGICAL VIEW OF LAND-USE IN MIDDLE AMERICA

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IN ORDER TO DETERMINE THE POSSIBILITIES of an area for the production of organic material, it is necessary to have some kind of norm, or standard of measurement. Where undisturbed natural communities of plants and animals are present, they serve this purpose. Such communities exemplify the degree to which organisms can utilize energy and raw materials for production, without disrupting the system itself.

Where such natural communities have been largely destroyed by human activity, examples of the best land-use and management in the area must serve as a standard by which to judge potentialities. Such examples must be selected, not in terms of the highest immediate return regardless of the effect upon soil, water economy, etc. but in terms of high average yield combined with long-sustained operations which do not depreciate the capital value of the area in use.

In the language of thermodynamics, both the well developed natural community and the healthy artificial community represent a "steady state" (Sears 1949). Each must use the available materials and inflowing energy to maintain its own organization, while performing work as efficiently as possible. In one instance the work is measured by the sustained produc-

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tion of native flora and fauna, in the other by a sustained human economy embracing man and his domestic plants and animals.

I propose to consider briefly two areas in Middle America—the highlands as represented by the Cuenca de Mexico (usually called the Valley or Basin of Mexico) and the lowlands as represented in Honduras, using areas under efficient human management in each instance. For Mexico I shall draw upon history and prehistory, in Honduras upon observations of scientifically controlled modern industrial land use and management.

The use of these standards of measurement is the more striking because of the general and serious deterioration of the physical base of land-use in much of Latin America, noted by such observers as Gill (1951), Vogt (1949) and Sharp (1949). These and other workers have approached the problem with the utmost sympathy and concern. All of them agree that population presses hard on the means of subsistence, a precarious balance being maintained by high mortality. Erosion is heavy and widespread, current practices often intensifying it.

Fortunately for our purpose, the Cuenca de Mexico is rich in archeological material which has been systematically and skillfully explored. Fortunately, too, its ancient lake-beds contain, in the form of fossil pollen, a record of climatic changes, of such sort that its more recent span can be correlated with human activity (Sears 1952). Finally, and again fortunately, we have the studies of Cook (1949) on the ancient population of Central Mexico and on the erosion which has resulted from certain known phases of cultural history.

Briefly, two great waves of culture and population occupied the lower part of the Cuenca during times of high lake level and moist climate, while a third developed on the uplands during an intervening period of low lake level and dry climate.

The first of these was the Archaic, 2000 to 500 B. C., whose early and middle remains are abundant, correlated with moisture and high lake level. The late Archaic, however, shows its final phase during dry climate at minimum lake level. From here it shifted to higher lands northward, where presumably ground water was available. A similar phenomenon is

to be observed near the dry lake bed below Bat Cave in western New Mexico. There is only one course left when a lake dries—that is to move upward into the zone of springs or other running water. The archeological evidence suggests that, until climate became unfavorable, the Archaic culture was well developed, and in reasonable balance with environment.

Moving about 500 B. C. to the higher land at Teotihuacán, the Late Archaic developed into a remarkable culture, as evidenced by the pyramids there. Although it was sustained, in all probability, as a religious center important to a considerable region including the moister lowlands towards Vera Cruz, and covered a span from 500 B. C. to about 800 A. D., its termination marks a cultural disconformity. Vailliant had suggested this was due to deforestation, and Cook (l.c.) has shown that extensive erosion took place. In view of the fact that it carried on throughout a dry interval of climate, its vulnerability to improper land use is obvious.

From 800 A. D. until the Spanish Conquest in 1521, with a recurrence of moisture and high water level, the Basin once more became populous, this time with the Nahua, under which group the Aztec is included. The effective land-use developed by this culture is attested by its ultimate vitality and dominant position among the many local civilizations of Mexico.

Essentially it was a horticultural enterprise. The shallow lake margins were fringed by canals, the mud being heaped into gardenplots, whose rich mineral and organic content insured fertility while the water of the canals was ready at hand for irrigation as needed. It was these substantial and productive lake margin developments, rather than the flowering rafts of fiction, which were the "floating gardens" and the solid basis of food economy.

The water-crop itself was harvested with skill and care, not only small fish and crustaceans but other invertebrate materials, notably the egg-masses of the water-bug, being used. The adult insects themselves were harvested by scoop nets at appropriate seasons, as they still are, dried on clay courts and brought into the city as bird-food. Waterfowl were abundant, and hunted with a light javelin or bow. Birds and dogs were the chief domestic animals, the latter being bred to have broad loins and to serve as food.

Although wood was used extensively, there is evidence that the forests were well conserved in Nahua time — thanks to the absence of steel tools and grazing, and the absence of competition with the forest for agricultural space. That there was some upland agriculture is indicated by the remains of excellent terraces, for example, on the hillsides northwest of the present City of Mexico — terraces which are still used and which represent a kind of fossil culture in sharp contrast with general present practice. It is unlikely that such upland agriculture extended far into the lower margin of the oak-pine forest of the mountains. This spared the Nahua that inevitable ambivalence of mind toward the forest which has plagued us and every other culture whose need for the benefits of the forest has been in conflict with a need for the space which it occupied.

Cook's (l.c.) carefully documented studies of former populations of Central Mexico, viewed in light of the foregoing patterns of land use, strongly suggest an efficient system in reasonably good equilibrium at the time of the Conquest. How long this might have continued without undue population pressure, we do not know. Doubtless human sacrifice and tribal warfare had their influence in reducing numbers somewhat. Among the Scots who practiced strict monogamy, the killing of males in border and clan warfare is known to have depressed the birth-rate, but whether such an effect existed in ancient Mexico is problematical. One may assume that infant mortality was fairly high and life-span relatively short, since the image of Death occupied a prominent place in Nahua symbolism.

Summing up, it seems clear that in pre-Columbian Mexico water was the obvious limiting factor on land use, and that in the last, or Nahua phase when water conditions were relatively favorable, a remarkably efficient system of husbandry developed while equilibrium was maintained by various population checks.

Naturally the immediate effect of the Spanish conquest upon this pattern of land-use, as upon other indigenous aspects of culture, was severely disruptive. The Kingdom of New Spain was a primarily military administration, tempered to a degree by ecclesiastical influence, but with more emphasis on mineral extraction than upon husbandry. Some excellent agricultural

communities were established and in the long run a far greater proportion of the original population survived than in what is now the United States. But the mountain forests were laid under heavy tribute for structural timber and charcoal. Cattle, goats, and horses were put to graze on the upland, which, in the words of Henrico Martínez (1606) soon became "descarnado" — that is stripped to the bone by the resultant erosion.

In his judgment the increased downwash of mud severely menaced the city. Meanwhile the prolonged moist phase of climate which had made possible the Nahua development continued. Even before the Conquest the city had been flooded from hydrographic systems lying above it. Thereafter floods became more frequent and more severe, and were certainly not mitigated by the conditions which Martínez described.

Thereupon began a drainage project which lasted for three centuries, beginning with the Cuautitlán River and culminating in 1900 with drainage of those down in the Cuenca, adjacent to the city. The visible effect has been to reduce the old, productive practice of lake-margin gardening to a minimum, expose vast areas of former lake bottom to wind erosion, and largely eliminate whatever food resources had been obtained by the ancient cropping of the waters themselves, for fish, fowl, and invertebrate food.

In this instance, the limiting role of man-induced change is obvious. Less obvious is the fact that since drainage was begun in 1607, the role of available climatic moisture as a limiting factor is once more operating.

The present trend of climate, as revealed by studies of glacial recession, is toward warming and drying. Because of intensive human disturbance of recent vegetation and surface sediments, this effect has not been generally visible in pollen profiles. However it does appear in our fossil pollen records from New Mexico, and during the summer of 1952 was demonstrated in peat from high-altitude bogs at Las Lagunas de Zempoala in Mexico. In terms of climate, then, the extensive drainage of the Cuenca de México comes at a peculiarly bad time.

The prognosis is not reassuring at best. It is true that hybrid corn, developed through the efforts of the Comisión de Maíz, has greatly increased food production. But unless proper

of ancient and established ways that these young men face many discouragements when they return home. One of these is familiar to young men in the United States — the unwillingness of parents to take them seriously, even though their advice might be extremely profitable.

Finally, one may observe on a modest scale an attack on what is perhaps the most serious land-use problem in Latin America. This problem is that of successful hill-farming, through the development ot terraces. Experiments are still in their infancy, but seem full of promise. Even if their success is established, there remains the baffling problem of changing the ways of a people, caught between the ancient and familiar, but now shattered system of one culture, and the ways of a new which is external to them. For the solution of this problem infinite patience and sympathy, as well as a long span of time, will be required.

SUMMARY

One of the tasks of the applied ecologist is to appraise the actual efficiency of land use in terms of potential. This requires the presence of some kind of norm, or standard of comparison. Two such norms are used in the present paper: (1) the efficient and well-balanced Nahua culture which existed in the Cuenca de Mexico at the time of the Conquest in 1521 and (2) the scientific operations of modern agricultural industry in the Republic of Honduras.

Comparisons made in both areas indicate that possibilities for production of food and other organic material are far greater than those now prevailing among the general population. Serious obstacles to speed improvement must be recognized; these are both physical and cultural.

SUMARIO

Una de las labores del ecólogo práctico es valorar la actual eficiencia del uso de la tierra en términos de sus posibilidades de producción. Esto requiere la presencia de cierta