Human-Environment Interactions

Human ecology, most broadly defined as the study of human interactions with the environment, has in recent years gained greatly increased attention in- all of the social sciences.

Despite this, there appears to be little consensus as to what human ecology actually is or should be. In particular, there is continuing vigorous discussion about the suitability of applying several different theoretical approaches in understanding human-environment interactions.

Alternative conceptual models of human relations with the environment – Classical and early modern theories of environmental influence on human affairs (determinism and possibilism) are often employed by historians. Most notable of such historians is Arnold J. Toynbee, who advocates a possibilist stance in his influential *A Study of History.*

ORIGINS OF HUMAN ECOLOGY

Since ancient times there have been many attempts to explain events in terms of environmental influences on human behavior.

Ancient Greek philosophers recognized that man was both influenced by nature and a force for change in the environment. It was suggested, for example, that the different forms of political organization of the Greek city states and the Eastern empires reflected the influences of climate on the personalities of their citizens.

This theme later was developed by Montesquieu and other French writers of the Enlightenment and advocated in recent times by the American geographer Samuel Huntington. Other classical writers commented on the destruction of the natural landscape of Attica and North Africa resulting from deforestation and overgrazing, a theme takenupinthemid-1800s by George P. Marsh, whose book, *Man and Nature, or, Physical Geography as Modified by Human Action* was a precursor of the ecological catastrophe writings so popular recently.

The first theoretical approach to be tried, however, was that of environmental determinism—a false start that greatly retarded subsequent development of human ecology.

Geographers Friedrich Ratzel in Germany and his American disciple, Ellen C. Semple, espoused the view that humans were completely the product of their environment, a theory that came to be called environmental determinism.

For example, the Eskimos were primitive nomads *because* the harsh conditions of their arctic habitat forbade their development into a complex civilization. The books of Semple and others were filled with endless listings of seemingly plausible environmental determinants of cultural forms.

Although seductive when first encountered, such claims of causal correlation between environment and culture were easily refuted once given careful consideration. For example, the Tasmanians, who lived on an island not unlike the one inhabited by the English, made no ships.

Therefore, there is simply too much variation in human behavior in seemingly similar geographical settings for it *to* be environmentally determined.

ENVIRONMENTAL POSSIBILISM

In place of the discredited determinism, a new theory, called environmental possibilism, was proposed. Its proponents asserted that while the environment did not directly cause specific cultural developments, the presence or absence of specific environmental factors placed limits on such developments by either permitting or forbidding their occurrence.

For example, island peoples could be seafarers, but residents of Inner Mongolia could not be; inhabitants of temperate regions might practice agriculture, but those living in artic latitudes could not.

The value of the possibilist approach was perhaps best demonstrated by the American anthropologist A. L. Kroeber, who showed that the Indians of northwestern North America could not adopt maize agriculture from their southern neighbors because the frost-free growing season in their region was shorter than the four months required for the maize plants to reach maturity. Their environment thus limited the ability of their culture to evolve in an agricultural direction.

A possibilist stance was also taken by the British historian Arnold Toynbee in his multi volumed *A Study of History* (1947), in which he argued that the development of civilizations could be explained in terms of their responses to environmental challenges.

Cultures located in the benign tropics failed to evolve because they were not sufficiently challenged by their environment;

Those in extremely harsh habitats such as the Eskimos in the arctic remained forever primitive because simply coping with the demands of their environments sapped all of their creative energies. Only those secure cultures in environments offering sufficient but not excessive challenges had the possibility of progressing to higher stages of civilization.

British anthropologist Daryll Forde concluded in his book, *Habitat, Economy and Society* (1934), which was perhaps the last major scientific exploration of possibilism, "between the physical environment and human activity there is always a middle term, a collection of specific objectives and values, a body of knowledge and belief in other words, a cultural pattern."

THE ECOSYSTEM-BASED MODEL OF HUMAN ECOLOGY

Basing their approach on the concept of the ecological system that had been formulated by biological ecologists following World War II, American anthropologists Andrew Vayda and Roy Rappaport suggested that instead of studying how cultures are adapted to the environment attention should be focused on the relationship of specific human populations to specific ecosystems. In their view, human beings constitute simply another population among the many populations of plant and animal species that interact with each other and with the nonliving components (climate, soil, water) of their local ecosystem. Thus the ecosystem, rather than the culture, constitutes the fundamental unit of analysis in their conceptual framework for human ecology. Cultural traits are of interest only as they can be shown to contribute to the population's survival in the context of the ecosystem.

Such a framework, however attractive it might seem for reintegrating human ecology into general ecological thinking, serves to stand anthropology on its head by emphasizing the biological survival of populations rather than the persistence of the sociocultural systems in which these populations participate. Cultural traits arc studied in terms of the possible contribution they make to a population's adaptation to its ecosystem rather than as being part of coherent systems in their own right, the traditional concern of social scientists.

Moreover, research following the ecosystem-based model tends to be guided by the unspoken assumption that if a cultural trait exists then it must somehow necessarily serve the adaptive needs of a local population.

The ecosystem-based model of human ecology is exemplified by Roy Rappaport's well-known book *Pigs for the Ancestors* (1968), in which he attempted to demonstrate how the religious rituals practiced by the Tsembaga tribal group of New Guinea functioned to maintain their population in balance with the available resources of their environment. Rappaport saw religion, an institution that Steward had largely excluded from his concept of the ecologically adaptive cultural core, as playing a key regulatory role in relations between the Tsembaga population and the other components of their ecosystem.

Like many of the tribal groups of the central highlands of New Guinea, the Tsembaga employ a swidden system of farming similar to that described by Geertz for the outer islands of Indonesia. The principal domestic animal raised by these New Guinea tribes is the pig. A continuing puzzle to anthropologists has been their custom of slaughtering animals only on ritual occasions, when hundreds of pigs may be consumed in only a few days, while the people go meatless for most of the rest of the time. From a nutritional standpoint, it would seem better to slaughter smaller numbers of animals on a regular basis to ensure more frequent consumption of protein by the human population. The great ritual feasts have therefore often been thought to be an example of a maladaptive cultural trait similar to the sacred cows of India.

After spending fourteen months living among the Tsembaga, Rappaport concluded that, far from being a maladaptive feature of their culture, the ritual regulation of pig killing actually functions to better adapt the Tsembaga population to their tropical forest ecosystem. He asserted that the ritual restrictions of killing pigs only on certain ceremonial occasions serves to (1) maximize the supply of protein at times when the Tsembaga most need it, and (2) maintain the size of the Tsembaga population in balance with available re- sources.

According to Rappaport, the Tsembaga are able to raise adequate supplies of carbohydrates in the form of sweet potatoes, taio, and sugar cane in their swidden plots, but they are chronically short of protein, particularly high quality animal protein, which is necessary to ensure good health and resilience in the face of disease and injury. The fact

that the limited number of pigs that the Tsembaga are able to raise can be slaughtered only on ritual occasions associated with illness, battle, and the beginning and end of periods of fighting may serve therefore to ensure that protein is available in significant quantities at precisely those times when it is most needed nutritionally.

Illness, injury, wounds, and fear all place the human organism under greater than usual stress with consequent greater physiological demand for protein, the basic building block for bodily tissues. Individuals consuming an inadequate quantity of protein are unable to produce sufficient in bodies to recover quickly from stress effects and are more likely to die from even minor wounds or injuries than are better fed individuals. Even a temporary increase in protein intake can produce dramatic recoveries among such malnourished invalids. Thus, even though the Tsembaga killing of pigs is done for supernatural reasons to appease evil spirits believed to cause sickness and ensure the help of ancestral spirits in fighting, since it occurs at times of illness and war it may allow the human population to derive the maximum nutritional benefit from the small supply of animal protein that their tropical forest ecosystem is capable of producing.

Rappaport not only sees ritual as serving the nutritional best interests of the Tsembaga population; he further claims the ritual cycle functions to maintain the population density compatible with the long-term carrying capacity of the ecosystem by regulating die frequency and intensity with which warfare occurs. According to the cultural ground rules followed by the tribes of the New Guinea highlands, war is only permitted during certain limited periods, the beginnings and ends of which are signaled by great ritual pig feasts. No group can go to war, however great the provocation, until a sufficient herd has been assembled to hold a proper feast. Thus, the very ability of the Tsembaga to engage in war is determined by their ability to produce pigs, and their ability to raise pigs is determined by the overall state of their ecosystem.

Of course the Tsembaga are not concerned with ecological efficiency; they slaughter pigs for religious and social reasons and not because they are striving to ensure the maximum flow of protein from the ecosystem to themselves. In particular, the mass slaughter of pigs at the end of a truce is intended to display the wealth and power of the tribe to potential friends and enemies alike while ensuring the support of both their ancestoral spirits and their human allies in the next round of fighting. The mass consumption of pork

on these occasions, however wasteful it may be from a nutritional standpoint, serves the social needs of the Tsembaga by promoting the formation of effective alliances with needed allies in the coming war. The efficacy of the ritual slaughter should therefore be assessed, not as Rappaport has done in terms of the interaction of the Tsembaga population with their local ecosystem, but-in terms of the adaptation of the tribal society to the conflict-ridden social environment of the New Guinea highlands.

Despite the many serious criticisms of Rappaport's study, it remains a valuable contribution to human ecology. Perhaps its greatest impact has been to *focus* attention on the adaptive significance or ideology, an aspect of culture that Steward had largely excluded from consideration as affecting human interactions with the environment. By suggesting plausible ways in which religious ritual might regulate Tsembaga relations with other components of their ecosystem Rappaport opened the eyes of social scientists concerned with ecology to a new area of study. That his particular model of the interactions between ritual, human population, and other ecosystem components may not be a valid one is a reflection on the specific conceptual approach that he employed, not a rejection of his more fundamental insight that religious ritual could be just as significant ecologically as the technological aspects of culture that Steward emphasized.

THE ACTOR-BASED MODEL OF HUMAN ECOLOGY

In the face of severe empirical problems in defining the social unit of ecological adaptation, it has been suggested that adaptation occurs at the level of individuals rather than of cultures or populations. This actor-based model of human ecology, as Orlove (1980) has labeled it, has become the major new wave inhuman ecology. The model reflects both anthropologists' general concern with individual decision-making processes and evolutionary biologists' current preoccupation with showing that natural selection operates exclusively at the level of the individual organism. From this perspective, any higher levels of organization, whether communities, ecosystems, or human social systems, exist only as the fortuitous outcome of interactions among many individual organisms.

In the case of human society, therefore, environmental adaptation is seen as occurring not as the result of natural selection on the cultural or social system level but rather as the

result of the outcome of thousands of individual decisions about how best to interact with the environment. Individuals are assumed to be making choices constantly about how to exploit available resources while coping with environmental hazards. Those who make the "correct" choices will survive and prosper; those who choose less wisely will be selected against. Over time, the more successful adaptive strategies will become institutionalized as cultural norms. Such norms, however, are no more than the statistical outcome of individual choices and have no independent reality of their own as has been the usual conception of social scientists.

For example, an actor-based analysis of the Tsembaga might explain the ritual cycle of pig killing described by Rappaport as simply the accidental out- come of hundreds of separate decisions by individual tribesmen about how to best maximize the use of the limited resources available in order to achieve power and prestige with in their society. Thus, while the success of the feast from the societal viewpoint is measured by the total number of pigs that are sacrificed, the status of each individual Tsembaga male is enhanced only in direct relationship to the number of pigs that he contributes. The larger the number of animals he can kill, the greater the number of guests he can entertain and the larger the portions of meat he is able to present to his guests, thus placing them under greater obligation to assist him in the future. Each Tsembaga male therefore will seek to build up the largest herd that his family's labor force can support. Only when he reaches that limit will he want to hold the feast and only when a sufficient number of men have achieved the desired number of pigs will the community as a whole agree that it is time for the ceremonial slaughter. It may be, as Rappaport claims, that this happens before the carrying capacity of the ecosystem is exceeded and its future productivity degraded but, from the perspective of the actor-based model of decision making, this happy result is no more than the summed outcome of many separate individual decisions.

The actor-based model, with its emphasis on the processes by which people make decisions about how to interact with their environment, is a valuable approach for understanding how change occurs in social systems in response to environmental perturbations. The approach is particularly useful for the insight it gives in to why traditional farmers accept or reject agricultural innovations. A study by Michael Mocrman (1968) has, for example, helped to explain why peasant rice farmers in

northern Thailand have adopted tractors under certain environmental circumstances while they continue to rely on water buffalo under other circumstances. Similarly, Michael Calavan (1977) has shown how willingness of Thai farmers to plant improved rice varieties reflects rational consideration of environmental forces affecting crop yields.

These and other studies of individual decision making have shown convincingly that Asian peasants arc far from being the tradition-bound creatures of the economic development textbooks. Instead, they are shown to be highly rational *decision* makers who carefully assess agricultural innovations in terms of potential benefits and costs. Despite their promise of higher yields, "mod- ern" cropping methods are often rejected because such innovations may re- quire high inputs of fertilizer, pesticides, and water. These inputs are unavailable to the poorer farmers, and modern cropping methods are also much more vulnerable to environmental hazards such as floods, droughts, and insect and disease outbreaks.

An individual Tsembaga tries to raise the largest possible pig herd, not because that is the optimum strategy for adapting to the New Guinea environment but because that is the way in which he can gain status within Tsembaga society; a Thai farmer chooses to grow rice variety A instead of rice variety B because he believes that it will give him a higher yield from his land and a higher yield will allow him to live in the style that Thai culture considers good. Their decisions may or may not be correct ones within the context of their cultural values, but they as individuals did not create these values. Instead, the values arc a pre-existing aspect of the social systems into which these individuals were born. As children they were socialized to accept these values as correct, and as adults they make their choices about interactions with the environment in terms of those values. The Thai farmer does not try to accumulate a large herd of pigs and the Tsembaga people do not try to raise a rice crop, however suitable such a strategy might be from an ecological standpoint, because such decisions arc not even options with the frameworks of their respective cultures.

The actor-based model of human ecology is thus one of limited applicability. It can reveal a great deal about why individuals within a particular social sys- tem make the particular choices about interactions with the environment that they do, but it cannot explain why their social system presents them with the particular choices it does. An

explanation of the character of a social system as a system cannot be achieved by looking all the characteristics of the individuals Thai compose the social system. Instead, it is necessary to focus on the characteristics unique 10the higher order system itself as it interacts with its environment. This approach is called the systems model of human ecology.

THE SYSTEMS MODEL OF HUMAN ECOLOGY

A major scientific development in recent years has been the formulation of "general systems theory," which is concerned with the general properties of the structures and functions of systems as such, rather than with their specific contents. According to this theoretical approach, atoms, cells, organisms, ecosystems, societies, and even the universe as a whole all share the common properties of being self-organizing systems and can therefore be studied in terms of a common theoretical perspective, Biological ecologists have long been aware of the system inequalities of the natural world, as their use of the term *ecosystem* reveals. Among social scientists, the recognition that human societies constitute organized systems is also an old one, dating back at least to the work of the French sociologist Emile Durkheim. His writings, particularly *The Elementary Forms of Religious Life* (1915), provided the basis for the development of the structural-functional social systems model that has been the dominant paradigm of British and American anthropology and sociology since the 1930s.

Structural-functionalism, as first theoretically articulated by A .R. Radcliffe-Brown (1965) and Bronislaw Malinowski (1922), and as developed empirically by E.E. Evans-Pritchard(1940) and especially Sir Raymond Firth (1936), saw all of the diverse institutions of society as being organized into an integrated system, where each institution fits harmoniously with every other one, and where change in any single institution would ramify into complementary change in all of the other institutions with which it was functionally connected.

The structural-functional model, with its conception of societies as systems proved to be of great value operationally, producing many new insights into the ways in which societies were organized. Numerous formerly inexplicable customs suddenly became intelligible in the light of their functional relations with other institutions. The payment of

“bride price” in tribal societies, for example, became comprehensible when ii was perceived that it served to strengthen marriage bonds by making divorce more difficult and that such strengthening was important since marriages served politically to unite other- wise autonomous clans. Thus, what had earlier been perceived as a quaint, “savage” custom was now recognized as serving important functions in the maintenance of tribal social solidarity.

The problem with the social system concept as developed by the structural- functionalists was not their postulation of integration among system components but their failure to conceive of the system as an open one. Following the lead of Durkheim (1938), it was argued that “social facts” must be explained only in terms of other “social facts”; one could not seek the causes of social change outside the boundaries of the social system itself. This limitation of the field of inquiry—originally conceived as a way to prevent the resort to reductionist psychological or physiological explanations of social systems such as "explaining" the development of Nazi Germany in terms of Hitler's pathological personality or "explaining" the incest taboo in terms of man's instinctual horror of interbreeding—became an obstacle to understanding the process of systems change. The development of human ecology can be seen as an attempt to escape this theoretical impasse by treating social systems as open rather than closed systems. Beginning with Julian Steward's concept of cultural ecology (1955, 1968), it was recognized that "social facts" might be explained not only in terms of other "social facts" but also in terms of "ecological facts."

An alternative approach, the "systems model of human ecology," describes social systems as they interact with ecological systems. Adaptation is assumed to occur, not at the level of discrete cultural traits or social institutions—as in the model of cultural ecology—or in terms of specific human populations—as in the ecosystem-based model of human ecology—or in terms of specific individual decision makers—as in the actor-based model of human ecology—but at the level of the total social system as a system. Cultural trails, therefore, do not necessarily function to ensure the welfare of either individuals or local populations but instead serve primarily to ensure the survival of the social system itself. From this perspective, the ritually regulated warfare of the Tsembaga is not seen as directly benefiting either most individual Tsembaga or the Tsembaga local

population as a whole. In just one battle eighteen died and the people were defeated and driven from their territory, hardly what can be labeled an adaptive outcome either for the individual casualties or the dispossessed survivors. Instead, such endemic conflict is considered essential for maintaining the type of social system characteristic of the New Guinea highlands. Individuals, or even the whole Tsembaga local population could be destroyed, but the larger social system endured.

In the systems model of human ecology both the social system and the eco- system with which it interacts retain their integrity as systems, with each changing its structural configuration according to its internal dynamics. At the same time, however, it is recognized that each system receives energy, material, and information from the other, and these inputs also influence its structure and functioning. Each system, of course, is also open to influence from other systems of the same kinds of that a social system may be altered by inputs received from a neighboring social system (the processes anthropologists call diffusion and acculturation) just as an ecosystem may be changed by inputs from other ecosystems (e.g., migration and colonization). Causality in the systems model of human ecology is thus extremely complex with no primacy being assigned *apriori* to any element or force in the total system. Figure 6 is a simplified diagram of the basic structural and functional relationships involved in the systems model of human ecology. This model emphasizes four relational aspects:

Inputs from the ecosystem into the social system—These inputs can be in the form of flows of energy (e.g., food, petroleum), materials (e.g., protein, construction materials), or information (e.g., sounds, visual stimuli).

2. Inputs from the social system into the ecosystem—Again, these can take the form of flows of energy, materials, or information generated by human activities.

3. Change in the institutions making up the social system in response to inputs from the ecosystem—Such change may be either primary, as when an increase in the death rate due to environmentally transmitted diseases changes the population structure of a society, or secondary, as other social system institutions change in response to environmentally generated primary change in one institution. Social system changes in response to inputs from the ecosystem may be and often are adaptive, that is, they contribute to the continuing survival of the social system under changed environmental conditions. They

need not, however, result in a better or happier way of life for individual human participants. In other words, it is the social system itself, rather than the people who are involved in it, that is the unit of natural selection and adaptation.

4. Changes in the ecosystem in response to inputs from the social system— Just as human society changes in response to environmental influences, so docs the ecosystem change in response to human influences. Such change may be either primary, the direct impact of a human activity on an ecosystem component such as the killing of a particular animals' species by overhunting, or secondary, alterations in other ecosystem components caused by anthropogenic primary change in one component.

The point of this discussion is that the relationship between the social system and the ecosystem is both complex and dynamic. The virtue of the systems model of human ecology is that it focuses attention on the processes of change and adaptation rather than emphasizes the sialic structural characteristics of the social and ecological systems. Moreover, this approach avoids any necessity for specification of any universal "prime mover" for change: neither environmental nor social factors have any *a priori* primacy because impulses for change may flow in either direction. The systems model therefore overcomes to a large extent the limitations of the model of cultural ecology with its lack of provision for dealing with the environmental change caused by human activity. The systems model also, by its careful specification of the parameters of the social and ecological systems as integral independent systems, avoids many of the boundary definition problems inherent in the ecosystem-based model of human ecology.

There is no inherent *contradiction* between the systems model and the actor-based model of human ecology. The latter approach is simply one among many that can be incorporated within the larger social systems framework. Certainly, decision making by individual participants affects both the character of the social system and its interactions with (he ecosystem, but, as has already been discussed, all such decisions are made within the context of these systems.

Perhaps the greatest virtue of (the systems model of human ecology is that it offers specific guidelines for doing research on human interactions with the environment.