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Title

Natural Resource Anthropology

Permalink

<https://escholarship.org/uc/item/9dp2946r>

Journal

Human Organization, 45(3)

ISSN

0018-7259

Authors

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Publication Date

1986-09-01

DOI

10.17730/humo.45.3.r7392g356u535444

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Commentary

Natural Resource Anthropology

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Natural resource anthropology offers special promise as a field of applied anthropology. It integrates the theoretical perspectives of three subfields—cultural ecology, cognitive anthropology, and economic anthropology. We discuss the application of these theoretical paradigms to U.S. marine fisheries, arid lands pastoralism, and tropical forest agriculture. We suggest that anthropological training in natural resources should involve ethnographic field methods, multivariate statistics, and the subject matter of allied disciplines in the social and natural sciences.

Key words: natural resource management, development anthropology, fishing, pastoralism, farming

In the past the role of applied anthropology has differed in important ways from those of other applied social sciences such as clinical psychology, agricultural economics, and urban planning. These disciplines have clearly identifiable missions and methods, and well-developed and stable relationships with institutional clients who provide employment, consulting arrangements, and research funds. Practitioners of these fields are expected to know specific research skills which include procedures for measurement and evaluation, such as psychological assessment, intelligence testing, or analysis of demand elasticities; and techniques for solving conventional problems, such as the design of transportation systems, improvement of market efficiency, or treatment of depression. Those research skills become part of the organizational culture of clients of the applied social scientists, so that requests for proposals, analyses, or assessments are defined in terms of standard procedures. Importantly, the applied social scientist is retained with a particular assessment or analysis in mind, not provided with a *carte blanche* to do generalized research.

By contrast, the mission of the applied anthropologist has not been well understood. There are few clients who feel that they must regularly obtain the advice of anthropologists. More often, potential employers seem uncertain as to what to demand from anthropologists in the way of substantive knowledge, research skills, and specific problem-solving abilities. These problems can be exemplified by two articles about the

role of anthropologists in development agencies. Almy (1977) notes that the public is unfamiliar with the complex nature of anthropology and often strictly equates anthropology with archaeology. Hoben (1982) points out that development agencies often assume that anthropologists are generalists whose main skill is description, and who are unwilling to commit to a substantive focus. In this role anthropologists have limited themselves to criticizing other people's proposals for change, rather than providing their own solutions. Development administrators often complain that anthropologists are too culturally conservative, offer too little in the way of realistic suggestions, and ideologically oppose economic development.

Any applied science must offer a corpus of scientific knowledge and methods for the purpose of achieving some set of consumer goals (e.g., transportation efficiency, mental health, a rising GNP). Anthropologists, however, have ignored this requirement, preferring one of two roles: a) expert on the ethnography of a culture or region, or b) advocate for the interests of the local community in its dealings with the larger society.

Both of these roles pose considerable dangers for the future of the applied discipline. Neither is grounded in the concept of anthropology as a science with its own cumulative tradition of research methods, theories, and findings. In addition, the first role fails to take the constraint "applied" seriously, and the second role offers no way to resolve situations where one must decide among policies with differential impacts on a multiplicity of small-scale communities, each one having equal appeal to the anthropological imagination.

The study of natural resource management systems is an anthropological subfield which is logically tied to anthropological traditions, and which concerns an applied niche not well served by the other social sciences. Natural resource management is associated with such (sometimes incompatible) policy goals as the achievement of economic productivity, ecological stability, equity, and the conservation of heterogeneous cultural systems.

Anthropology is relevant to natural resource management for two reasons. First, anthropology has a tradition of considering biological data, notably in the subfields of cultural ecology and biological anthropology, whereas biological models are rare in other social sciences. Second, anthropology critically depends upon ethnography, a tradition which is less well developed in the other social sciences. The combination allows for a unique understanding of the relationship between the natural and social environments.

Three branches of anthropology are especially appropriate to the study of natural resource systems—cultural ecology,

cognitive anthropology and economic anthropology. These three fields have contributed to the study of ecological stability, adaptation and decision-making, and linkages between local social systems and the external economy. They differ in their respective foci upon the natural environment, indigenous knowledge systems (Brokensha et al. 1980), and the larger economic system. All three require research methods and training that are unique to anthropology. Because ecological adaptations, knowledge systems, and local economic relationships are central to much of current anthropological theory, natural resource studies can also build upon and contribute to academic anthropology.

This article is organized in the following way. First, we introduce the concept of natural resource management systems and discuss several dimensions of social and environmental change. Next, we discuss applied anthropology in the study of U.S. marine fisheries, arid lands pastoralism, and tropical forest agriculture. Finally, we comment on the future of natural resource anthropology.

Natural Resource Management Systems

Natural resource management systems can be examined at several organizational levels. At the bottom of the full ecological system are natural resources—fish, forests, rangelands, river basins—with their special physical and biological properties. At the first level of the associated social system is the community of people who make economic use of that resource, who possess a cultural knowledge system for use with that activity, and whose political system makes decisions about the management of that resource. At the second social level are local or regional managers of the resource—regional economic planners, fisheries management councils, national forest administration, etc. At the highest social system level are the decision-makers of the political and economic system—corporate executives, national government bureaucrats, and employees of international development agencies. Many of the managers at these last two levels tend to see themselves as exogenous to the system under management (Miller and Van Mannen 1983). By studying the entire system, anthropologists can identify policy solutions which call for changes in the behavior of resource managers, as well as that of resource-dependent communities and industries.

Studying the whole system requires that the conventional anthropological perspective on adaptation and social change be combined with a macroscopic view of global economic change. The world systems perspective (Wallerstein 1974) emphasizes ways that the world economy affects local communities. Five of these processes appear to us to be especially important in the applied study of natural resource management.

The first process concerns a shift in the locus of decision-making from the local community to higher bureaucratic settings. As a result, the kinds of information that are processed in making decisions are transformed, and the local socio-political system may be undermined. Economic decisions in traditional communities usually depend upon well-practiced procedures (Barlett 1980; C. Gladwin 1980; H. Gladwin and Murtaugh 1980) which incorporate detailed

taxonomic knowledge of the environment (Berlin et al. 1974; Brokensha et al. 1980; Conklin 1957). Local “policy” considerations include status in the local social system (Cancian 1964, 1979), conservation, and ecological stability, as well as cash income. Decisions that are made in the higher levels of the world economy stress the maximization of such indices as GNP and sectorial profits.

A second process concerns the introduction of new technologies, such as fishing nets, chemical fertilizers, snowmobiles, shotguns, and iron hoes. The new technologies often upset the ecological balance because they allow for a much more rapid harvest of natural resources. Furthermore, they increase dependency upon the world system, since money must be obtained to pay for them.

The third process involves the substitution of export crop production for subsistence production, often as a result of decisions made outside the local community. This has been blamed for current shortfalls in Third World food production, and can result in the replacement of a diverse and relatively balanced food-producing ecosystem with an unstable monocrop system.

The fourth process, often an antecedent of the export production, is the expropriation of land by outside interests. This is most likely to happen to forest or grazing land. The usual process is for an external authority to judge that current users of the land are either under-utilizing or mismanaging the resource, and that it would be in the national or global interest to increase formal economic maximization through increased logging, commercial agriculture or ranching, or through the resettlement of impoverished colonists. In many cases, the analyses that justify such expropriation seem to anthropologists to be incomplete because they underestimate social costs, lack an understanding of the local sociocultural and ecological system, and underestimate the value of the natural resource.

The fifth process concerns the change in the organization of labor resulting from, and feeding back upon, the changes described above. Long distance or seasonal labor migrations, for example, can promote changes in the sex ratio in local communities, as well as the balance of resources available to men and women, and affect a wide range of household decisions in such areas as fertility, agricultural production, and consumption.

Applied Anthropology in Three Resource Management Arenas

In this section we provide an overview of anthropological work in three areas of food production—U.S. marine fisheries, arid lands pastoralism, and tropical forest agriculture. These three areas have considerable potential for future economic development, and are presently the focus of serious environmental problems. They are, however, only a subset of the larger field. Other arenas of anthropological interest include mountain environments (Guillet 1981), forests (Brokensha 1984; Gale and Miller 1985), the polar environment (Pelto 1973), and American farmland (Bennett 1969). Our goal is not to provide a comprehensive survey of anthropological work in each area, but rather to examine the role of applied anthropology in terms of: 1) motivation for re-

search, 2) contributions to date, 3) niches for applied anthropologists, and 4) future prospects.

U.S. MARINE FISHERIES. *Motivation.* Over the last quarter century there have been dramatic changes in attitudes toward the natural and fishery resources of the oceans. In anticipation of a world heavily dependent on ocean-derived proteins, minerals and energy resources, coastal states have now partitioned and claimed, through the various processes of economic and/or fishery jurisdiction, the open sea territories once regarded as common property. United Nations Law of the Sea Conferences have convened repeatedly in attempts to establish an international regime responsive to the complex issues of ocean control, resources management and conservation.

In 1976 the U.S. passed the Magnuson Fishery Conservation and Management Act (MFCMA; PL 94-265), which extended national jurisdiction over fisheries to 200 miles (320 km) from shore. The MFCMA established eight regional fishery management councils—quasi-federal authorities composed of federal, state and industry representatives—and charged them with the preparation of fishery management plans for selected commercial and recreational species.

Ideally, fishery biologists determine, for different levels of fishing effort, the corresponding short- and long-term biological costs to the population pyramid. Fishery economists model the aggregated economic costs and benefits of different regulatory configurations. Generally, many of the economic arguments in the management of fisheries have vigorously promoted the criterion of economic efficiency over its counterpart, equity.

The expected role of anthropologists in fisheries management is to make explicit the social and economic consequences of alternative policies at the regional and at the micro-regional level. From an ethnographic perspective anthropologists are challenged to identify the special interest groups and communities which vie for fishery resources, as well as the socio-cultural context of their interactions. Research must thus address the impacts of policy at many different levels of social organization. Anthropologists can perform highly informed and technical mediation among different interest groups in a way similar to mediation among different tribal groups. In this instance, however, the “tribes” may be subdivisions among bureaucracies, political action committees, and branches of large corporations, and the anthropologists must have command, not only of sophisticated ethnographic approaches, but of a variety of quantitative approaches as well.

Anthropological Contributions. Since 1976 a variety of anthropologists have been involved in the study of U.S. fisheries and their management (cf., Acheson 1981; Anderson and Wedel 1972; Maiolo and Orbach 1982; M. L. Miller 1983; Paredes 1985; Poggie 1980; M. Smith 1977a). Fishing communities and systems have been described ethnographically and results have been applied toward policy prescriptions, preparation of management planning texts, and numerous research reports. Maritime anthropology has played an important role in development of the decision paradigm that has become increasingly popular in economic anthropology (Davenport 1960, H. Gladwin 1971, Randall 1977). It has

played an equally important role in the development of awareness of the larger bureaucratic contexts that constrain local actors' decisions.

Marine anthropologists have been able to outline their role as mediators in a multicultural environment of resource managers, natural resource scientists (fishery biologists and economists), fishery attorneys, and the multifaceted fishing industry. Marine anthropology, however, has not been entirely accepted as a label of anything other than a general geographic dimension of interests, and the academic legitimacy of such a postulated subdiscipline has been the subject of debate (cf., M. Smith 1977b; Bernard 1976). Of course, scientists in other fields have successfully negotiated analogous academic statuses. Oceanographers, for example, have Ph.D.'s in many disciplines, including anthropology.

Part of this problem is reconciled by the nature of the MFCMA. First, the MFCMA, in specifying that social factors be considered in the formulation of policy, created the formal mandate for the participation of social scientists in fishery policy. Second, by involving the input of such a diverse set of interests, the management community and associated researchers need to consider issues confronting commercial fisheries in a holistic perspective. In this regard, the marine anthropologists have been able to have a definition of their role conferred to them explicitly by law. This is something not even the anthropologists involved in social environmental impact assessment have been able to enjoy.

Niches. Anthropologists pursuing applied studies in marine commercial fisheries constitute a professional community and legitimate the occupational labels of “marine anthropologist,” “natural resource anthropologist,” and “fisheries anthropologist.” There are now 20 to 30 such anthropologists in the U.S.

Predictably, the most senior members of this loosely affiliated and informal group have tenure-track academic appointments in departments of anthropology and sociology, and must reconcile their research opportunities with the assorted and standard responsibilities of teaching and administrative duties. For many of these anthropologists the study of fisheries is one of several specialities. Several anthropologists are directly connected to the fishery policy process by their participation as appointed members of scientific and statistical committees which assist regional fishery management councils in the development of policy and regulations.

Other marine anthropologists operate in a non-traditional mode and hold research and administrative positions in departments and institutes concerned with ocean fisheries, and coastal and marine studies. Together with resource economists, political scientists, and geographers, these anthropologists constitute a very small minority of social scientists in an occupational world established by natural and biological scientists.

Another niche in the National Marine Fisheries Service (Department of Commerce) calls for an anthropologist to work with the U.S. commercial, recreational, and subsistence fisheries. Three anthropologists (and one sociologist) have held this position in the last decade and are intended to interpret natural resource anthropology for the federal bureaucracy, the scientific fishery community, and the fishing industry.

Future Prospects. In the near future it appears that applied research, proposed to or solicited by regional councils and the federal departments and agencies to which they are administratively connected, will be supported to the extent that the fisheries phenomena under question command public interest. Examples of important social policy topics common to fisheries include: (1) criteria for limited-entry licensing programs in the multi-fishery applications; (2) patterns of fishermen's fishery commitment, and recruitment of "part-time," "seasonal," "newcomer," and other fishermen; (3) changes in the organization of work in international joint ventures experiments; (4) the formal organization of multinational firms with controlling interests in the American processing sector; (5) the social organization of recreational, charter-boat, and subsistence fishing within the context of user group and gear-type conflicts, including the harvesting and management of marine mammals; and (6) the impact on fisheries of other ocean activities such as those connected to military operations and to national security, ocean transportation and shipping, and deep-sea oil drilling and mining.

The basic problem facing U.S. fisheries is one of resource allocation in the face of increasingly scarce resources. National fisheries have historically been treated as common property resources, but the demonstrated potential to overcapitalise and to increase fishing effort in the harvesting sector suggests that tragedies of the commons loom in the future. The fishing industry has discovered that it is the fisherman who is managed, if there is to be any conservation of fish. Fishery managers now must decide how to allocate access in domestic fisheries with relatively few regulatory and enforcement options.

ARID LANDS PASTORALISM. *Motivation.* Arid lands have recently received increased academic and policy attention. Economic development and population pressure have led to attempts to resettle pastoralists and convert their lands to farmland. Problems occurring with these social changes are intensified by worldwide shortages of water and fuelwood. Arid regions are vulnerable to food shortages, overgrazing, and desertification (Spooner and Mann 1982). The pastoral peoples who live in these regions tend to be poorly understood by social planners. Many critics have seen arid land pastoralists as having environmentally destructive land use practices, and have questioned whether they have any future, claiming that their land must be turned over to farming or to commercial ranching. However, the lands on which they live are often too arid for farming to be economical, and rising national incomes will mean rapidly increasing demand for their products (Aronson 1981). Furthermore, it is now becoming apparent that the transition to commercial ranching is difficult, and may not be feasible in the near future.

Anthropological Contributions. Anthropological studies of pastoralists have tended to focus on pastoral social organization, group decision-making, and land tenure. Recent studies have focused on technical features of pastoral ecology (Spooner and Mann 1982; Nyerges 1982; Sandford 1982; Dahl and Hjort 1976).

Anthropological studies have emphasized that arid lands pastoralists have viable traditions of land management, which are threatened by the pressures of economic change. The

pastoral adaptation requires a complex social organization in order to stabilize fluctuations in herd structure and assure access to grass and water. Pastoralists have survived by exploiting several ecological zones through transhumant migration. Consequently, planning pastoral development requires a regional perspective. High quality dry season grazing land is essential to arid lands pastoralists (Breman and de Wit 1983; Galaty 1980; Jacobs 1973). Treating the separate pastoral ecological zones as independent regions can be disastrous (Fanale 1982).

Understanding transhumance requires a knowledge of land use practices that are based on kinship or on other features of social structure such as age set systems. This kind of research is at the core of anthropological theory and method, and tends not to be included in the research programs of other social scientists.

Anthropological studies of pastoralists show that the adaptation of pastoralists to arid environments has been effective and that development policies designed to improve the lot of pastoralists have backfired (Bennett 1976; Franke and Chasin 1980). When pastoral development programs fail, development experts tend to blame deficiencies in the pastoral adaptation, even though there is increasing evidence that pastoralists are sophisticated participants in the world market economy, and that their systems can be more productive than neighboring agricultural systems (Scott and Gormley 1980; Kjaerby 1980; Rigby 1981). Part of the problem is that pastoralists are culturally conservative, and policy makers may dislike such practices as nomadism, polygyny, and low levels of school attendance. Anthropologists are more likely to view these behaviors as rational adaptations to the environment, and can play a valuable role in helping to understand them.

Summarizing ethnographic studies, Goldschmidt (1981) describes the problems with a number of pastoral development programs. Digging wells results in a reduction in transhumant migration and overgrazing on the land near the wells. Preventing the seasonal burning of grass reduces the quality of the grass and can lead to invasion of insect pests. Stock reduction programs are often unenforceable, and can lead to increased social stratification. Veterinary medicine programs can lead to great increases in animal populations, and then to overgrazing. Projects to settle pastoralists as farmers usually put a small minority of the pastoral population on the best land, depriving the rest of the community of its dry season grazing land. All too often, the first consequence of sedentarization is overgrazing near the new settlements.

A major focus of many pastoral development programs is the attempt to register and enclose land. This has the advantage of turning land into a commodity, so that it can be used as collateral for development loans, and so that its owners will have an economic incentive to develop it. All too often, however, the newly enclosed parcels are too small to maintain the optimum scale of livestock movement. The loss of the flexibility that was obtained through the old migration patterns can lower the total productivity of the pastoral system (Lawry et al. 1984).

The study of land use practices requires a perspective both on social structure and on individual decision making. The decision approach has been used in contexts as diverse as Navajo energy development and Maasai settlement patterns

(Schoepfle, Burton and Morgan 1984; Schoepfle, Begische, Morgan and Reno 1984; Western and Dunne 1979).

Niches. Anthropologists with arid lands specialties often refer to themselves as "cultural ecologists," "developmental anthropologists," "veterinary anthropologists" (Solod et al. 1984) or "economic anthropologists." Few research institutes are devoted entirely to the study of arid lands or pastoralists.

Within universities many anthropologists are involved in studies of pastoralists along with other academic pursuits. A journal, *Nomadic Peoples*, is devoted mainly to pastoralists. Agencies, such as USAID, sometimes employ anthropological specialists on pastoralists (Atherton 1984). However, there appear to be two major problems with AID's handling of pastoral projects. The first is the inclusion of pastoral development programs under the livestock section of the agriculture office, thereby emphasizing the animals rather than the people who keep them (Hoben 1980). The second is a tendency to emphasize cattle and meat production which are men's tasks, rather than small livestock and the production of animal products, which are women's tasks (Hoben 1980; Scott and Gormley 1980). Pastoral women have been understudied, and their economic contributions tend to be underestimated (Horowitz 1981). These kinds of findings, focusing on household production systems, are made possible by the use of ethnographic research to pursue economic anthropological questions.

Future Prospects. Anthropologists engaged in arid lands policy must study the cultures of the organizations which have produced the present bias against pastoralists. This entails the understanding of the tendency of livestock specialists to over-emphasize cattle and under-emphasize small livestock (Wilson 1984), and of policies favoring forced sedentarization (Aronson 1980).

If anthropologists are to take advantage of the opportunities available for applied research on pastoralists, they must be able to communicate both with biologically-oriented technicians, such as livestock specialists and agronomists, and with macroeconomic planners. The training of many anthropologists in cultural ecology provides good preparation for the former role. Too often, however, anthropologists are weak in economics, and lack training in the research techniques used in macroeconomic planning—survey techniques, statistical analysis, analysis of elasticities of demand, and market channel analysis.

Problem areas which are likely to draw upon anthropological expertise in the future include: 1) integrating pastoralism with agricultural development, 2) determining the optimal size of grazing areas in group ranch or resettlement schemes, 3) assessing the likely social impacts of the introduction of new breeds of animals, 4) making decisions concerning competing uses for land, including pastoralism, national parks (Deihl 1985), and agriculture, 5) assessing the effects of increased commercialization of livestock production (Behnke 1983; Evangelou 1984), and 6) studying the consequences of relocation and resettlement (Scudder 1973, 1982).

TROPICAL FOREST AGRICULTURE. *Motivation.* Tropical forests are especially vulnerable to the stresses of economic development and agricultural intensification, and the world's

tropical forests are severely threatened (Brown 1981; Gomez-Pompa et al. 1972). Shortening of the fallow period as the result of population pressure, and increased competition of commercial crops with subsistence crops, invite the problems of soil erosion and laterization, degradation to a grassland environment, destabilization of water flow, and damage to riverine fisheries (Goulding 1983). These processes are often exacerbated by commercial logging and by the deliberate creation of grassland for cattle production (DeWalt 1982, 1985b; Hecht 1983; Stearman 1983). Further, tropical deforestation poses global environmental threats involving possible increases in atmospheric carbon dioxide levels, the extinction of numerous species of plants and animals, and the loss of human cultures. These threats have now reached the attention of international policy makers (Guppy 1984).

Anthropological Contributions. Anthropologists have a tradition of studying agricultural peoples, focusing on topics such as agricultural intensification (Geertz 1963; Netting 1968), peasant social structure (Cancian 1979), and food marketing (Plattner 1985; Skinner 1964; C. Smith 1976). A large body of this work has been in the cultural ecological tradition (Bennett 1969; Netting 1968), and another intersecting body of work has concerned economic change. Studies of social impacts involving the commercialization of agrarian systems identify a number of possibly detrimental outcomes, including decreased subsistence production (Appleby 1982; Gross and Underwood 1971; F. C. Miller 1982; DeWalt 1982), changed patterns of fertility (Mamdani 1974; B. White 1973), and increased stratification. Anthropological contributions have been especially important to understanding swidden agriculture (Conklin 1957; De Schlippe 1956; Geertz 1963; Meggers 1971; Dove 1983). Anthropological studies of swidden systems have emphasized their homeostatic properties and their value for the preservation of genetic and cultural diversity.

There are several good reasons for anthropological involvement with the study of agrarian resource management. First is the strength of anthropologists in studying local production systems. Anthropologists have made important contributions to the study of the household economy (Netting et al. 1984), and the use of household labor. Given those strengths, they are especially able to study the effects of social change upon the household economy and the family, as well as the role of household decision-making in the management of natural resources. By contrast with this microscopic approach, national and international planners are often biased toward macro-level planning and toward large-scale organizations, and may neglect the development of local human resources (Moran 1983).

Second, anthropologists have a special appreciation of land tenure systems. In swidden systems, a common error of policymakers has been to assume that the fallow land is unused, and therefore open for settlement activity, or for logging. A related error is to assume that swidden farmers use communal land ownership, assumed by economists to be inefficient (Dove 1983).

Third is the anthropological expertise in the study of exotic crops. Tropical farmers often grow very different kinds of crops (e.g., peach palms, lontar palms, taro) than are supported by national governments and world development

agencies. Crops that are not important to global trade tend to be undervalued in national income accounting and agronomists tend not to receive training in them. Anthropologists are more likely than other social scientists to study these crops, and to make accurate estimates of their contributions to farmer's income. By contrast, standard economic analysis is likely to over-estimate the income contribution of highly commercialized crops, leading to policies which favor the crops traded in the world economy.

Fourth is the anthropological perspective on gender, which is valuable for studying the effects of economic change on female status, fertility, and nutrition. Two common themes of this literature are that economic development may lower female status as well as the nutritional standards of women and children; and that the increased demand for labor in the transition to a cash cropping system may lead to increased fertility rates.

Western agronomists and social scientists often know too little about tropical adaptations to be able to plan effective programs. We now hear more frequently the call for the invention of new agricultural practices for these regions. Rather than inventing new farming practices from scratch, policymakers may save much time and effort by learning from people who have already made a successful adaptation to such environments as the Amazon (Posey 1983; Posey et al. 1984). The cognitive anthropological approach is ideal for such investigations.

Niches. Since the 1970s there have been a number of anthropological experts on agrarian societies employed by development agencies and by non-profit organizations such as the International Potato Center (Rhoades 1984). The early 1970s saw a policy shift in international development, to placing less emphasis upon capital intensive farming or industrial projects and more emphasis upon small farmers and rural institutions such as markets. USAID is mandated by law to consider the effects of development projects on gender roles, and the World Bank's policy is now shifting in the same direction.

In the past few years the commonalities among anthropologists involved with agriculture have been recognized through the organization of an anthropological study group on agrarian systems and its bulletin, *Culture and Agriculture*. The study group is concerned with food production systems including fishing (McCay 1981), farming, and livestock management.

Future Prospects. Anthropology may have a major role to play in understanding the trade-offs between subsistence food production and cash cropping. Grossman (1981, 1983) and others have shown that increases in production of such commodities as coffee and cattle can lead to decreases in subsistence food production and to increases in social stratification. This kind of assessment will become increasingly important in the future.

As population pressure and economic development cause increased intensification of tropical forest agriculture, anthropologists can play an important role in helping to find appropriate methods of intensive farming. It appears that these can include better development of tree crops (Fox 1977; Puleston and Puleston 1971) and root crops. Anthropological research may show the way to alternative forms of agricul-

tural intensification which are ecologically less destructive than the European complex of cereal grains and large livestock production, or export crop plantation systems.

Policy issues relevant to anthropology include whether small farms are more productive than large farms, the effects of development upon gender roles and nutrition, the social consequences of agrarian settlement schemes, access to credit and markets, management of irrigation systems (Fleuret 1985), grassland succession, the trade-offs between cash cropping and subsistence farming, and the effects of economic development on cultural diversity.

Discussion

We have discussed some common themes in the application of anthropology to natural resource studies. We suggest that a successful subfield of applied anthropology will need to build upon anthropological theory in the areas of cultural ecology, cognitive anthropology, and economic anthropology, and have a clearly comprehensible set of problems that it solves. Furthermore, its practitioners will need to be able to work with multi-disciplinary research teams and must be literate in one or more of the allied fields that would make up such teams. A natural resource anthropology thus construed has great potential. Anthropologists can fill a variety of roles within this field, as academic researchers, as field workers, and as members of interdisciplinary research and assessment teams. Furthermore, because of their interdisciplinary focus, their familiarity with the regions in which they do research, and their willingness to live in exotic cultures, natural resource anthropologists can make excellent managers within development agencies and similar organizations.

Given the forces operating in its favor, one might ask why natural resource anthropology has been slow to emerge as a formally recognized subfield. We feel that this is due to three factors. First is the existence of a division within anthropology between comparative research and ethnography. Too often, anthropologists have been seen by outsiders only as specialists in field work. Studying natural resource systems requires a regional perspective, in which ethnographic data are integrated with macroscopic social and economic data. Regional analysis requires the use of sampling and statistics, and too many ethnographically-oriented anthropologists have resisted any form of quantification. Second is a tendency to partition peoples by subsistence mode. Anthropologists who study fishing, for example, tend to be isolated from anthropologists who study pastoralists or farmers; even though most people practice a mix of subsistence strategies. Third is the split between biological anthropology and socio-cultural anthropology. Antagonism to the use of biological data is widespread in sociocultural anthropology—and this appears to us to have extended far beyond any legitimate criticism of sociobiology to a blanket condemnation of biological models—weakening the study of such topics as nutrition, livestock demography, or human reproductive biology.

If these constraints on the development of the field can be overcome, there is considerable potential for applied natural resource anthropology. As guidelines for growth, we offer four suggestions.

First, natural resource anthropology should promote the concept of a natural resource management system as a social system which includes an administrative (and scientific) hierarchy, subsistence communities, profit-making industries, other publics, and natural resources.

Second, natural resource anthropology should use a variety of qualitative and quantitative methodologies, allowing both for local ethnographies and larger scale comparisons. The common methods will include participant observation ethnography, structured interviewing, and social surveys. Given the regional nature of natural resource systems, natural resource anthropologists must blend the ethnographic approach with the analysis of more macroscopic social and economic data. These data must be collected using sampling techniques; hence the natural resource anthropologist must be conversant with multivariate statistics. Furthermore, natural resource anthropologists must be able to interact in a multidisciplinary research environment with other professionals, such as agronomists, agricultural economists, marine biologists, livestock specialists, or soil scientists. The approach we describe here resembles the farming systems paradigm (DeWalt 1985a; Norman et al. 1982).

Third, anthropological training must be modified if the subfield of natural resource anthropology is to flourish. Because of its complex character, anthropology students who are interested in natural resource management must attain literacy (if not expertise) in one or more of the other professional fields. Anthropology departments which want to pursue this specialization must allow their students freedom to take course work in these other fields. These courses should properly compete with such time-honored topics as kinship. Furthermore, training must be more quantitative than the current norm. Economics and biological science are both highly quantitative, and the anthropologist member of the research team must be fully a participating scientist, who can comprehend and make useful suggestions about research design and multivariate analysis. These topics must be taught in school, not learned by trial and error during on-the-job training.

Fourth, natural resource anthropology should be recognized in applied professional organizations which are organized around meaningful applied subfields. There is great diversity among applied anthropologists, and public discussions have recently appeared to be mainly about the management of careers (how to set up a consulting firm or how to get a job) rather than the development of intellectual fields. This contrasts with the development of successful applied fields in other sciences, such as clinical psychology, engineering, agricultural economics, and educational psychology. These fields all have their own theories, intellectual debates, and organized faculties. Natural resource anthropology can have this vital relationship to the ongoing development of anthropological theory.

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