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The quality of forestry policies in Costa Rica and Honduras depends on the successful incorporation of sound economics and natural science findings in the policymaking process. Several obstacles to the use of these scientific outputs are enumerated in this paper. They are traced back to institutional structures and the political economy of natural resource exploitation. More appropriate policies of land use, reforestation incentives, social forestry, and sustainable yields could be achieved through institutional changes that would offer greater incentives for forestry officials and others in the forestry sector to accept the implications of sound economics and natural science.

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REPORT

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SCIENCE AND FORESTRY POLICY IN COSTA RICA AND HONDURAS

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SUMMARY

The quality of forestry policies in Costa Rica and Honduras depends on the successful incorporation of sound economics and natural science findings in the policymaking process. Several obstacles to the use of these scientific outputs are enumerated in this paper. They are traced back to institutional structures and the political economy of natural resource exploitation. More appropriate policies of land use, reforestation incentives, social forestry, and sustainable yields could be achieved through institutional changes that would offer greater incentives for forestry officials and others in the forestry sector to accept the implications of sound economics and natural science.

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INTRODUCTION

Under what circumstances can science be effectively integrated into the practice of natural resource management and conservation? Scientific premises are often used as the bases for regulation (for example, theories of natural regeneration cycles may be the basis of harvest scheduling), official standards (for example, theories of animal migration may establish the minimal standards for the size of wildlife sanctuaries or other protected areas), classification systems (for example, land classification may be based on theories of the importance of soil rather than the importance of rainfall), and policy formulation (for example, tree-planting incentive policies based on theories of how private actors respond to incentives). This report focuses on that question as a key aspect of our research on forestry institutions in Costa Rica and Honduras. It is based on interviews with government officials and forestry experts as well as analyses of specific forestry policies and performance.[1]

In raising this question, "science" must be understood to include both natural science and social science. If biology, biochemistry, ecology, and hydrology are basic to understanding how specific actions by the public and private sectors affect resources and the environment, so too are economics and institutional analysis basic to determining what actions would be expected under different policies and structures.

The connections between natural science findings and their policy implications for the pursuit of particular objectives are often seen as obvious. For example, the discovery of wide-ranging migratory patterns of certain species is of direct relevance to planning protected areas to pursue species preservation. By the same token, the revolution in economic thinking over the past decade, which has highlighted the importance of market signals and of providing incentives rather than relying on regulation, ought to have a profound impact on resource policies that shape the behaviors of resource exploiters. Social sciences may also have much to say about how natural resource management institutions ought to be organized. These institutions typically grow out of tradition and happenstance, often arising out of governmental structures that pre-date concern for sustainable development. Alternative structures more capable of balancing economic development, social equity and conservation are often possible, but structural reform typically faces skepticism, controversy, politicization and inertia.

Therefore, it is important to look at the uses of natural science knowledge, economic analysis, and institutional assessments. In some respects, the reactions of policymakers to natural science and social science inputs reflect similar dynamics. Natural science sometimes enjoys a reputation that its "findings" are definitive, that the accumulation of natural science knowledge is an orderly, uncompromised process, and that the institutions that undertake and disseminate science deserve an honored place. Yet we will find that even natural science, though honored in the abstract, is often questioned in its particulars. Scientists in general may be admired, but the public and policymakers find it difficult to put scientific disputes into proper perspective. Such conflicts are often interpreted as reflecting general scientific weakness rather than the simple fact that most scientific discourse naturally focuses on areas of

[1] Based on documentary research at Duke University, previous field trips in 1986 and 1988; and field research for this project in July 1991. Much more detail on the Honduran case can be found in Miranda et.al. 1992.

disagreement rather than on areas of agreement. Thus when scientists disagree, faith in science falters and scientists' statements are more likely to be viewed as part of the promotional process of advocating particular policy outcomes.

In developing countries in particular, there is a tendency to be skeptical about the quality of local science. This frequently leads to narrow prescriptions for improving the effectiveness of science, such as pouring money into science research and training. Our argument is that simply doing better science does not ensure that good science will be incorporated more effectively. It is not only a matter of developing better institutions for producing science; it is also essential to change the institutions that formulate and implement policies dependent on scientific inputs.

Our comparative examination of forestry policy reforms in Costa Rica and Honduras reinforces this diagnosis. Costa Rica is justifiably proud of its scientific infrastructure. This extends not only to natural sciences (with both national institutions such as the University of Costa Rica, and international institutions such as the *Centro Agronomico Tropical de Investigacion y Ensenanza* (CATIE) and the Organization for Tropical Studies (OTS) operating in Costa Rica), but also to economic and institutional analytic capability. Yet in critical areas the forestry policies of Costa Rica are widely regarded by Costa Rican and outside experts as deficient. Scientific knowledge seems not to influence policy design. Frequently, the knowledge in the natural or social sciences exists to "do better," whether the issue is the design of tree-planting incentive schemes or the management of natural forest.

Ironically, the more modest "scientific establishment" in Honduras seems to provide greater receptivity to specific scientific inputs. For example, when AID-financed analysis formulated a better stumpage-fee system, it was adopted in Honduras with remarkable speed. This was clearly not a case of a conceptual breakthrough in economic science, since the stumpage-fee system has been known in the forest economics literature for many decades. The accomplishment lies in the fact that once the concept was adapted to the specific case of Honduras, it was adopted straightforwardly. In recent years the state-controlled exploitation of Honduran commercial pine forests has, according to our interviews with experts within and outside the Honduran forestry agency, approached the sustainable-yield level. This occurred despite the fact that the immediate institutional interests of the state forest enterprise called for more rapid exploitation.

Thus, the thesis of this meditation on the impact of scientific knowledge on forestry policy is that the caliber and prestige of science may help to formulate better policy, but they do not by any means guarantee the incorporation of its findings. Economic analysis, institutional assessments, and even natural science are often viewed and disputed through the lenses of partisan politics and ideology. Scientific understanding is often "available" but not used in any meaningful sense. The obvious questions are why; and what can be done about it?

General Obstacles to Incorporation of Scientific Inputs

This report argues there are seven technical and five "political" impediments to the transmission of science to policy.

The technical impediments include the following:

1) Scientific research does not automatically focus on policy-relevant issues.

2) Policy analysts and policymakers may be unaware of relevant scientific findings.

3) Potentially relevant research, even if known to policy analysts and policymakers, may not be presented in terms that are useful or even understandable. Therefore, they may either ignore scientific implications or be unaware of the limitations of applying complex scientific knowledge to particular cases.

4) The natural science relationships most relevant to long-term issues (such as multi-decade forest regeneration patterns) can only be addressed by long-term studies that are frequently not yet completed, or by artificial-environment experiments wherein the artificiality raises doubts about the validity of the results in natural contexts. In any event, governments typically lack enthusiasm for financing long-term studies, since they can have little impact on immediate issues of political import.

5) Because the documentation of results is itself a costly (and sometimes politically embarrassing) undertaking, impact studies are often lacking for "natural experiments".

6) The generalizability of a scientific finding from the original context to another context is almost always open to question.

7) Scientific disagreement undermines the credibility of science.

These last two obstacles warrant some elaboration, as they are less obvious than the others and yet are central to the situation of natural resource policies in developing countries. Applied natural science is highly sensitive to contextual specifics. Indeed, the "message" of ecological science is that the details of relationships are crucial. Therefore, a particular natural science finding, such as the discovery that a particular exotic tree species can do well within one micro-environment, may or may not hold in a different context. Thus, the success of that exotic cannot resolve whether that species, or any other exotic species, would do well in another micro-environment. However, scientists are often called upon to to judge whether research findings can be applied to other contexts and, therefore, a degree of uncertainty and disagreement is inevitable.

The same holds for economic analysis and even more so for institutional assessments. Even the most rigorous empirical evaluations of the performance of economic policies and institutions cannot guarantee that the best performers will do so in other circumstances, or even in the same system at a different time. Recommendations inevitably rest on some theoretical understanding; theory is always subject to challenge.

The political impediments are:

1) Scientific inputs, once recognized as having promotional value to support or oppose particular policies, are often subjected to deliberate efforts to discredit them by one side or the other.

2) The dissemination of scientific information is frequently restricted because, like any other policy-relevant information, it can be a currency of power -- those with such information are in a stronger position to win the policy battles.

3) Clear-cut connections between science and policy are often embarrassments to the government if it prefers policies that are not supported by good science.

4) Official endorsements of scientific inputs (such as, making them the bases for regulation, standards, or official classification systems) can alter the standing of such inputs -- providing them with either greater or lesser prestige -- irrespective of their intrinsic merit. In many cases, the government's imprimatur endows a scientific conclusion with greater stature, but in other instances the scientific input can be discredited through its association with poor policies or the rejection of the government in general.

5) Bureaucratic politics -- the rivalry among governmental agencies -- often leads to the manipulation of scientific efforts and, even when that does not occur, suspicion exists that such manipulation occurs.

THE FORESTRY CHALLENGES FACED BY COSTA RICA AND HONDURAS

Costa Rica and Honduras share several forest-sector problems:

1) Hardwood ("broadleaf") forests have been experiencing rapid depletion.

2) Highly diverse wildlife (among the world's richest in terms of biodiversity) has been subject to rapid depletion.

3) Watershed destruction results in soil erosion and flooding.

4) Wood-products industries are relatively inefficient, and now are suffering from supply

shortages as domestic timber supplies dwindle.

5) Population pressure, particularly from people displaced by disruptions in El Salvador and Nicaragua, has put substantial strains on natural systems in many parts of both countries.

6) Expansion of agriculture and grazing has pushed far into areas best devoted to forest.

From an institutional perspective, several other common problems lie behind those enumerated above:

1) Enforcement of existing, overly-ambitious forest-use regulations and restrictions is very difficult.

2) The level of information concerning forest uses, and the rates of depletion of forests and biodiversity is low.

3) Institutional capabilities and predispositions to engage in social forestry are weak; 4) budgets are too small to undertake all the functions the agencies are required to undertake.

5) Public-sector salaries are low, driving some capable officials to the private sector.

6) Attracting forestry officials to remote stations is difficult.

7) Forestry issues, apart from the national park system in Costa Rica, rank rather low among national priority issues.

8) Official forestry institutions, again apart from the Costa Rican National Park Service, have relatively low political and bureaucratic power compared to official institutions representing competing sectors such as agriculture and livestock raising.

Other challenges are distinctive to either Costa Rica or Honduras. In Honduras, extreme poverty plagues large portions of the people who live in and near the forests; shifting cultivation is the major direct threat to extant forests. Fuelwood demands are also extremely high in Honduras. Cooking and heating technologies are wasteful, corresponding to the low incomes of most Hondurans (only 20% of the population have electricity in their homes). Honduras also faces the challenge -- and opportunity -- of managing significant commercial softwood forests; the state has to manage private concessionaires, establish optimal harvesting rates, and enforce harvesting regulations.

From an institutional perspective, Honduras faces the problem that many local people living in or near forested areas view the state forestry agency as a heavy-handed, commercially-oriented bureaucracy that has ignored their interests to serve commercial loggers and increase its own revenues.

In Costa Rica, unsustainable logging occurs both with official harvesting permits and without. According to our interviews with government officials and forestry experts, the requirement of harvesting plans is regarded as nothing more than a formality; therefore, little effort goes into developing sustainable harvesting systems. Even the presumably secure national parks have been subject to encroachments from illegal logging and mining Tortuguero National Park has suffered from significant illegal logging, while Corcovado and other national parks, have been subjected to serious damage from unlicensed small-scale mining. The decline in domestic lumber supply is much more severe than in Honduras. This is particularly costly in light of the prior investment in sawmills and down-stream processing. Between 1980 and 1990, the number of operating sawmills in Costa Rica declined from 220 to 161 (Abt & Associates, 1990a: 89).

Costa Rican institutional problems include ambiguity in the state's authority to regulate natural-resource uses on private lands. Another serious problem is the especially weak standing of the forestry agency, Direccion General Forestal, vis-a-vis other governmental agencies.

SPECIFIC SUCCESSES AND GAPS IN THE TRANSFERENCE OF SCIENCE

In a rather thorough AID-funded inventory of Central American environmental policies and problems published in 1990, Abt and Associates identified numerous policies and initiatives regarded as either successes or failures. Many of these policies involve the use and misuse of scientific understanding in formulating policy, including the failure of policy to ensure that scientific understanding is conveyed clearly from experts to individuals involved in resource use and conservation.

Costa Rica

Three issues are particularly notable in Costa Rica. First, the failure to use land optimally is rooted, in part, in the failure to establish an acceptable land-use classification system. Second, the tree-planting incentive system has foundered on a poorly-conceptualized design that, in theory, could have been markedly improved in light of economic theory. Third, the potential for natural forest management has been obscured by the fact that the only large-scale experiment has been in the hands of a controversial private operation.

Land-Use Classification

At the time of the Abt inventory, there were ten different land-classification systems used by twenty-two government institutions. Apparently each agency requiring a land-classification system either developed one *ad hoc* or adapted a borrowed system, without a system-wide arbiter or coordination. The lack of a generally accepted land-classification system weakens the hand of the government agencies mandated to formulate and enforce land-use restrictions. Land-use restrictions according to best-use classifications

cannot be enforced, especially when different governmental agencies are sponsoring different uses.

The impact of bureaucratic politics and the struggle for agency autonomy are clearly at play in this issue of a widely-accepted land-use classification system. The problem has long been recognized, and the non-governmental *Centro Cientifico Tropical* (CCT) was commissioned by the Ministry of Agriculture to synthesize existing systems to develop a common system for the use of all official agencies. In 1985, the CCT published a modified Holdridge World Life Zone Classification System (*Centro Cientifico Tropical*, 1985), which was officially adopted through the Forestry Emergency Decree of 1987. Nevertheless, key government agencies have ignored the CCT system, including the Agriculture and Renewable Natural Resources Planning Secretariat (SEPSA) and the Land Reform Institute (*Instituto de Desarrollo Agrario*, or IDA).

Various perspectives can be applied to understand the failure to adopt a single land-classification system. One is that the multiple land-classification systems provide an example of normal, expectable differentiation of systems developed for different purposes. While there may be differences of scientific opinion to account for part of the proliferation of systems, it may also be the case that different regulatory purposes justify some differences in classification. Yet the CCT classification was specifically designed to overcome this difficulty by developing a system that could be applied to the entire range of regulatory needs.

What is striking about the Costa Rican case is that the application of classification-based regulations seems to have been paralyzed because of the multiplicity of systems. For example, the Land Reform Institute (IDA) took advantage of the absence of a predominant land classification system by designing its settlements without reference to any land-use classification system. This enabled the IDA to establish farms on land that, according to other existing land classification schemes, should have been reserved for forest.

From a political economy perspective, the question is whether the failure to establish a definitive or dominant land-classification system is a convenient way for the government to avoid having to enforce land-use regulations. The application of scientific knowledge concerning the impacts of soil quality, hydrology, climate, and terrain on agricultural productivity should have clarified that agricultural and pastoral uses of large tracts of Costa Rican territory were myopic and, even discounting future benefits, suboptimal. One reading of Costa Rican economic history since the start of the collapse of the Central American economy in 1979 is that the Costa Rican governments have allowed the rapid liquidation of the natural resource endowment to offset the politically damaging decline in jobs, exports and incomes. It could be argued that the government's lack of insistence on adopting a single, definitive land-use classification enabled the government to deal more flexibly with land in ways that responded to important demands by the population but did not correspond to long-term best uses. In blunter terms, if science can put a damper on political maneuvering, the government may not be enthusiastic about accepting the science.

In 1990 a new inter-agency commission was formed to look again at the possibility of a unified classification system. Since the most relevant government agencies (including the forestry agency, the

Land Reform Institute and SEPSA) and the technical non-governmental institutions (CCT and the two major universities) are involved this time, the system that emerges may avoid being rejected on the grounds that it was imposed without regard to each agency's specific needs and desire for autonomy. However, the problem remains that any unified system that lends itself to unambiguous enforcement will constrain those agencies that find land-use regulations an impediment to pursuing their objectives.

Tree-Planting Incentives

The tree-planting incentive system that operated in Costa Rica during the 1980s was based on highly faulty economic analysis, and some faulty natural science assumptions as well.[2] Costa Rica's reforestation incentive programs were ostensibly designed to encourage plantation forestry to meet domestic timber demands and to restore forest cover. In exchange for planting trees of specified species, planters would receive a tax-credit certificate that pays off at given percentages over five years. The certificates are tradeable on the Costa Rican stock exchange.

While the regulations did specify which tree species would qualify (fast-growing species, especially exotics such as gmelina and eucalyptus), they did not identify particular geographical areas where each species could or could not be planted to qualify for the fiscal benefit. Consequently, the possibility was left open for reforestation with the least expensive species in areas where soil or climatic conditions were inappropriate for their long-term survival.[3] There was no effort to restrict the incentives to fast-growing domestic species, despite findings of the Organization for Tropical Studies that several native species have comparable growth rates and do not face the unknown risks of pest infestation that exotic species always confront (Wille, 1990). In this respect, the tree-planting incentive policy adhered to the established (but increasingly challenged) enthusiasm for exotic species like eucalypts and gmelina, as expressed by many international research centers and foreign assistance agencies. Even when this enthusiasm was being brought into question by further scientific research and theory, the species eligibility criterion has been slow to adapt.

The scientific basis for including a wide variety of land types as eligible for the incentive program was also rooted in an increasingly problematic conventional wisdom developed beyond Costa Rica. As the Abt study notes, "[t]he prevalent thinking was that the replacement plantation would produce more wood volume, at a faster rate, and be easier to manage, than natural forest" (Abt, 1990a: 76). Yet this presumption led to the removal of natural forest and the destruction of the biodiversity therein. As these costs have not been offset by good yields, this policy of permitting forest removal is widely regarded as the most serious failure of the reforestation incentives (Gonzalez, Alpizar and Munoz, 1987). Yet no matter how convenient the presumption may have been for entrepreneurs trying to cash in on the incentives, it cannot be dismissed as deliberate false science, as it was a predominant belief of the global forestry profession at the time (Abt, 1990a: 76). Finally, while no definitive evaluation is available, there are myriad complaints that enterprises abused the program by planting inappropriate species and

[2] See Lutz and Daly 1990 for a highly critical account.

[3] It is significant that there are no studies of how widespread is this problem.

neglecting the post-planting care of the trees. In some cases, natural forests were cleared to make way for plantations. Many companies with little or no experience in forestry took advantage of the incentives.

Why has the Costa Rican incentive system worked so badly? On one level, the answer is technical: given the particulars of the incentive system, it is rather easy for those who can avail themselves of the certificates to reap benefits without contributing to sustainable reforestation. The economics involved in the design of the incentive system is clearly problematic. The Abt survey notes that in general little research or analysis of the administrative or economic aspects of forest management was conducted in Costa Rican university and research centers (Abt, 1990a: 84); our interviews revealed that even by 1991 only the CCT and a brand-new research center at the Costa Rican headquarters of the Central American Institute of Business Administration (*Instituto Centroamericano de Administracion de Empresas*, or INCAE) were undertaking such analysis outside of the government, and little was being undertaken within the government.

There is no evidence that the Costa Rican government conducted the analysis necessary to determine what kind of incentive-system elements would encourage appropriate responses. At a minimum, the design would have to reflect the opportunity costs of destroying existing vegetation, the direct costs of planting and maintenance, transactions costs, and externalities for the planters and the government; it would also have to anticipate and offset strategies to earn the incentives without undertaking serious silviculture.

A closely related problem is that neither the Costa Rican government nor any private or international institution has undertaken a systematic *ex post* evaluation of the tree-planting incentive policy. Economic theory cannot be definitively tested in the laboratory, and the failure to evaluate the key incentive program leaves at least some doubt as to whether it is indeed a failure. Thus even the Abt assessment, generally critical of the program, had to hedge its evaluation by noting that "Since [1979] when the fiscal incentives were first made available, 40,210 hectares have been reforested, 36,110 of which have enjoyed the incentives provided by the Costa Rican government...In light of these statistics, one would have to say that reforestation incentives do work if properly applied. Unfortunately, there has been no evaluation published, or other documentation, to say why the reforestation incentive system does or does not work" (Abt, 1990a: 75). The striking thing about this assessment is how the Abt assessment is forced to take, at face value, the isolated datum of how many hectares were reforested through the incentive program as an indicator of success. It is impossible, because of lack of information, to take into account the costs incurred, how many hectares could have been replanted with a better designed scheme, or whether the "reforested" land had been cleared for the purpose of replanting. Here again we encounter the problem that real-world tests of scientific (in this case economic) premises are under-documented and therefore do not contribute to the crucial function of disconfirming faulty premises.

From a political economy perspective, the Costa Rican government has established a system wherein private actors have had attractive rent-seeking opportunities.[4] Presumably recipients of these benefits

[4] A "rent" is the excess return on an investment beyond the return required to attract the investment (Tollison 1982: 575). For example, if investors would devote their capital to particular types of forestry investments if they could receive at least a 10% rate of return, but actually receive a 15% rate of return, then the additional 5% is a

may reciprocate by providing support for the incumbent government.

Natural Forest Management and Portico

The third area of Costa Rican forestry policy that bears attention is the difficulty of assessing the value of natural forest management. Can existing forests, as opposed to plantations, be exploited for adequate economic gain while still keeping the basic ecosystem, species mix, and wildlife more-or-less intact? It should, of course, be of great concern to Costa Rican policymakers whether natural forest management could provide greater benefits than either the plantation approach or strict forest protection. The issue has remained far from being resolved, despite the possibility that natural forest management could play a crucial complementary role with ecotourism and the wood products industry based on expensive hardwoods.

The Costa Rican government has not strongly promoted natural forest management. This may be related to the peculiar circumstance that the only significant[5] effort at commercial natural forest exploitation in Costa Rica has been undertaken by an extremely controversial U.S.-financed private enterprise, Portico S.A. The controversy has left considerable confusion about the potential and risks of natural forest management. Portico claims that its natural forest management for "royal mahogany" (*caobilla* is the local name) to be used in its own door and louver manufacturing operations is sustainable, because it adheres to adequately long harvesting rotations and minimizes damage to the residual stand. Portico claims that it relies on a staff of botanists and ecologists to plan its harvesting program. Its critics assert that Portico's scientific staff is window-dressing that has little to do with the actual logging operations, which are much more damaging than Portico claims. Critics also argue that the sustainable rotation cycle for *caobilla* has never been established, and, as the demand for the wood as input to Portico's processing increases, the company will probably further reduce the rotation period. They also claim that Portico has been using large bulldozers, causing severe collateral damage, and some maintain that Portico may be defrauding land investors by selling them forest land without clarifying the revenues of harvesting trees

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rent. Usually, investments of capital, land or labor yield rents because government policies restrict competition; otherwise competition would induce price-cutting or greater costs to compete on quality, either of which would erode returns to the minimum level necessary to continue to attract investment. Thus a monopoly license is the classic example of a rent, but so too are trade protection instruments such as tariffs and quotas.

"Rent-creation" is the action of government to alter policy guidelines and interpretations so as to provide rent opportunities. In writing and implementing protectionist legislation, in creating a licensing system in place of free access, and in many other ways, governments can create rents through both explicit policies and operational interpretations. "Rent-seeking" refers to efforts by private actors to capture rents. This is done by shifting economic activities into the areas favored by governmental policy, or by qualifying for special status within an area of economic activity, which may entail lobbying or even paying off government officials.

Because rent-seeking diverts resources from their most productive uses, and because it gives rise to corruption, it is widely condemned by economists.

[5] Aside from small efforts at natural forest management by cooperatives.

from these lands, or that Portico is maneuvering to buy more and more forestland to take advantage of government subsidies. As all of these claims and charges are controversial, and many are intrinsically unprovable (e.g., literally no one knows with any certainty how long it will take for *caobilla* to re-grow), the prospects for natural-forest management are mired in uncertainty and acrimony.

The forestry and conservation community, both within and outside of government, is deeply split over Portico operations. The treatment of Portico is an interesting case of how governments address uncertainty of strategies claimed to be sustainable. Backed by very sophisticated public relations, Portico has managed to purchase large tracts of forested land, qualify for some government subsidies, and sell limited partnership shares to investors.[6] The government, lacking definitive grounds for disputing Portico's claims and the viability of its strategy, claims that it has no basis for denying Portico the opportunities available to other entrepreneurs in the forestry sector. Then, too, Portico produces high-price finished products for export and employs a sizeable workforce.

Thus, while some highly reputable scientists regard Portico as one of the few hopes for sustainable natural forest management, with the implicit assumption that efforts in this direction ought to be given the benefit of the doubt, others react extremely negatively. To the critics, the fact that the company invokes conservation as part of its appeal makes any of its current or future shortcomings all the more objectionable. The difference in views is perhaps reflective of deep-seated divisions within the Costa Rican scientific community, and distrust of the government and business sectors on the part of the non-governmental organizations and academic scientists. In a sense, the government has left the scientific enterprise of testing the sustainability of natural forest management to the Portico managers. Whether this is good or bad depends on a host of currently unknown factors, including the present and future commitment of Portico to genuinely sustainable forestry. Certainly the suspicions that Portico would cover up findings to avoid the withdrawal of privileges or other economic risks means that its self-appraisals have less credibility than the government's appraisal of its own experiments. The broader phenomenon of privatized initiatives to formulate and apply new scientific findings is discussed in the next section.

If there is uncertainty about Portico, why does the government forego the conservative strategy of carefully limiting the company's activities until the sustainability of its operations can be confirmed? The fact that many questions can only be answered in the long term is both a limitation to how far science can go in resolving the issue, and an important consideration for a country pressed for short-term solutions to economic stagnation. In addition, under current interpretations of the rights of property owners and the current weakness of the forestry agency, there is little hope that the government would be able to prevent Portico from exploiting its extensive holdings in highly unsustainable ways. Another possibility is that the Portico case is simply another instance of the government's support for ventures that can help overcome the short-term economic problems. Yet another possibility is that the acquiescence to Portico's expansion is recognized as a way to consolidate control of natural forest into large-scale private holdings. Whether or not the extraction is fully sustainable, it may be seen as a second-best

[6] When Portico has bought land, it has, according to the company's claims, involved the former small-holder owners in the management of the forest resources.

solution to the problem that the state is incapable of keeping smaller private holdings or open-access state holdings from more severe deforestation. It is curious that the possibility of common property arrangements has hardly been explored in Costa Rica.

The Role of NGOs in Developing and Applying Forestry Science

The rather modest ambitions of the Costa Rican government to update its forestry strategies can also be seen from a political economy perspective. That is, we can ask whether the government's actions (or relative inaction) can be explained by resource constraints, distributional considerations, and the broad arrangements between the state and private groups. We do indeed find that all of these factors contribute to a partial privatization of key forestry initiatives. With meager resources from its own revenue sources, the Costa Rican government has concentrated on its essential statutory functions, and thus has taken a minimalist approach to its own resource-demanding project initiatives (as opposed to programs such as the tree-planting incentive scheme that do not require large-scale personnel involvement). At the same time, the external resources poured into Costa Rica in the name of conservation and sustainable development have by-passed the Costa Rican government. According to our interviews, many officials involved in bilateral or multilateral foreign assistance and international NGOs are extremely skeptical of state agencies' capabilities, and quite optimistic about the capacities of local NGOs to administer projects more effectively. While this optimism may be challenged, in light of the shaky performance of large local NGOs such as the Costa Rican Association for the Conservation of Nature (*Asociacion Costarricense para la Conservacion de la Naturaleza*, or ASCONA)[7], the fact remains that non-governmental actors have been given the resources to undertake experiments in sustainable forestry development. Thus the Fundacion Neotropica is the local administrator of the BOSCOSA project in the Osa Peninsula of the Pacific south, the CCT administers the Monteverde Cloud Forest Preserve, while CATIE (an international institution financed largely by external official and foundation funds) has run the experimental MADELENA project to stimulate the planting of fast-growing fuel-wood trees.

Whereas the availability of non-governmental institutions to undertake these innovative initiatives is probably a godsend in the context of such limited governmental resources, it does pose additional problems for the incorporation of the lessons from these experiments. There is inevitably an institutional gap between the non-governmental institutions and the governmental bodies that would have to apply the prototypes more broadly if they are to have a significant impact throughout the country. The success of integrated development in the BOSCOSA project under NGO supervision does not guarantee that similar programs will work under governmental auspices or under other NGOs.

Moreover, NGOs given the opportunity to administer large, heavily-funded development or conservation projects have at least as strong a motivation to appear successful as do governmental agencies. While the incentive to do well is appropriate, the incentive to avoid dispassionate assessment is also strong.

[7] The executive director of ASCONA publicly acknowledged in a 1991 presentation to ASCONA staff and guests that during the late 1980s the organization had been taken over by opportunistic individuals who sought to capture the largesse of USAID grants, until the disqualification of ASCONA led to its reconstitution and the restoration of its former leadership.

Honduras

In Honduras, two striking turn-abouts in forestry policy, and one failure, are highly revealing in terms of the role of science. The major institution deserving credit or blame for these developments is the forestry agency, the *Corporacion Hondurena de Foresteria* (COHDEFOR), formally constituted in 1974 as a state enterprise. At that time, the Honduran government, with more statist and resource-nationalism zeal than money, decreed the "nationalization" of all trees, regardless of the ownership of the property. Mindful of its scarce fiscal resources, the government opted for the self-financing state enterprise model rather than a more conventional state regulatory agency that would have required financing from the central budget (as in the case of Costa Rica). COHDEFOR was thus established to exploit forest resources, with a monopoly on timber export and the rights to the proceeds of all logging. COHDEFOR was to receive no funds from the central budget, but it could retain all of its earnings. In a sense, these earnings would offset the regulatory burden that COHDEFOR was mandated to undertake without fiscal help from the central government. However, this arrangement would also seem to run the risk of inducing COHDEFOR to over-exploit the forests in order to increase its revenues

The Stumpage Fee System

In 1991, after many years of administering a stumpage-fee system that failed to capture enough resource rent and encouraged wasteful harvesting, COHDEFOR, with technical studies funded by AID, adopted a good fee system that allows the government to capture the natural resource rent and thus discourage over-harvesting. This accomplishment has proven difficult in many countries (Repetto and Gillis, 1989).

The new Honduran system bases the stumpage fee on the value of the standing timber rather than the declared value of the removed timber, thus reducing the incentive for loggers to highgrade (i.e., harvest only the best timber). The Honduran stumpage fee is much higher than the comparable royalty in Costa Rica, thereby capturing most of the natural resource rent.[8] The outcome arose out of apparently highly constructive interactions among COHDEFOR, the AID officials and experts, and a few outside forest economists.

Now, the taxation of standing timber is not new to the field of forestry policy, and economists have long argued that such royalties induce greater conservation than royalties based on the volume or value of removed timber. For many years the existence of a scientifically-endorsed policy option did not move the Honduran authorities to action, yet finally in the 1990s the reform went through. The key question is why Honduras came to the point of willingness to incorporate these economic insights. Unlike Costa Rica, where there have been numerous suggestions and criticisms of current policy aired by legislators and non-governmental organizations, the AID-backed recommendation for the Honduran reform faced relatively little competition. The U.S. bilateral aid package is a major factor in the Honduran economy. The Honduran success may be a case of greater receptivity to sound science in the context of fewer

[8] In Costa Rica "the DGF...by fixing a low tax on standing timber...reinforces the concept of forests as a low-value resource...DGF has no documents showing actual timber value on which to base their tax. Instead, it must establish a price for categories of wood and charge accordingly" (Abt Associates 1990a: 86).

contenders and less confusion arising from multiple alternatives. It would be ironic indeed if the relatively lower level of technical forest-economics expertise in Honduras (as distinct from traditional silviculture expertise) made it more likely that a sound stumpage-fee reform could be enacted.

One compelling explanation for the timing of the shift to a standing-timber royalty system is that it was only in 1989 that COHDEFOR's National Forestry School ESNACIFOR began to train forestry technicians in the techniques for estimating the value of standing timber (*Secretaria de Planificacion, Coordinacion y Presupuesto*, 1989: 12). This lesson may be that the incorporation of the implications of scientific progress depends on the administrative capability of utilizing science.

Sustainable Yield of Commercial Pine Forests

The second revealing circumstance in Honduras is that both government officials and experts from universities and research institutes report that the harvesting rate in the pine forests approximates the sustainable-yield level. Because Honduras has a comparative advantage in pine production, and already has a forest-products industry, there is no rationale for liquidating the existing pines to convert the land to other uses.[9] Therefore a sustainable-yield strategy seems appropriate, and, according to those most knowledgeable about Honduran forestry, that strategy is being followed.

This state of affairs has to be interpreted carefully. Although it is certainly encouraging that opinion both within and outside of the government has it that the pine-forest harvesting rate is near the sustainable level, it is quite disconcerting that this opinion is not based on any sort of systematic assessment. It is difficult to rule out the possibility that all concerned have endorsed the most comfortable belief without an adequate basis.

However, to the degree that the harvest rate has come closer to a sustainable-yield level, there has been an important improvement compared to the earlier experience. Initially COHDEFOR did little to reduce the too-rapid exploitation of the Honduran pine forests -- this exploitation was the main source of COHDEFOR's income. Up to the mid-1980s, Honduras was losing 15,000 hectares of pine forest a year through conversion to grazing land, with an equally serious problem of high-grading mature trees such that the volume of commercial timber was declining steadily. At that rate, it was projected that by the Year 2010, only 20% of 1986 production would be possible (World Bank, 1989). This strategy reflected a lack of professional commitment and a short-sighted institutional perspective.

For a forestry enterprise/agency like COHDEFOR, the long-term standing and interest of the institution dictates a different strategy than the short-term considerations. Assuming that the financial arrangement does not change, any drastic reduction of the yield of Honduran pine forests would mean the demise of COHDEFOR in the long term. If the broadleaf forest also disappears (at the mid-1980s rate, this would

[9] Approximately 8 million hectares of Honduran land is most suitable for forest. One million to 1.5 million hectares that ought to be in forest are currently in pastureland or cropland. Approximately 2.3 to 2.8 million hectares of forestland have been degraded by slash-and-burn agriculture. Half a million hectares of pastureland ought to be cropped (Abt 1990b:3).

occur by the Year 2025 (World Bank, 1989)), the rationale of COHDEFOR as a forestry agency would evaporate even if central funding were available. Therefore if COHDEFOR policymakers have the long-term interest of the agency at heart, then one would expect them to moderate the harvest rate to a more sustainable level. If COHDEFOR policymakers are concerned primarily about their personal career advancement, and they do not expect to confine their careers within COHDEFOR because of opportunities to move into other government agencies or into the private sector, then short-term revenue maximization would be more likely, especially if few forecast the demise of COHDEFOR and hold today's officials accountable for tomorrow's failures.

Interviewing Honduran foresters within and outside of COHDEFOR reveals a notable professionalism that most attribute to two factors. First, COHDEFOR is in a position to do one job well: exploit the pine forests profitably and professionally. Because of the financing arrangement -- and in strong contrast with Costa Rica's *Direccion General Forestal* -- COHDEFOR has the resources to train its personnel, monitor the pine forest logging, and reap institutional as well as individual rewards for efficient operation. Second, the rigorous training and *esprit de corps* provided by the National Forestry School (ESNACIFOR) has socialized large numbers of COHDEFOR managers and foresters to hold professional attitudes. To an impressive degree, COHDEFOR officials have developed professional norms that compel them to take responsibility for long-term impacts because that is how professional responsibility is often defined. This is a strong reinforcement to the agency orientation and the concomitant concern that a future decline in harvestable timber could jeopardize the agency's budget and their own standing in the future. In short, the professional orientation within COHDEFOR helps to create a receptivity to scientific inputs that emphasize the long-term consequences of forest management, in regard to both the stumpage-fee system and the overall rate of pine-forest harvesting.

Deforestation of the Broadleaf Forests

The third revealing aspect of Honduran forestry policy is the failure of COHDEFOR and the Honduran governments in general to fulfill the broader stated mandate of using forest resources to assist marginal populations and to reverse the deterioration of the marginally-commercial broadleaf forests. The broadleaf forests, which are of high biodiversity, are being converted into unsustainable agricultural land through slash-and-burn agriculture; at the current rate of deforestation, these forests would be eliminated by the year 2025 (World Bank, 1989). COHDEFOR has also acquired an unfortunate reputation of ignoring or even restricting the role of poor populations living in and around the forests. Two apparently sound ideas, the Integrated Management Areas system (*Areas de Manejo Integral*, or AMI) and a joint COHDEFOR-Canadian approach to social forestry[10], have been well formulated but have made distressingly little progress in implementation. (Abt, 1990b: 54-55) The AMI approach tries to establish community forestry institutions within Integrated Management Areas of 1,000 to 10,000 hectares that report to the nine regional forestry offices. The program requires a forestry technician to be stationed at each AMI location -- in effect, a highly decentralized extension agent. Perhaps the strong centralist tradition within COHDEFOR, and the administrative complexity of setting up these institutions, have

[10] Social forestry is defined as forestry practices and programs designed to involve and benefit the (usually low-income) populations living in or near the forests.

limited their development to only fifty as of mid-1991 (Miranda et.al., 1992).

It is true that COHDEFOR has developed a very strong cadre of forestry professionals who know how to manage the forests, develop harvesting plans, and interact with the private sector so as to extract considerable profit from pine exploitation. With the exception of an abortive initiative into down-stream processing through a state-owned wood-products industry, the opportunity to earn profits made COHDEFOR behave as many would want a state enterprise to behave -- as a profit maximizer. Unfortunately, COHDEFOR was supposed to do much more than that, especially when dealing with a renewable resource.

CONCLUSIONS

The "uptake" of science becomes an issue of political economy. Science that is endorsed by government or by prestigious scientific institutions, in the sense of being acknowledged as the best or most authoritative available scientific findings or theories, has a much greater potential to "require" policy reform. That is, if a recognized natural-science finding, economic evaluation, or institutional assessment clearly implies a change in policies or institutions, then the government faces the choice of either adopting the change or incurring considerable embarrassment and loss of political support. In the case of resource management and sustainable development, good science generally recognizes long-term consequences that would otherwise be ignored or underemphasized: indirect consequences, non-obvious ecological connections, and inter-dependencies that make resource use for immediate benefit more problematic than otherwise would be thought. When the government is reconciled to trading off long-term objectives for short-term objectives, it has a strong temptation to suppress or ignore the messages of well-founded natural science, economics and institutional assessment.

Rent-creation and rent-seeking, in so far as they create economic distortions and induce wasteful exploitation of resources, are facilitated by scientific indeterminacy that obscures the true costs of the policies permitting rent-seeking. Policymakers and the groups that government relies on for support may perceive, correctly or incorrectly, that science does not provide a definitive answer to the question of whether a given policy is suboptimal. When the problem is true disagreement among qualified, responsible scientists, then the result may simply be that harmful policies are selected without knowledge of their true costs. But in other cases the government may ignore inconvenient findings, or minimize the impact of sound science by making it difficult for responsible research to proceed, or by endorsing marginal scientists or problematic scientific findings. While this may bring to mind such extreme abuses as the Soviet government's support for Lysenko's neo-Lamarckianism, most cases are more mundane and therefore often escape notice: a harvesting system based on a 35-year cutting cycle for tree species that actually require longer reproduction cycles; using land-classification criteria based on research conducted in temperate climates; establishing the boundaries of national parks in ignorance of the migratory patterns of species targeted for preservation, and so on.

Bureaucratic politics also thrives on scientific ambiguity. Definitive scientific findings could arbitrate

between conflicting positions. For example, the jurisdictional claims of an agricultural ministry or land reform agency would not be defensible if scientific soil analysis showed definitively that the land in question is unsuitable for agriculture or grazing. The agency's ability to throw its weight around would be limited if accepted scientific conclusions definitively undermined their position. In terms of whether government agencies will try to undermine sound science, the question is whether a given agency has an incentive to advocate poor policies, and then either try to invoke poor science or ignore good science, to back up its position. If rent-seeking opportunities were restricted, agencies would have fewer incentives to do so. Thus when institutional incentives are brought into line with pursuing sustainable development, then agency officials and experts may be quite disposed to relying on good science.

To reduce scientific ambiguity -- when justified -- governments should learn to provide provisional state-of-the-art endorsements. They should specify which policy relevant scientific inputs are to be taken as definitive for the time being. To be sure, the advantages of such endorsements have to be balanced against the potential danger of freezing policy-relevant products of science even as scientific knowledge advances. For that reason, the endorsements must be subject to periodic revision. Yet at any point in time, the government may have to provide its imprimatur to such science-based policy inputs as a single land-use classification system, a single estimate of the sustainable harvest rate, a particular assessment of institutional strengths and weaknesses, or a specific economic evaluation of feasible tree-planting incentives. Each input would serve as a basis for a consistent treatment of forestry issues on the part of all relevant governmental institutions.

Of course, in so far as the ambiguity arises out of its convenience for government, the non-governmental scientific community may have to pressure the government into such an endorsement. This can be accomplished if the scientific community itself suspends its own internal rivalries long enough to make its own endorsements of the science-based policy inputs for which consensus exists. The scientific community should also strive to overcome the impression that scientists disagree on most fundamental issues, by emphasizing the broad areas of scientific agreement. This can be pursued through scientific panels devoted to identifying areas of agreement on findings related to forestry practices, and through the publication of syntheses of broadly-accepted wisdom and scientifically-supportable practices.

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