PN-ABP-285
82739

Fragile Lands Management in Latin America and the Caribbean: A Synthesis

DESFIL

Development Strategies for Fragile Lands
7250 Woodmont Avenue, Suite 200, Bethesda, Maryland 20814

Development Alternatives, Inc. • Tropical Research and Development, Inc.
in association with Earth Satellite Corporation • Social Consultants International

Fragile Lands Management in Latin America and the Caribbean: A Synthesis

Edited by

Philip D. Young

October 1991

The opinions expressed in this document are those of the editor and the authors and do not necessarily reflect either the views or the policies of the U.S. Agency for International Development.

Prepared for the U.S. Agency for International Development
under contract number DHR-5438-C-00-6054-00

TABLE OF CONTENTS

CHAP PAGE

1 FRAGILE LANDS MANAGEMENT: THE NATURE OF THE PROBLEM IN LATIN AMERICA, Philip D. Young 1
INTRODUCTION 1
THE FRAGILE LANDS PROBLEM IN LATIN AMERICA 1
Degradation of Fragile Lands 1
Causes of Degradation of Fragile Lands 6
APPROACHES TO SOLUTIONS 12
THE CONTENTS OF THIS STUDY 13
ENDNOTES 14
REFERENCES CITED 16

2 CONCEPTUAL FRAMEWORKS, SUSTAINABLE DEVELOPMENT, AND THE MANAGEMENT OF FRAGILE LANDS, Philip D. Young 21
INTRODUCTION 22
The Silent Revolution 24
Environmental Problems and Human Problems 25
GOING, AND GETTING THERE 27
CONCEPTS 28
Choosing a Conceptual Path 28
Conceptual Frameworks in General 29
Thinking and Doing 29
Focal Concepts: Fragile Lands and Growth and Sustainable Development 30
MODELS 35
General Limitations 35
Humans, Nature, and Development 36
Ecosystem Models 37
Environmental Management Models 39
Human Ecology Models 42
Accumulated Knowledge 44
SUSTAINABLE MANAGEMENT OF FRAGILE LANDS 46
ENDNOTES 50
REFERENCES CITED 53

3 TECHNOLOGY FOR FRAGILE LANDS MANAGEMENT IN LATIN AMERICA, Gene C. Wilken 59
INTRODUCTION 59
The DESFIL Focus 60
PRINCIPLES OF FRAGILITY AND DEGRADATION ON SLOPES: SOIL LOSS 61
Energy Sources for Degradation 62
Measuring Available Energy 63
Measuring Erosion 63
Measuring Surface Characteristics 63
Calculating and Estimating with Minimum Data 64
MANAGERIAL OPTIONS IN SLOPE SYSTEMS 64
Basic Approaches 64
Countering Deposition 65
ON-FARM TECHNOLOGIES 66
PRINCIPLES OF FRAGILITY AND LAND DEGRADATION IN THE HUMID TROPICAL LOWLANDS: FERTILITY LOSS 66
Nutrient Loss 66
Measuring Available Energy 67
MANAGERIAL OPTIONS IN LOWLAND SOILS SYSTEMS 68
THE DESFIL EXPERIENCE 70
TECHNOLOGY FOR FRAGILE LANDS MANAGEMENT 71
Suggested Procedure 71
Sources of Information: Soil Loss from Steep Slopes 75
Sources of Information: Fertility Loss in Tropical Lowland Soils 75
WHAT ARE THE BEST TECHNOLOGIES FOR SOLVING THE PROBLEM? 75
RESEARCH AND DEVELOPMENT FOR THE FUTURE 77
ENDNOTES 78
REFERENCES CITED 79

4 INSTITUTIONS IN FRAGILE LANDS MANAGEMENT, Karen LeAnn McKay 89
INTRODUCTION 89
FRAGILE LANDS MANAGEMENT BY INSTITUTIONS 91
The Public Sector 92
The Private Sector 93
INSTITUTIONAL CONSTRAINTS 94
Proliferation of Institutions 95
Institutional Sustainability 96
Inappropriate Models and Professional Biases 97

Staffing and Institutional Development: Demand versus Supply 100
Interinstitutional Conflict 100
OVERCOMING INSTITUTIONAL CONSTRAINTS 102
Establishing Credibility 102
Links Among Institutions 103
Internal versus Process Capacity 104
Fitting the Institution to the Situation 104
CONCLUSIONS AND RECOMMENDATIONS 105
Institutional Sustainability 105
Working with Existing Institutions 105
Institutional Links 106
Time and Process 106
ENDNOTES 107
REFERENCES CITED 108

5 RESOURCE STEWARDSHIP AT THE LOCAL LEVEL, David D. Gow and Philip D. Young 111
INTRODUCTION 111
LIVELIHOOD SECURITY AND EMPOWERMENT 114
Livelihood Security 114
Empowerment 115
LOCAL ORGANIZATIONS, THE COMMONS, AND PRIVATIZATION 116
LOCAL ORGANIZATIONS AND FRAGILE LANDS MANAGEMENT 119
Resource Characteristics 119
User Characteristics 119
CASES OF RESOURCE MANAGEMENT AT THE LOCAL LEVEL . 121
Agroforestry in Haiti 121
On-Farm Water Management in the Dominican Republic 124
Watershed Management and Soil Conservation in San Martin Jilotepeque 127
Kuna Conservation Efforts in Panama 129
LESSONS LEARNED AND GUIDELINES FOR THE FUTURE 132
ENDNOTES 134
REFERENCES CITED 135

6 ECONOMICS AND RESOURCE USE IN THE DEVELOPMENT OF FRAGILE LANDS IN LATIN AMERICA AND THE CARIBBEAN, Michael Hanrahan 141
INTRODUCTION 141
MEASURES AND STANDARDS: RESOURCE AND ENVIRONMENTAL DEGRADATION AND ECONOMIC DEVELOPMENT 141
CONSEQUENCES AND ECONOMIC EFFECTS OF RESOURCE AND ENVIRONMENTAL DEGRADATION OR CONSERVATION: HOW THE MEASURES OF ECONOMIC DEVELOPMENT ARE INFLUENCED 143
Production: The Supply of Products, the Demand for Production Inputs, and Dynamic Changes in Technology 143
Consumption: the Demand for the Goods and Services Derived from Resource and Environmental Amenities 146
Aggregation to the Macroeconomy 146
Welfare and Equity Through Time 147
MEASURES AND VALUES: HOW ECONOMICS ATTACHES VALUE TO THE CONSEQUENCES AND EFFECTS OF RESOURCE AND ENVIRONMENTAL DEGRADATION 148
Producers 148
Consumers 151
VALUATION AND EVIDENCE: MEASURES OF RESOURCE AND ENVIRONMENTAL CONSERVATION OR DEGRADATION ON THE ECONOMIC DEVELOPMENT OF LATIN AMERICA AND THE CARIBBEAN 154
Physical Effects on Productivity and Yields 155
Valuing the Effects of Degradation or Conservation on Economic Development 158
CONCLUSIONS 160
ENDNOTES 162
REFERENCES CITED 164

7 THE USE OF INCENTIVES TO PROTECT FRAGILE LANDS AND RESOURCES, John K. Gamman 171
DEFINING INCENTIVES 171
INCENTIVES AND THEIR CONSEQUENCES 172
DESIGNING INCENTIVES 174
Specific Types of Incentives 175
Incentives That Have Worked 178
Incentives That Have Not Worked 179

RECOMMENDATIONS FOR THE DESIGN AND USE OF INCENTIVES 180
Create Packages of Economic and Noneconomic Incentives 180
Design an Incentive Strategy with a Series of Sequential Steps 181
Train Project Planners in Politics and Culture 182
ENDNOTES 183
REFERENCES CITED 185

8 PLANNING AND POLICY IN FRAGILE LANDS MANAGEMENT, Michael Hanrahan 187
INTRODUCTION 187
ISSUES IN PLANNING AND POLICY 188
HIGH IMPACT PLANNING 189
Saint Kitts: Planning the Uses of the Southeast Peninsula 190
Honduras: Developing an Institutional Capability for Natural Resources Analysis 192
Central America: Coordinating Agendas and Programs for Natural Resources Use in Development 196
POLICY FAILURE: RESOURCE ALLOCATION DECISIONS IN THE EASTERN CARIBBEAN 199
RESULTS 200
CONCLUSIONS 201
ENDNOTES 202
REFERENCES CITED 204

9 THE TROPICAL FOREST: COMPETING DEMANDS FOR PRESERVATION, EXPLOITATION, AND CONVERSION, Joshua C. Dickenson III and Francis E. Putz 207
INTRODUCTION 207
A Political Mandate 207
Competing Demands 208
TROPICAL FORESTS 208
Definition 208
Diversity of Ecosystems and Species 209
Fragility 210
Sustainability 211
Valorization 213
Buffer Zone Management 214
Ecotourism 215

THE CASE FOR PROTECTION 216
THE CASE FOR FOREST MANAGEMENT 218
Forest Use Decision-Making 218
Extractive Reserves 218
Selective Logging with Natural Regeneration 220
Enrichment Planting of Native Species 222
Strip Clearcuts with Natural Regeneration 223
Coppicing of Native Species 224
DISCUSSION 225
REFERENCES CITED 230
APPENDIX: The Holdridge Life Zone Classification System, by Joshua C. Dickinson III 237

10 ENVIRONMENTAL ANALYSIS OF FRAGILE LANDS, Dennis McCaffrey 243
OVERVIEW 243
A.I.D. POLICIES AND PROCEDURES FOR ENVIRONMENTAL ANALYSIS 243
Regulation 216 243
Provisions of the Foreign Assistance Act Related to Environment 246
Relating Environmental Laws and Regulations to Fragile Lands 247
ENVIRONMENTAL ANALYSIS OF FRAGILE LANDS DEVELOPMENT PROJECTS: CASE STUDIES 248
USAID Peru Central Selva Natural Resources Management Project 248
USAID Guatemala Maya Biosphere Reserve Project 252
Comparison of the Environmental Analysis Approach for the Central Selva and Maya Biosphere Reserve Projects 258
Environmental Information for Fragile Lands Development 259
Processes for Influencing National Development Policy through Environmental Information 262
ENDNOTE 263
REFERENCES CITED 264

11 ENVIRONMENTAL EDUCATION AND EXTENSION, Sam H. Ham and David S. Sutherland 267
RAISING PUBLIC CONSCIOUSNESS THROUGH ENVIRONMENTAL EDUCATION 268
ENVIRONMENTAL EDUCATION AS A DIFFUSION AND ADOPTION AGENT 270
KEY AUDIENCES FOR FRAGILE LANDS ENVIRONMENTAL EDUCATION 272
Formal Environmental Education Programs 272
Nonformal Environmental Education Programs 276
EVALUATION AND ASSESSMENT 286
RECOMMENDATIONS FOR FUTURE ACTION 287
ENDNOTES 289
REFERENCES CITED 290

12 LOOKING TO THE FUTURE: FRAGILE LANDS MANAGEMENT IN THE 1990s AND BEYOND, Philip D. Young 299
SUMMARY OF THE FRAGILE LANDS PROBLEM IN LATIN AMERICA 299
SUMMARY OF CONCLUSIONS OF THIS REPORT 301
Technology 301
Institutions 302
Local Stewardship 303
The Economics of Fragile Lands Management 303
Incentives 304
Planning and Policy 305
Managing Humid Tropical Forests 306
Environmental Assessment 307
Environmental Education 308
GENERAL RECOMMENDATIONS 309
An Illustration of the Complexity of the Problem 309
Procedural Recommendations 310
Methodological Recommendations 314
LOOKING TO THE FUTURE 315
ENDNOTES 317
REFERENCES CITED 318

LIST OF TABLES

NO PAGE

1.1 Soil Erosion Rates in Latin America 3
1.2 Closed and Open Forest and Average Annual Deforestation in Selected Countries of Central and South America, 1980s 5
2.1 Basic Distinctions Between Five Paradigms of Environmental Management in Development 40
3.1 Production of Yellow Yams from Run-Off Plots, Jamaica 61
3.2 Proportions of National Area, Arable Land, and Population on Steep Slopes in Tropical America 62
6.1 Selected Phenomena, Their Consequences, and Economic Effects Associated with Depletion and Degradation of Natural Resources and Environmental Amenities 144
9.1 Forest-Use Prescription Arranged in Order of Increasing Intensity and Costs 219
9.2 Key Ecological Determinants in Making Forest Land Use Prescriptions, Ecological Qualifiers 227
9.3 Key Sociological Determinants in Making Forest Land Use Prescriptions, Economical Qualifiers 228
9.4 Key Economical Determinants in Making Forest Land Use Prescriptions, Economical Qualifiers 229
10.1 Environmental Profiles for USAID-Assisted Latin American and Caribbean Countries 260
11.1 Selected DESFIL Projects That Address Critical Audiences for Environmental Education 275

LIST OF FIGURES

NO PAGE

2.1 Approaches to Management of Resources 38
2.2 Value Orientations and Adaptive Strategies of Frontier Economics and Deep Ecology 41
2.3 Some Basic Features of a Socionatural System 43
2.4 Simplified Model of a Socionatural System 45
2.5 Elements of a Conceptual Model of Sustainable Development 48
11.1 Hypothetical Generational Effects of Continuous Public Environmental Awareness Campaigns 269

11.2 Typology of Adopters 271
12.1 Interactive Dimensions of Fragile Lands Management 311
12.2 A Simplified Decision Tree Model of Fragile Lands Management: Managing for Sustainability 313

LIST OF ACRONYMS AND ABBREVIATIONS

AED	:	Academy for Educational Development
AGRICOLA	:	[An agricultural data base of the USDA]
AGRIS	:	[An agricultural data base of the FAO]
AHE	:	Asociación Hondureña de Ecología (Honduran Ecology Association)
AID	:	Agency for International Development (see USAID)
AOP	:	Agroforestry Outreach Program (in Haiti)
ASAE	:	American Society of Agricultural Engineers
BOSCOSA	:	Osa Peninsula Forest Management and Conservation Project (in Costa Rica)
CATIE	:	Centro Agronómico Tropical de Investigación y Enseñanza (Tropical Agricultural Research and Training Center in Costa Rica)
CELOS	:	Centre for Agricultural Research in Suriname
CFR	:	Code of Federal Regulations
CTTA	:	Communication for Technology Transfer in Agriculture Project
CURLA	:	Centro Universitario Regional del Litoral Atlántico (Regional University Center of the Atlantic Litoral, Honduras)
DAI	:	Development Alternatives, Inc.
DESFIL	:	Development Strategies for Fragile Lands
EAP	:	Environmental Action Plan
EE	:	Environmental Education
ENR	:	Environment and Natural Resources
ENRM	:	Environmental and Natural Resource Management
FAO	:	Food and Agriculture Organization of the United Nations
FLM	:	Fragile lands management
FSDP	:	Forestry Sector Development Project (in Ecuador)
GIS	:	Geographic Information System
GNP	:	Gross National Product
GOH	:	Government of Honduras
GOSKN	:	Government of Saint Kitts and Nevis
GTZ	:	German Agency for International Technical Cooperation
ha	:	hectares
HEP	:	Honduran Environmental Program

ICRAF	:	International Committee for Research on Agroforestry
IERAC	:	Instituto Ecuatoriano de Reforma Agraria y Colonización (Ecuadorian Institute of Agrarian Reform and Colonization)
ILACO	:	International Land Development Consultants
INDRHI	:	Instituto Nacional de Recursos Hidraúlicos (National Water Resources Institute of the Dominican Republic)
IRR	:	Internal Rate of Return
ISTI	:	International Science and Technology Institute
IUCN	:	International Union for the Conservation of Nature and Natural Resources
km	:	kilometers
m	:	meters
masl	:	meters above sea level
mm	:	millimeters
MAYAREMA	:	Maya Resource Management Project (the Maya Biosphere Project)
NGO	:	Non-Governmental Organization
NPA	:	National Program for Agroforestry (in Haiti)
NRM	:	Natural resources management
NTFP	:	Non-Timber Forest Products
OFWMP	:	On-Farm Water Management Project (in the Dominican Republic)
PADF	:	Pan American Development Foundation
PET	:	Potential EvapoTranspiration
PVO	:	Private Voluntary Organization
RENARM	:	Regional Environmental and Natural Resources Management (program for Central America)
ROCAP	:	Regional Office for Central American Programs
SECPLAN	:	Secretaría de Coordinación, Planificación y Presupuesto (Secretariat of Coordination, Planning and Budget of Honduras)
SEP	:	South East Peninsula (of St. Kitts)
SKNED	:	St. Kitts Newsletter on Environmental Development
STAB	:	Secretariat Technique à l'Aménagement des Bassins Versants (Technical Secretariat for Watershed Management of Haiti)
SUFOREN	:	Subsecretaría Forestal y de Recursos Naturales (Subsecretariat for Forestry and Natural Resources of Ecuador)

TAU	:	Technical Analysis Unit
TNC	:	The Nature Conservancy
TFAP	:	Tropical Forestry Action Plan
UN	:	United Nations
UNAH	:	Universidad Nacional Autónomo de Honduras (National Autonomous University of Honduras)
UNDP	:	United Nations Development Program
UNEP	:	United Nations Environmental Program
UNESCO	:	United Nations Educational, Scientific and Cultural Organization
USAID	:	United States Agency for International Development
USAID/LAC	:	United States Agency for International Development/Bureau for Latin America and the Caribbean
USAID/PPC	:	United States Agency for International Development/Bureau for Program and Policy Coordination
USDA	:	United States Department of Agriculture
USDS	:	United States Department of State
WB	:	World Bank
WCED	:	World Council on Environment and Development
WRI	:	World Resources Institute
WWF	:	World Wildlife Fund

CHAPTER ONE

FRAGILE LANDS MANAGEMENT:

THE NATURE OF THE PROBLEM IN LATIN AMERICA

by

Philip D. Young

INTRODUCTION

This chapter explores the causes of the fragile lands problem in Latin America. Many of these causes are the same or similar to those elsewhere in the world. Chapter two provides a theoretical discussion of conceptual frameworks that influence our interaction with the environment, suggests a conceptual framework that will foster sustainable development, and offers discussion and definition of fragile lands and of growth and sustainable development. The other chapters in this study examine several approaches to the problems and issues of fragile lands management in Latin America and the Caribbean.[1]

THE FRAGILE LANDS PROBLEM IN LATIN AMERICA

Degradation of Fragile Lands

Our knowledge about tropical ecosystems and the fragile lands that support them has increased significantly during the decade of the 1980s (see, for example, Browder, ed. 1989; Lugo et al., eds. 1988; Goodland, ed. 1990; Wilson, ed. 1988). However, we are still far short of a sufficient understanding of tropical ecosystems and the long-term consequences of human activity on these systems. And in the case of development interventions, applications of existing knowledge often lag behind its accumulation.

At the most general level, the principal problem of fragile lands is deterioration, that is, productivity for human purposes declines, and the principal issues are how do we reverse deterioration where it is occurring, institute preventive measures where it is not, and thus manage these environments to achieve sustainable production.[2] According to Denevan (1989:12,21) fragile lands make up 80-87 percent of the total land area of Latin America.[3] Of this, Browder (1989:4) estimates that rainforests alone cover 44 percent of the region. The steep slopes and highlands of the Andean countries (Venezuela, Colombia, Ecuador, Peru, and

Bolivia) make up 48 percent of their total area. Fragile lands comprise 78 percent of the Central American countries (Guatemala, El Salvador, Honduras, Nicaragua, Costa Rica, and Panama) and 67 percent of selected countries of the Caribbean (Dominican Republic, Haiti, Jamaica, and Puerto Rico) (Posner et al. 1981, 1982).

The foci of the efforts of the Development Strategies for Fragile Lands (DESFIL) Project from 1986-1991 have been **steep slopes** and **humid tropical lowlands**. The latter are more accurately described as constituting several fragile (and some not so fragile) ecosystems. Browder (1989) describes the rainforest, which covers much of the humid tropical lowlands, as a fragile land biotope.

Fragile lands are rapidly being degraded through inappropriate use; such mismanagement results in sharp production declines in a few short years. The economic consequences for the Latin American nations can be varied and severe (see Chapter Six).

Prevalent processes of degradation differ between steep slopes and tropical lowlands but they also overlap to some extent. Many of the degradational processes also occur naturally (for example, erosion and nutrient loss), but generally at a much slower rate. Human use of fragile lands carries with it the potential of greatly accelerating the degradational processes. Good management can slow and even reverse degradation. Bad management can lead to degradation that is irreversible in a time frame meaningful to humans.

The most evident and pervasive degradational process on steep slopes is soil erosion. On-site, this leads to loss of topsoil and organic matter, reduced water holding capacity, nutrient loss and imbalance, stream turbidity, reduced water supply, and in extreme cases desertification. Salt imbalance in the root zone and soil structure deterioration are additional problems in irrigated areas. Off-site effects may be quite far-reaching and include watershed degradation, flooding, siltation, reduced hydroelectric capacity, and reduced lifespan of hydroelectric facilities. Coastal and near-shore marine ecosystems may also be effected. Data on actual erosion rates from the steeplands of Latin America are not abundant (Byers 1990, Lal 1991). Table 1.1 provides some sample data. Most noteworthy is the extreme range of variation. More research under controlled conditions is clearly called for to achieve a better understanding of the contribution of different combinations of conditions to soil loss.

Interestingly, it was the overwhelming opinion of those who participated in the DESFIL Conference on Sustainable Uses for Steep Slopes, most of whom were not social scientists, that technical measures to control degradation on steep slopes that have proven effective under on-farm conditions already exist. These include terraces of various types, windbreaks, hedgerows and living barriers, diversion or infiltration ditches, mulching, crop rotation, and contour farming (Hanrahan 1988a). Often, socioeconomic, political, and cultural factors make difficult the adoption of improved science-based technologies (Lal 1991).

TABLE 1.1 SOIL EROSION RATES IN LATIN AMERICA

COUNTRY	CRITERIA	EROSION RATE (t/ha/yr)
Colombia	Cropland	21.5
Ecuador*	Steeplands cultivated in maize	600
El Salvador	Steeplands	130-260
Guatemala	Steeplands cultivated in maize	200-3600
NE Brazil	Cropped land	115
Peru	Bare soil	148
Trinidad	10-20° slope, bare	490

Sources: Lal 1991:72, * Byers 1990:53.

In the lowland tropics of Latin America, extensive deforestation is the catalyst that accelerates on-site degradational processes such as soil erosion; loss of soil organic matter (usually low in tropical lowland soils); nutrient depletion due to acidity, leaching, and removal of vegetation; deterioration of soil structure; and compaction from machinery and later cattle. Off-site impacts are similar to those listed above for steep slopes. Eight percent of the Amazon basin (about 39 million hectares) has soils of high erodibility (Sanchez et al. 1982, cited in Lal 1991:73). "Leaching and acidification are serious problems in soils of tropical climates with seasonally humid (Alfisols) and humid moisture regimes (Ultisols and Oxisols). . . . Substantial areas of acid tropical soils occur in . . . the Amazon basin" (Lal 1991:76). Nutrient content of soils is low with few exceptions. Most of the nutrients in a tropical forest ecosystem are stored in the plants themselves (Gradwohl and Greenberg 1988). Although there are areas of rich soils in the humid tropics (a generous estimate for the Amazon basin would put the total at 3 percent), these lands have already been settled and developed and most of what is left is truly marginal land (Gradwohl and Greenberg 1988).

As with the steeplands, socioeconomic, political, and cultural factors contribute to the problem of sustainable management of fragile lands in the humid lowlands. In addition, much less is known about effective technologies for sustainable intensive agriculture in the lowland humid tropics of the Americas. Indeed, it may be that intensive agriculture is not sustainable throughout much of the tropics. Agroecological and agroforestry systems have proven effective

in some areas. It may be that natural forest management combined with conservation practices and protected areas represent the wisest alternative for sustainable management of much of the lowland humid tropics (see Chapter Nine).

However, not everyone would agree with this view. In a classic example of the "tech fix" mental set, Villachica et al. (1990) note that soil nutrient constraints can be overcome through the regular and systematic application of chemical fertilizers, and they discuss a variety of what they term sustainable agricultural systems for the Amazon basin. Their orientation is clearly that of high production (commercial) agriculture. Although they speak of low input systems, it is not likely that any of what they describe would be perceived as low input by a poor farmer. They argue that the constraints on sustainable agriculture in the Amazon rainforest are socioeconomic, not technological ("lack of markets, inadequate infrastructure and credit, and unfavorable economic policies and some uncertainty about land tenure" [1990:434]). Technically they may be correct, but the specter of the impact on the rainforest ecosystems of the intensive agriculture and cattle raising systems they describe is nothing short of horrifying. They express no concern about where poor farmers might get the wherewithal to purchase the inputs necessary for their "sustainable" agricultural systems. They entirely ignore questions of impact on indigenous peoples. In contrast, the strength of the DESFIL integrated approach to fragile lands management is precisely the attention given to the ecological, cultural, socioeconomic, and political dimensions of the problem, as well as the technological dimension.

Deforestation and its attendant degradational processes lead to loss of habitats, declines in biodiversity, species extinction, and a host of problems for the native peoples who are dependent for their livelihood on the lowland tropical forests. Deforestation is taking place in Central and South America at an alarming rate. However, estimates of annual rates of deforestation, total area deforested, and forested area remaining vary significantly for scientific reasons (incomplete data, unanalyzed data, data difficult to interpret, and spotty diachronic data) and political reasons (face-saving, public deception, concessions, and graft and corruption). Table 1.2 provides information on estimated rates of deforestation for selected countries in Latin America.

The World Resources Institute (1990) notes that recent data from selected countries indicate that world rates of deforestation in the tropics may be much greater than previously believed. In Latin America, recent studies show rates to be much higher in Brazil and Costa Rica than previously estimated. In 1980, the Food and Agriculture Organization (FAO) estimated that worldwide annual deforestation in the tropics was 11.4 million ha. The World Resources Institute (WRI) notes that if the new studies are accurate, 20.4 million hectares of tropical forest are lost annually, an area about the size of Panama.[4]

What are the sources of deforestation in Latin America? Cattle raising already accounts for 85 percent of the Amazonian rainforest cleared to date. The Brazilian government, with subsidies, tax holidays, and other fiscal incentives, makes it almost impossible not to profit from a large cattle ranch (Gennino, ed. 1990:10). Yet cattle ranching has long been known to be

among the least appropriate production systems for the humid tropics of Latin America (Ledec and Goodland 1989).

TABLE 1.2 CLOSED AND OPEN FOREST AND AVERAGE ANNUAL DEFORESTATION IN SELECTED COUNTRIES OF CENTRAL AND SOUTH AMERICA, 1980s

COUNTRY	Extent of Forest & Woodland, 1980s (000 hectares)			AVERAGE ANNUAL DEFORESTATION					
				Closed		Open		Total	
	Closed	Open	Total	Extent (000 ha)	%	Extent (000 ha)	%	Extent (000 ha)	%
Costa Rica	1,638	160	1,798	124[a]	7.6	X	X	124	6.9
El Salvador	141	X	141	5	3.2	X	X	5	3.2
Guatemala	4,442	100	4,542	90	2.0	X	X	90	2.0
Honduras	3,797	200	3,997	90	2.3	X	X	90	2.3
Nicaragua	4,496	X	4,496	121	2.7	X	X	121	2.7
Panama	4,165	X	4,165	36	0.9	X	X	36	0.9
Bolivia	44,010	22,750	66,760	87	0.2	30	0.1	117	0.2
Brazil	357,480	157,000	514,480	8,000[b]	2.2	1,050	0.7	9,050	1.8
Colombia	46,400	5,300	51,700	820	1.8	70	1.3	890	1.7
Ecuador	14,250	480	14,730	340	2.4	0	X	340	2.3
Peru	69,680	960	70,640	270	0.4	0	X	270	0.4
Venezuela	31,870	2,000	33,870	125	0.4	120	6.0	245	0.7

Source: FAO. Table adapted from WRI 1990, Table 19.1, p. 292.
Notes: a = Annual deforestation for 1977-83; b = Annual deforestation for 1987 — considered by some an abnormally high year; 1988 estimate is 4.8 million ha, and for 1989 about 2.9 million ha; 0 = 0 or less than half the unit of measure; X = data not available.

> After more than 20 years of public investment, the livestock sector has absorbed more in subsidies than it has generated in revenues and has contributed little to permanent regional employment . . . and it has been the principal engine of destruction of the Amazon's rain forests (Browder 1988:288).

Commercial logging is now directly responsible for 20 percent of all rainforest destruction in the Amazon (Gennino, ed. 1990:8). Colonization, cattle ranching, logging, and mining combined have resulted in the deforestation of 600,000 km^2 of the Amazon basin and contiguous areas of Brazil (the "legal" Amazon) by 1988 — 12 percent of the total area (Anderson 1990). Brazil is illustrative of the general problem of deforestation in Central and South America.

Gradwohl and Greenberg (1988:46) compiled a list of predictions made by scientists about the consequences of large-scale deforestation in the tropics:

- Loss of people and cultures whose way of life depends upon the forest, along with a loss of their knowledge;
- An increase in barren land and desertification in drier tropical regions;
- Regional decreases in rainfall, exacerbating desertification;
- Extinctions of large numbers of plant and animal species, including the loss of important wildlife species and potentially important food and medicinal plants;
- Declines in temperate zone birds that migrate to the tropics;
- Increased exposure and erosion of soil;
- Loss of hydroelectric power potential;
- An increasing downward cycle of rural poverty; and
- Global increases in temperature due to a rise in atmospheric carbon, leading to a rise in sea levels.

Except for the last, about which there is considerable debate, it is worth noting that to some degree **all of these predictions have become reality.**

Causes of Degradation of Fragile Lands

Both the degradation of the steep slopes and the deforestation and consequent degradation of the tropical lowlands in Latin America share underlying causes. These causes do not work in isolation but rather in combination. There are no single or simple solutions. Arresting degradation on fragile lands will require an integrated approach.

A dictum of the U.S. Agency for International Development (A.I.D.) — and perhaps that of the development community in general — is to avoid complex projects, apparently in reaction to the failure of the so-called integrated rural development approach of the 1970s.[5] But the problems of development, especially those of sustainable development on fragile lands, are complex and will admit to no simple solutions. Any attempt to avoid the complexity of the issues when designing and implementing projects will surely result in failure of the development process. The failure of the integrated approach to rural development was not due to the inherent complexity of the approach but to a lack of understanding of the interactions among the significant variables in the system and how they affected one another. And conversely,

simplicity itself does not guarantee the success of any development project or process. For example, structural adjustment may falter if it attempts through policy changes alone to adjust economies without attending to the underlying causes that produced current economic conditions. It may lead to even more intense demands on the resources of the rural environment. This is not to say that policy adjustments, economic and otherwise, are never appropriate for clearly they often are; but policy changes must be accompanied by a variety of other changes if they are to succeed in serving as incentives for sustainable production in concert with conserving resources, the two most widely accepted measures of successful economic development.

What are the underlying causes of the fragile lands problem in Latin America? Those of most general and immediate concern are **population growth, poverty, inequitable distribution of land, inadequate tenure security, policy failures, market failures** and **use of inappropriate technologies**. These causes are intertwined and together they account for what we are calling the fragile lands problem.

Population Growth

Populations in almost all countries of the world continued to grow throughout the 1980s. In Latin America, the annual rate of increase has slowed to about 2.1 percent between 1985-1990.[6] However, the substantial additions to the populations of all Latin American countries since the 1950s, when average annual rates of increase were as high as 3.5 percent in some countries (and the average annual rate of increase in all Latin America and Caribbean (LAC) countries between 1950 and 1975 was 2.7 percent — the highest growth rate in the world during that time period), have produced a doubling of the population in many countries during the past 35-40 years. The population will continue to increase well into the twenty-first century before a predicted stabilizing, based on current trends, at 1.1 percent in the year 2025 (WRI 1990:54). Most of the nations of Latin America are not yet overpopulated in the absolute sense of having populations too large to be supported by their existing resource bases (El Salvador and Haiti are exceptions). But ownership or control of the resources is very unevenly distributed (see below). Increasing numbers of people create increased demand for food and fuel. Because all of the good lands have long since been brought under production, agricultural expansion extends to more and more marginal, fragile lands.

Agricultural production increased in Latin America as a whole by 25 percent between 1977 and 1988 and total food production has gone up by 27 percent, exactly keeping pace with population growth (WRI 1990:36, citing FAO *Quarterly Bulletin of Statistics*, 1989 2(2):12, 16).[7] Much of this increase can be attributed to expansion onto ever larger areas of steep slopes and the clearing for permanent agriculture (and pasture) of vast tracts of tropical forest. These gains may soon turn to losses. To the extent that farming of fragile lands accounts for the increases, a sharp decline in production in the near future is predictable, barring substantial capital inputs to maintain current levels of yield. And in many instances such inputs may turn out not to be cost effective. If we add to this the prediction that food production will have to increase by another 26 percent by the year 2000 to keep up with population growth, we may

begin to comprehend the seriousness of the situation in Latin America and the urgency to manage fragile lands for sustainable yields (as well the need to limit population growth). Technologies exist for sustainable production on steep slopes, but sociocultural, economic, and political factors often limit their application (DESFIL 1988; Hanrahan 1988a; Chapter Three, this volume). In the case of tropical forests, nonagricultural use or low intensity agricultural use combined with other uses may often turn out to be the only sustainable forms of management (Chapter Nine).

Poverty

There is a close relationship between poverty and the degradation of fragile lands and depletion of natural resources. The landless rural poor of Latin America are being forced onto ever more fragile steep slopes and ever farther into the lowland tropical forest in an often elusive search for livelihood security. Their increasing numbers, combined with lack of access to good lands, tenure insecurity, and the limited natural capabilities of the lands they occupy, keep them frequently on the move. The relationship is a vicious circle. Resource depletion and degradation of fragile lands reduce yields, thus reducing income and contributing to poverty. Improving livelihood security for the poor can help alleviate poverty and enhance resource conservation (Chapter Five).

Inequitable Distribution of Land

The current demographic problem in rural Latin America is one of uneven geographic distribution of the population in relation to the arable land base. Latin America has the least equitable distribution of arable land in the world. For the region as a whole, 10 percent of the landowners control 95 percent of the arable land (WRI 1990:5). Most of the fertile, productive agricultural land is in the hands of this 10 percent. This inequitable distribution is another force, along with population growth and poverty, that pushes the land poor and landless onto fragile lands that are far less suited for agriculture or cattle raising, where yields will always be less, and where choices of technologies that will produce sustainable yields are far more limited or expensive.

Would there be enough land to produce livelihood security on a sustainable basis for the small farmers and landless if it were equitably distributed? In some countries like El Salvador, perhaps not — at least not without sustainable production technologies that would result in much greater yields. But it would appear that in other countries, like Brazil, land redistribution would go a long way toward relieving pressure on fragile lands. Anderson, citing Caufield (1984) states that

> if all potential farmland *outside* of Amazonia were equally distributed, each person in Brazil could have four hectares. Instead, 4.5 percent of Brazil's landowners hold 81 percent of the country's farmland, and 70 percent of rural households are landless (1990:9).

Of course, it is not realistic to expect that those possessing the productive lands will voluntarily permit their redistribution in the interest of the environment and the public good. Agrarian reform programs in Latin America have come and gone, waxed and waned, with a frequency almost as great as changes in government. None have lived up to initial expectations. Some attempts to achieve more equitable land distribution have met with armed resistance and have caused governments to fall.

New laws, much policy reform, and a radically different set of incentives than now exists will be necessary to achieve greater equity of land ownership. The necessary government action to accomplish this is problematic because the large land owners are often also the political powerholders.

Inadequate Tenure Security

Tenure security refers to legally recognized ownership of land or to legally guaranteed use rights for a specified period of time, often with a renewal option. For tenure to be secure, the legality of the claim must be enforceable. For tenure to be most secure, rights must be exclusive. Throughout Latin America, the rural poor and indigenous peoples often find it difficult to obtain legal title to the lands they claim, or find the government unwilling to protect their claims even when they have legal title. Forced to exploit fragile lands without tenure security, small farmers are understandably reluctant to use technologies that will produce sustainable yields over the long term if such technologies diminish immediate returns.

Inadequate tenure security, combined with policies that serve as incentives for deforestation and other forms of resource depletion, is another element contributing to the fragile lands problem.

Policy Failures

For our purposes, policies that contribute to the degradation of fragile lands, the depletion of natural resources, and the destruction of habitats and loss of biodiversity may be termed policy failures. The impact of counterproductive and poorly coordinated government policies has had a massive destructive impact in the lowland humid tropics at least as great as that of the moving frontier of smallholders.

Policies often take the form of subsidies (economic incentives), such as progressive land taxes, tax credits for commercial agriculture and livestock operations, subsidized credit, price controls on basic agricultural products, and exemption of agricultural land from tax. Whatever form they take, such subsidies can constitute incentives for destruction of the natural resource base and, by the same token, disincentives for sustainable production. Even subsidies designed to promote sustainable production or conserve resources should be used with caution. Skillfully applied as initial investments in the development of technologies and management systems that result in sustainable production, they can make a positive contribution to fragile lands

management; but any system that must continually rely on subsidies to cover recurrent maintenance costs cannot persist indefinitely.

A government's need for hard currency may result in policies that promote large-scale production of export crops without regard for environmental consequences. For example, the forested areas near Santa Cruz, Bolivia, are rapidly giving way to soybean fields. The government's need for hard currency from exports fuels the fires that burn the forests (Chris Seubert, Development Alternatives, Inc. staff member, personal communication). As Repetto and Gillis point out:

> Many governments of countries endowed with rich forest resources have created economic incentives that powerfully accelerate the rate of deforestation (1988:37).

Land titling policies are often counterproductive with respect to fragile lands and natural resource management. In several countries, secure title to land is contingent upon "improving" it and this is most often defined as clearing it and making it "productive." The quickest and least costly "improvement" is to turn the forest into pasture (despite the fact that the pasture becomes economically unproductive in a very few years). As Binswanger (1989) has pointed out, land claim security laws often virtually require deforestation. Such land is often quickly (and cheaply) sold to monied interests and the smallholders move on. Exploitation that rapidly degrades the land causes continual population movement to new lands, particularly in the humid tropics, and thus continual degradation of ever larger areas. However, reduction of policy incentives for deforestation is not sufficient to produce conversion to reforestation and systems of sustainable agriculture. Coherent land use planning is also needed (Binswanger 1989).

Finally, it is often the case that responsibility for oversight of areas of land and their natural resources is divided among different government agencies whose policies are inconsistent and sometimes contradictory. This is the case in Ecuador where the Subsecretariat for Forestry and Natural Resources (SUFOREN), the Agrarian Reform and Colonization Institute (IERAC), the National Agriculture Bank, and the Agricultural Extension Service all exercise authority and carry out activities in the Gran Sumaco area in eastern Ecuador. Even though they are all branches of the Ministry of Agriculture, they do not coordinate their efforts with one another. IERAC gives land titles within an area declared protected forest by SUFOREN without consulting the latter. The Bank gives loans for cattle ranching precisely on lands not suited for this activity (Hanrahan and Pereira 1990).

Policy failures are a major cause of degradation of fragile lands and depletion of natural resources. Policy reforms will clearly go a long way toward improving the situation in countries like Ecuador.

Market Failures

For markets to function efficiently in a free enterprise system, several conditions must be met, among them: rights over land and other resources must be clear and secure, supply and demand pricing must apply to scarce resources, there must be no significant externalities, and competition must prevail (Panayotou 1989). Market failures result when these conditions are not met. A major consequence is that resources are wasted in the present, leaving too little for the future.

In addition to insecure tenure and policy failures, mentioned above, Panayotou (1989:18-38) discusses several other factors that result in market failures. These include unpriced resources and absent or thin markets, pervasive externalities (Chapter Six), high transaction costs, public goods that cannot or should not be provided by the private sector, lack of competition, planning horizons that are too short and discount rates that are too high, uncertainty and risk aversion, and irreversibility. Actions based on predictions about future markets are always based on the assumption of reversibility if they turn out to be unwise. In many decisions involving natural resources, this assumption does not hold (Panayotou 1989:38).

Inappropriate government incentives such as some of those mentioned above can cause serious distortions in the market. On the other hand, government intervention is sometimes necessary (but not necessarily sufficient) to correct market distortions that result in destruction of resources. In Brazil, although the government has greatly reduced incentives and cattle ranching has proved economically unviable, cattle pastures continue to spread. The land has become more valuable as a speculative investment than actual returns from use in Brazil's inflationary economy. Also, it remains easy to establish claim to large areas of land after they have been converted to pasture, important in a region characterized by chronic land conflicts (Anderson 1990:9). High inflation and tenure insecurity have combined to produce market failure and consequent destruction of resources.

Use of Inappropriate Technologies

No technologies are appropriate everywhere; they must be adapted to local conditions (Chapter Three). The practice of applying temperate zone technologies in the tropics, once perhaps a major impediment to sustainable production, is clearly on the wane as research on tropical ecosystems and agricultural systems has intensified.

In the larger-scale commercial operations, technology may be used only as a means to increase agricultural production with no concern for the need to maintain the productive capacity of the environmental resource base (FAO 1990). This is prevalent in the debt-ridden countries of Latin America and is clearly a cause for concern.

Added to this is the fact that the good lands held in large blocks are often seriously underexploited in relation to potential yields and often are not being used for the most productive agricultural activities. This contributes to the overexploitation of fragile lands.

For the poor small farmer, the use of technologies that do not result in sustainable production is a matter of expediency fueled by tenure insecurity and the need to feed his/her family. In the case of colonists, unfamiliarity with alternative technologies that would produce sustainable results in the ecosystem in which they find themselves is another factor.

> All too often, expansion into new and marginal agricultural land is, out of basic necessity, led by those least able to overcome its difficulties or to farm it in a sustainable manner (WRI 1990:6).

APPROACHES TO SOLUTIONS

In fragile lands management development professionals of all types, researchers, planners, policy makers, administrators, and implementers, face three critical challenges during the decade of the 1990s:

- **Adequacy of knowledge.** Do we know enough about the right kinds of things to successfully address fragile lands problems?

- **Use of knowledge.** Can we successfully apply existing knowledge to the problems of sustainable production on fragile lands, tropical deforestation, species loss, watershed degradation, and so forth in the face of such impediments as misguided policies?

- **Cultural values.** Can we come to appreciate the true magnitude and consequences on ecosystem dynamics of human intervention in time to make the changes in our values and attitudes that are needed to generate the political will and popular support necessary to the creation of sustainable systems over the long haul?

Much current research is directed toward seeking new technological solutions to problems that in many cases are a product of our technology. New technologies may temporarily alleviate some problems but technology simply does not address others, such as the problem of the environmental consequences of contemporary cultural values. Indeed, while technology is clearly a part — but only a part — of the solution, the emphasis on technological solutions is a manifestation of our value system and in this sense technology is also a part of the problem.

Uses that exceed the inherent natural productive capability of the land are inappropriate uses; they will inevitably result in degradation. Inputs in the form of engineering technology (for example, terracing or irrigation) or nutrients (organic or synthetic) can be used to

supplement or enhance the land's natural capability and thus convert unsustainable management systems into sustainable ones. But the problems of fragile lands management go well beyond the simple application of technology. It must be determined that the technology is appropriate. This may be done through environmental and land capability assessments. The technology must be cost-effective (the economic dimension of the problem). Users must see some obvious benefit to be gained (the incentives dimension). People must be willing to use the technology (the sociocultural dimension — education and extension help here).[8] Governments must promote its use while at the same time discouraging less sustainable technologies (the policy dimension). And to be most effective, the application must be systematic (the planning dimension). Institutions may need to be strengthened to effectively carry out plans and policies. The involvement of local organizations may be necessary to insure needed cooperation (for example, in the maintenance and operation of irrigation systems). This clearly illustrates the multidimensionality of the fragile lands problem and the makes it clear why an integrated approach to solutions is imperative.

THE CONTENTS OF THIS STUDY

The chapters of this study have been prepared by DESFIL core staff and collaborators. They examine a variety of factors (but certainly not all possible factors) that significantly affect both the natural ecosystems that are supported on fragile lands and the human production systems that are imposed on them. The factors discussed are technologies; institutions; local organizations; economics; incentives; planning and policy; preservation, exploitation, and conversion of tropical forests; environmental assessments; and environmental education and extension. All these factors influence the way in which fragile lands are managed.

Most, but not all, of the examples and case materials used in this volume are drawn from Latin America. A good portion are based on the experience, both short-term and long-term, of the Development Strategies for Fragile Lands Project.[9] DESFIL experience has ranged from the relatively rapid evaluation of other projects, such as, hillside agriculture in Jamaica (Koehn, Tai, and LeFranc 1989) and on-farm water management in the Dominican Republic (Hanrahan et al. 1990), to the design of the Regional Natural Resources Management (RENARM) program for the USAID Regional Office for Central American Programs (ROCAP) (Hanrahan 1988b; Hanrahan, Russo, and Valencia 1990), to long-term project intervention in the Tropical Forestry Action Plan (TFAP) for Guatemala (Johnson 1990, Government of Guatemala 1991), the Honduran Environmental Program (Daugherty, ed 1990; Valencia 1989), the St. Kitts Southeast Peninsula (SEP) Project, and the Forestry Sector Development Project (FSDP) in Ecuador.[10] Relevant professional experience of the DESFIL core staff and collaborating authors and the experience, views, and interpretations of other projects and professionals, as reported in the published and documentary (grey) literature, have also been a valuable source of information.[11]

When DESFIL began in late 1986, there was clearly concern about the accelerating deterioration of fragile tropical lands in Latin America. Especial concern existed in regard to the rapid erosion of steeply sloped lands and the alarming rate of tropical deforestation and accompanying loss of biodiversity. These were, in fact, the concerns that gave birth to DESFIL.[12]

The chapters in this volume will address the questions raised by these challenges in a variety of ways. Although each author focuses on a set of problems surrounding a particular factor of fragile lands management, such as incentives, policy, or the role of national institutions, we stress our belief that only through an integrated approach to fragile lands management that recognizes the systemic relatedness of these factors are we likely to find viable solutions to fragile lands management problems.

An integrated approach will involve coordination of policy changes, careful planning, development of improved technologies that are not solely production oriented but also appropriate to ecosystem maintenance, attention to the role of market factors, population control, and in many instances changes in cultural values. All this will require political will, a commitment to achieving greater equity, a substantial amount of research on ecosystem dynamics and production technologies, programs to sensitize professionals in many fields to environmental issues, expanded training programs to meet professional manpower needs, broad spectrum environmental education programs, the establishment of realistic (in other words, sustainable) limits to growth, and an indeterminable amount of luck.

ENDNOTES

1. Throughout this study, Latin America will be understood to include the Caribbean unless otherwise noted.

2. A discussion of the meaning of sustainability is provided in Chapter Two.

3. A discussion and definition of fragile lands is provided in Chapter Two.

4. The reader is referred to *World Resources 1990-91*, a publication of the World Resources Institute, for the most complete recent compilation of facts and figures on Latin America and comparison with other parts of the world relevant to the fragile lands problem.

5. "Keep it simple" and "avoid complex projects" are phrases frequently heard at A.I.D. bureau meetings and workshops. This is specifically recommended in the report of the Committee on Agricultural Sustainability for Developing Countries (1989).

6. Contrary to the observation of Iglesias (1989:99), Latin America no longer has the highest rate of population growth in the developing world. Africa now takes this prize. However, the

problems stemming from population increase in Latin America should not be minimized simply because the average annual population growth rate has decreased during the past five years.

7. Declines in agricultural production occurred during this same period in Barbados, El Salvador, Nicaragua, Trinidad & Tobago, and Guyana (WRI 1990).

8. Use does not automatically follow the perception of obvious benefit.

9. We use the standard A.I.D. definition of "long-term" with reference to projects — one year or longer.

10. Several DESFIL publications resulted from the St. Kitts SEP project: Brown, ed. 1989a, 1989b, 1989c; Foster 1989; Hanrahan, Russo, and Valencia 1990; Jackson 1989; and Noble 1989. Documents from the Ecuador FSDP have not yet been published. For a description of the project, see Young 1990.

11. DESFIL, a centrally funded A.I.D. project supported by the Bureaus of Science and Technology (S&T) and Latin America and the Caribbean (LAC), provided the support for this study. DESFIL has two central functions: research and service to LAC. This study should be understood as a product of DESFIL's research function. This is important because what it means in practical terms is that DESFIL's field experiences resulting from service to LAC missions could not (and were not expected to) cover the entire range of issues and approaches in fragile lands management. We point this out because several reviewers of an earlier draft of this study questioned the appropriateness of using non-DESFIL examples to illustrate points. Scientific research ideally makes use of ALL available data and evidence. Although we do not pretend to have achieved this ideal, we do believe that it is not only appropriate but required by the cannons of scientific research to draw upon studies and literature that are not a part of the DESFIL experience and that are outside of Latin America, when necessary.

12. An early, excellent examination of issues in the humid tropics is the National Research Council volume *Ecological Aspects of Development in the Humid Tropics*, published in 1982.

REFERENCES CITED

Anderson, A. B.
1990 Deforestation in Amazonia: Dynamics, Causes, and Alternatives. In A. B. Anderson, ed., *Alternatives to Deforestation: Steps Toward Sustainable Use of the Amazon Rain Forest*. New York: Columbia University Press, pp. 2-23.

Binswanger, H. P.
1989 Brazilian Policies that Encourage Deforestation in the Amazon. World Bank: Environmental Department Working Paper No. 16.

Browder, J. O.
1988 Public Policy and Deforestation in the Brazilian Amazon. In R. Repetto and M. Gillis, eds., *Public Policies and the Misuse of Forest Resources*. New York: Cambridge University Press.

Browder, J. O., ed.
1989 *Fragile Lands of Latin America: Strategies for Sustainable Development*. Boulder: Westview Press.

Browder, J. O.
1989 Introduction. In J. O. Browder, ed., *Fragile Lands of Latin America: Strategies for Sustainable Development*. Boulder: Westview Press, pp. 1-8.

Brown, M. T., ed.
1989a The Southeast Peninsula Project in St. Kitts, Vol. I: Resource Management Plans. DESFIL Technical Report. Washington, D.C.: Development Alternatives, Inc.

Brown, M. T., ed.
1989b The Southeast Peninsula Project in St. Kitts, Vol. II: Constraints and Opportunities--A Synthesis of the Planning Process. DESFIL Technical Report. Washington, D.C.: Development Alternatives, Inc.

Brown, M. T., ed.
1989c The Southeast Peninsula Project in St. Kitts, Vol. III: Park and Recreation Plans. DESFIL Technical Report. Washington, D.C.: Development Alternatives, Inc.

Byers, A. C., III
1990 Erosion Processes in Tropical Watersheds: A Preliminary Assessment of Measurement Methods, Action Strategies, and Information Availability in the Dominican Republic, Ecuador, and Honduras. DESFIL Technical Report. Washington, D.C.: Development Alternatives, Inc.

Committee on Agricultural Sustainability for Developing Countries
1989 The Transition to Sustainable Agriculture: A Two Year Review of AID's Agricultural and Rural Development Programs and an Agenda for the 1990s (ms).

Daugherty, H. E., ed.
1990 *Perfil Ambiental de Honduras 1989.* DESFIL Technical Report. Washington, D.C.: Development Alternatives, Inc.

Denevan, W. M.
1989 "The Geography of Fragile Lands in Latin America," in J. O. Browder, ed., *Fragile Lands of Latin America.* Boulder: Westview Press, pp. 11-24.

DESFIL
1988 Memoria de la Conferencia Usos Sostenidos de Tierras en Laderas. Tomo I. DESFIL Technical Report. Washington, D.C.: Development Alternatives, Inc.

Food and Agriculture Organization of the United Nations (FAO)
1989 FAO *Quarterly Bulletin of Statistics* 2(2):12, 16.

Food and Agriculture Organization of the United Nations (FAO)
1990 Sustainable Rural Development in Fragile Ecosystems in Latin America and the Caribbean. Twenty-First Regional Conference for Latin America and the Caribbean (ms).

Foster, R. D.
1989 The Potential Fiscal Impact from Southeast Peninsula Development 1989-1994. DESFIL Technical Report. Washington, D.C.: Development Alternatives, Inc.

Gennino, A., ed.
1990 *Amazonia. Voices from the Rainforest: A Resource and Action Guide.* San Francisco, Calif.: Rainforest Action Network.

Goodland, R., ed.
1990 *Race to Save the Tropics: Ecology and Economics for a Sustainable Future.* Washington D.C.: Island Press.

Government of Guatemala
1991 Plan de Acción Forestal para Guatemala: Documentos Base y Perfiles de Proyectos. Guatemala City.

Gradwohl, J., and R. Greenberg
1988 *Saving the Tropical Forests.* Washington, D.C. & Covelo, Calif.: Island Press.

Hanrahan, M.
1988a "Sustainable Uses for Steep Slopes," Workshop Proceedings. Vol. II: Synthesis Report. DESFIL Technical Report. Washington, D.C.: Development Alternatives, Inc.

Hanrahan, M.
1988b Central America: Environmental and Natural Resource Management. DESFIL Newsletter 2(1):15,38-9.

Hanrahan, M. and J. Pereira
1990 Manejo de la zona del Gran Sumaco Provincia del Napo, Ecuador. DESFIL Technical Report. Bethesda, Md.: Development Alternatives, Inc.

Hanrahan, M., S. Russo, and I. Valencia
1990 Strategic Environmental and Natural Resources Planning: Hypotheses, Case Studies, and Policy Conclusions from Latin America and the Caribbean. DESFIL Technical Report. Washington, D.C.: Development Alternatives, Inc.

Hanrahan, M., B. Lynch, W. McAnlis, and J. Wolf
1990 Evaluation of the On-Farm Water Management Project in the Dominican Republic. DESFIL Technical Report. Washington, D.C.: Development Alternatives, Inc.

Iglesias, E. V.
1989 Putting Development into Practice: The Latin American Experience. *Development* 89(4):96-102. Journal of the Society for International Development.

Jackson, I. L.
1989 Conditions and Trends in Caribbean Tourism Influencing the Development of the Southeast Peninsula. DESFIL Technical Report. Washington, D.C.: Development Alternatives, Inc.

Johnson, D. V.
1990 Guatemala Tropical Forestry Action Plan. DESFIL Newsletter 4(2):4,7.

Koehn, K., E. Tai, and E. LeFranc
1989 Process Evaluation of the Hillside Agriculture Project in Jamaica. DESFIL Technical Report. Washington, D.C.: Development Alternatives, Inc.

Lal, R.
1991 Soil Research for Agricultural Sustainability in the Tropics. In National Research Council, *Toward Sustainability: A Plan for Collaborative Research on Agriculture and Natural Resource Management*, Appendix C, pp. 66-90. Washington, D.C.: National Academy Press.

Ledec, G. and R. Goodland
1989 Epilogue: An Environmental Perspective on Tropical Land Settlement. In D. A. Schumann and W. L. Partridge, eds., *The Human Ecology of Tropical Land Settlement in Latin America*. Boulder, Colo.: Westview Press.

Lugo, A. E., J. R. Clark, and R. D. Child, eds.
1988 *Ecological Development in the Humid Tropics: Guidelines for Planners*. Morrilton, Ark.: Winrock International Institute for Agricultural Development.

National Research Council
1982 *Ecological Aspects of Development in the Humid Tropics*. Washington, D.C.: National Academy Press.

Noble, J.
1989 Strategy for Conservation and Development of the Southeast Peninsula of St. Kitts. DESFIL Technical Report. Washington, D.C.: Development Alternatives, Inc.

Panayotou, T.
1989 The Economics of Environmental Degradation: Problems, Causes and Responses. Paper prepared for USAID under CAER Task Order #3. Cambridge, Mass.: Harvard Institute for International Development (ms).

Posner, J. L., G. A. Antonini, G. Montañez, R. Cecil, and M. Grigsby
1981 Un Sistema de Clasificación para los Areas de Ladera y Altiplanos de América Tropical. In A. R. Novoa and J. L. Posner, eds., *Agricultura de Ladera en América Tropical*. Turrialba, Costa Rica: CATIE and Rockefeller Foundation, pp. 109-129.

Posner, J. L., G. A. Antonini, G. Montañez, R. Cecil, and M. Grigsby
1982 A Classification of the Steeplands in the Northern Andes. *Mountain Research and Development* 2(3):273-279.

Sanchez, P. A., D. E. Bandy, J. H. Villachica, and J. J. Nicholaides
1982 Amazon Basin Soils: Management for Continuous Crop Production. *Science* 216:821-827.

Valencia, I.
1989 Managing the Honduran Environment. DESFIL Newsletter 3(4):4,6-7.

Villachica, H., J. E. Silva, J. R. Peres, and C. M. C. da Rocha
1990 Sustainable Agricultural Systems in the Humid Tropics of South America. In C. A. Edwards, R. Lal, P. Madden, R. H. Miller, and G. House, eds., *Sustainable Agricultural Systems*. Ankeny, Iowa: Soil and Water Conservation Society.

Wilson, E. O., ed.
1988 *Biodiversity*. Washington, D.C.: National Academy Press.

World Resources Institute
1990 *World Resources 1990-91*. A Report by the World Resources Institute in collaboration with The Untied Nations Environment Programme and The United Nations Development Programme. N.Y. & Oxford: Oxford University Press.

Young, P. D.
1990 Forestry Sector Development Project in Ecuador. DESFIL Newsletter 4(3):1,6.

CHAPTER TWO

CONCEPTUAL FRAMEWORKS, SUSTAINABLE DEVELOPMENT, AND THE MANAGEMENT OF FRAGILE LANDS

by

Philip D. Young

Man has a peculiar and potential dominance over his ecosystem even though he is in no way independent of it; when he insults an ecosystem, he can expect to be slapped back. As he puts resources out of place, he can expect changes — undesirable concentrations of toxic substances, consequent reductions in the number and abundance of species, and a resultant and consequential community instability. . . . The problem . . . is intelligent and resourceful management. The quality of our environment will be a reflection of man's capacity to manage it. It will require much more understanding of ecological ramifications than are presently known and much more interplay of the myriad facets of a complex society in their resolution. Solutions to [environmental] problems will certainly not come with ease. These problems are not ecological only. They are sociological, economic, governmental, psychological, and, in the final analysis, moral as well. These problems will not be put down by a cry to return to a bygone day . . . nor to maintain the status quo. No ecologist . . . can argue for either; to do so would be a controversion of the most basic of ecological principles — dynamic and adaptive change.

Change is the essence of nature. . . . Man's hopes and chances . . . lie in the regulation of the changes that he, as a natural and integral part of the landscape, induces. He is a partner with other natural processes in the management of his resources and of his cultural and biological wastes. The future depends on man's intelligence to develop a body of knowledge about such management and on the wisdom which few now have to apply that knowledge. This demands a rethinking of man's place in nature. . . . The roots of the crisis . . . are deep in the outlook western man . . . has had about the land — land as his adversary to be conquered, as his servant to be exploited . . ., as a possession of rightful and eminent domain, and, most importantly, land of unlimited capacity. These concepts must give ground to an ecological conscience, to a love, respect, admiration, and understanding for the total ecosystem of which we are part; our

course, otherwise, is one of collision, an inexorable Armageddon. (Edward J. Kormondy, 1969:195-6). [Kormondy's use of "man" and "he/his" as generic for "human" predates the current gender sensitivity in language use - Ed.]

INTRODUCTION

The purpose of this chapter is to develop a conceptual framework that will serve as a departure point for informed judgements about the extent to which development plans, strategies, actions, and activities are likely to result in sustainable management of fragile lands. A conceptual framework is a set of underlying assumptions and definitions contained in models designed to mimic reality or some part of it. We believe that a model of narrow scope that applies only to fragile lands must be based upon a viable model of much broader scope that applies to the development process in general; so we begin our discussion at a general (and somewhat abstract) level. The underlying assumptions of models are often implicit. We will attempt to make our assumptions explicit. Note that definitions of the terms used in this chapter are provided below.

A fundamental assumption of our conceptual framework is that any viable model of development will be a systems model rather than a linear-causal model. A linear-causal model consists of uni-directional relationships among variables. The simplest of such models would contain only one cause-one effect relations. A more complex model would also contain one cause-multiple effect and multiple cause-one effect relations. In no case would a linear-causal model contain feedback loops. Feedback loops are a fundamental characteristic of systems models. Researchers agree that systems models more closely approximate the realities of the biophysical world (for example, Hall and Day, eds. 1977; Botkin 1990) and the social world (for example, Bennett 1976) than do linear-causal models. The simplest systems model is a two variable model with feedback loop. Any model of an ecological system contains multiple, simultaneous interactions among numerous variables, and one or more feedback loops.[1] Simple cause-effect relationships can also be included in a systems model but seem to be the exception rather than the rule in natural systems.[2]

Systems models may range from highly deterministic/mechanistic (equilibrium as the natural state) to dynamic (change as the natural state). There are several systems models of development to choose from, based on differing conceptual frameworks (sets of basic assumptions), and they display a broad range of determinism/dynamism. We will examine some of these below. Colby (1990a) calls these models "paradigms of environmental management."

DEFINITIONS

ANALOGOUS: Similar or comparable in certain respects (Webster's New World Dictionary of the English Language, 1960).

CONCEPTUAL FRAMEWORK: A set of basic assumptions (and accompanying definitions) about how things function in the world, i.e., about the nature of the relationships among distinguishable entities (which may be either variables or constants).

ECOSYSTEM: A system, or a functioning whole, composed of both the physical environment and the organisms living within it (Haviland 1990:154).

FRAGILE LANDS: Lands with limited inherent capability that will display **rapid** and significant deterioration (soil loss, nutrient loss, sharp declines in productivity or biodiversity) under all but a highly restricted range of human uses.

MODEL: Any abstraction or simplification of a system (Hall and Day 1977:6).

NONRENEWABLE RESOURCE: A resource that cannot be replaced with a time period that is significant in terms of human use of the resource.

PARADIGM: A body of definition, belief, and fact associated with some area of science or metascience. A supermodel (Overton 1977:72).

RENEWABLE RESOURCE: A resource that can be replaced by natural means or through human intervention.

SOCIONATURAL SYSTEM: A system in which diverse human groups have adapted in patterned ways to other components (biotic and abiotic) of the ecosystem and in which humans decisions and behaviors are continually altering the adaptive dynamics of the system. (Adapted from Smith and Reeves, eds. 1989:14.)

SUSTAINABLE RESOURCE USE: A resource is being used in a sustainable way if some constant average supply of the resource is available over some agreed upon, significantly long, period of time. Annual supplies may vary so it is better to use constant averages as the measure.

SYSTEM: Any phenomenon, either structural or functional, having at least two separable components and some interaction between these components (Hall and Day 1977:6).

The Silent Revolution

A quiet revolution in thinking has been taking place since the 1960s in numerous fields of natural and social science. Knowledge has accumulated that has made increasingly evident the harmful impact on the biosphere of much modern human activity. Along with this, there have been changes in the assumptions about the functioning of natural systems, and about humankind's place, role, and function within natural systems. There is a shift underway from a view that considered nature as a storehouse of unlimited resources to be mined by humans to a view that acknowledges resources as finite and requiring certain conditions and inputs for continued production. There has also been a shift from a view that modeled ecosystems on the assumption of equilibrium as their ultimate natural state (perturbations would trigger adjustments that would function to move the system back toward the former equilibrium state — the mechanistic "thermostat" model), for example, the idea of "climax" forest, to a view of ecosystems as dynamic systems in which a condition of balance or equilibrium is never reached (Botkin 1990).[3] Perhaps equally important, a shift is gaining momentum from the idea that humans must dominate nature to a recognition that it is human activity that must be managed.

Researchers in such seemingly diverse fields as ecology, economics, anthropology, biology, and physics are moving toward a remarkable consensus regarding humankind-nature relationships, although many may themselves be unaware of the extent to which a convergence of thought is occurring among these diverse disciplines.[4,5] The basic assumptions of this new consensus are that resources are finite, natural systems are never in a state of equilibrium (although rates and magnitudes of change vary), and human survival depends upon placing limits on the growth of the economy (Daly 1990) and on the growth of the human population (Ehrlich and Ehrlich 1990).

Ultimately, it is likely that economic growth will have to cease altogether if sustainable production of renewable resources is to be maintained (Daly 1990), but this may still be a long time in the future. How far in the future is highly dependent on the rate of growth of the human population. The idea of limiting economic growth continues to be difficult to accept for those whose conceptual framework is based upon the assumption that growth is equivalent to progress, which in turn is equivalent to well-being, and that, for all practical purposes, the supply of resources is unlimited. And of course placing limits on growth will not by itself ensure sustainability of resources — but it would represent a good beginning.

The idea of limiting growth of the human population by other than natural means continues to be unacceptable to people of a variety of religious persuasions. Yet population growth combined with inequitable distribution of land are two of the major factors currently contributing to the degradation of fragile lands in developing countries.

There are those who believe that technological innovations will permit growth to continue indefinitely, that technology will save us in the future as it has in the past, that even if the supply of resources is finite, technological advances, for example in the fields of biotechnology

and nuclear physics, will blur the distinction between finite and infinite. We do not deny the importance of technology for effective and sustainable resource use. But, leaving aside the fact that many of our technological solutions in the past have created more problems than they have solved (for example, nuclear energy, large-scale hydroelectric dams, various agrochemicals), we believe it is far more reasonable to seek solutions now to problems of resource depletion than to place all our hope in future technological innovations. Such may be forthcoming, but until they are we must work with what we have.

Environmental Problems and Human Problems

While the particular focus of this study is development strategies for fragile lands, the development problems of fragile lands are not different from those of development in general, although they are frequently more acute. We must deal with the problems of sustainable resource management, whether these be fragile lands or other resources. However, while nonfragile lands may be resilient, degradation of fragile lands may not be reversible (for example, laterization).

The scientific and development literature on environmental and social problems in both the developing and the developed nations makes it clear that we are not currently making much progress toward the goal of sustainable development, that fragile lands and fragile ecosystems are being mismanaged and degraded at an alarming rate, and that world poverty is increasing (for example, WRI 1990; Korten 1990; Goodland, ed. 1990; World Bank 1988).

Some of the more obvious environmental problems of the developing world (but certainly not confined to the developing world) are deforestation; soil erosion; habitat destruction; species extinction (at a rate more rapid than at any time since the end of the Cretaceous Period 65 million years ago);[6] nuclear waste storage; chemical and waste pollution of land, air, and water; and indications of global climatic change, particularly warming, that many specialists attribute largely to the burning of fossil fuels and deforestation.

All nations, and particularly the developing nations, are also faced, to varying degrees, with a host of socioeconomic problems. These include overpopulation; rapidly growing populations; malnutrition; hunger; starvation, oppression; war; communal violence (occurring among citizens of the same nation — Korten 1990:14); crime; political and economic inequities; debt crises of varying degrees of severity;[7] and numerous health problems, many of them related to environmental deterioration. Some of these problems, like rapid population growth, have been viewed as causes of environmental degradation; others, like increasing poverty, as both causes and consequences. Establishing directions of causality, however, is worthwhile only if such one-directional models in fact mirror reality closely enough to lead to the solution of problems. Such cause and effect models have generally guided development efforts but, unfortunately, have not proven to be productive in the solution of human problems. For example, it is an assumption of the growth-centered model of development (the model currently pervasive) that poverty is caused by insufficient economic growth. More growth will supposedly

alleviate poverty in developing countries. Has it? The data are disturbing. Although the percentage of those considered to be below the poverty line in noncommunist developing countries decreased from 46.8 percent in 1960 to 30.1 percent in 1980 (Korten 1990:12, citing Adelman 1986), the World Bank calculates that the absolute number of people in the world below the poverty line increased from 650 million in 1970 to 730 million in 1980 and the situation continued to worsen during the 1980s (1988:4). Korten explains the meaning of the poverty line:

> The poverty line . . . is set at $50 per capita 1960 purchasing power — the income required to support minimally adequate calorie replacement at average levels of activity. In other words, those whose rise above the poverty line we celebrate have risen only above the level of absolute deprivation. So long as they devote *none* of their income to clothing, shelter or other nonfood indulgences they need not go to bed hungry each night (1990:11).

If growth alone can reduce poverty, those who think so need to explain why four decades of growth-centered development has resulted in increased poverty.[8]

A systems perspective views all of the socioeconomic, environmental, and political problems mentioned above as interrelated variables. Such a view requires an integrated approach to development, not one that assumes that there is a singular root cause for every problem. The vast majority of relationships among the variables are simultaneous as well as dynamic, and causal directionality can rarely be established. This does not make accountability and impact assessment of development interventions impossible. One can alter the value of a single variable within a system and measure the impact on one or a number of other variables. The extent to which other intervening variables may account for some portion of the impact has always been problematic. For example, in eastern Ecuador, various agroforestry techniques have been introduced on demonstration farms through the USAID Forestry Sector Development Project (Peck and Bishop 1991). It has been shown that production gains have resulted. Whether the technology has improved farm income is more problematic because income is dependent on other variables such as the condition of the market for the products. It has also been determined that these agroforestry techniques have been adopted by others in the area. However, since the techniques were in use in the area prior to the beginning of the USAID project, it cannot be determined how much of the "demonstration effect" can be attributed to project activities.[9]

But models of systems are not all alike either, and the often implicit assumptions we make about the functioning of a system and about what is problematic influence our choice of variables to include in the model and our choice of manipulative strategies.

Collectively, current socioeconomic and environmental problems are the result of human actions over scores of years, based on sets of values and perceptions of the relationships between humans and nature that may once have had adaptive value but, if so, have become increasingly

maladaptive. Regardless of their origins, current social and economic problems are placing ever increasing pressure on the resource base and the environment of Earth as a whole. This is why we need better management strategies for the use of Earth's resources by humans. Sustainable management of fragile lands will contribute to the solution of environmental and socioeconomic problems; but to achieve this, we need to reevaluate and reorient our thinking about the relationship between ourselves and our planetary ecosystem, about the relationships among ourselves, and about Earth's capacities and capabilities and our own. For example, we need to reconsider the relationship between common property regimes and resource use, as Bromley (1991) has done (see also Chapter Five, this volume).

GOING, AND GETTING THERE

> "Would you tell me, please, which way I ought to go from here?" asked Alice.
> "That depends a good deal on where you want to go," said the Cat.
> "I don't much care where---" said Alice.
> "Then it doesn't matter which way you go," said the Cat.

With these lines from Alice in Wonderland, James Ramsey (1969) began a devastating critique of U. S. government decisions regarding protection and rehabilitation of our environment and citizen complacency in the face of government decisions. He said

> Move over Alice, you've got a couple of hundred million Americans for company. We don't know where we are going or where we want to get to either.

More than 20 years have passed. Do we know now where we want to go? Much development literature from the Latin America region's governments and its donors, both public and private, suggests that we do. But do we know how to get there?

Environmental consciousness among U. S. citizens (and in many other countries) has vastly improved in the 22 years since Ramsey's article, as have our government's efforts to conserve and to clean up the environment, both at home and abroad. Today, both on the domestic scene and in our foreign aid programs, the efforts of the U. S. government include the concept of sustainable economic development, but the overall approach to development continues to be growth-centered.[10] These days, at least for the donor community, sustainable development ideally implies development that is:

- **Environmentally sustainable**, that is, ecosystems and resources are maintained in a healthy state over a long period of time, biodiversity is preserved, and the natural capacity of ecosystems is protected (Ack 1991);

- **Economically sustainable**, net benefits over costs are realized in the long term; and

- **Socially sustainable**, which includes cooperation of resource users, institutional capacity, and political will, among other things.

Sustainable development definitely seems to be where we need to get to, and where much of the developed world wants to go.[11] But we are only just beginning to explore ways to get there and we still have a long way to go. We need to seriously examine how consistent our concepts and values are with the above sketch of sustainable development. Policy makers, development planners, and large donor agencies like A.I.D. and the World Bank need to seriously consider whether a growth-centered approach is the best approach to achieve sustainability.

CONCEPTS

Choosing a Conceptual Path

Now that we know where we want to go — toward ecologically and socially sound sustainable development — how do we find the right path to get us there? What would be the characteristics of a conceptual framework that would guide the decisions and actions of governments and development planners in such a way as to achieve development that is sustainable over the long haul and economically and socially viable? What kind of balance do we wish to achieve between ecological costs and economic benefits, or between ecological benefits and economic costs? How do we achieve an improvement in the quality of life of those living today while at the same time ensuring the welfare of future generations of humanity?

Some have argued that humans have no special place in the scheme of things and we should focus on the welfare of the totality of Earth's organisms. This is the view of those whose conceptual model is that of "deep ecology" (Lewis 1990). Such a phrasing of the issue is morally and ethically satisfying to some people, and in a systems view is not without merit. But it is a view seldom shared by either impoverished users of resources or policy makers.

Many of us engaged in development work have argued that we must take account of the world views and knowledge of the local population (the beneficiaries of our development projects) and recognize that their goals and views are also valid rather than trying to impose a formulaic development scheme on everyone. We have argued that we must present our own views as alternatives to be considered and do so in terms that are understandable and acceptable within their cognitive framework. By the same token, we must remember that civil servants, government officials, bureaucrats at various levels, and those who advise them are also "locals," with their own particular world views and conceptual frameworks. What they have in common with the rural poor and other end-users of resources is that they make decisions within a framework of what they perceive to be human needs, not the needs of all Earth's organisms. In other words, their views are anthropocentric. If sustainable development is to be achieved, our arguments must be convincing to those who make the grand decisions as well as to the

resource users. Precisely because the viewpoint of deep ecology is decidedly nonanthropocentric, it is unlikely to be convincing to policy makers or to many resource users in developing countries. In this light, an anthropocentric phrasing of the issue seems not only appropriate but required.

Solutions to the sustainability problem depend not just on biophysical factors but upon a combination of political, social, economic, technological, and moral factors. All of the latter are a part of the **social system**, at whatever level from local to international we wish to circumscribe it, and

> man's use of Nature is inextricably intertwined with man's use of Man, . . . remedies for destructive use of the environment must be found within the social system itself (Bennett 1976:311).

Conceptual Frameworks in General

> One takes the components, interactions, and mechanisms that he believes to be operable in the system and considers them within the framework of the whole system and the questions he is interested in. . . . To construct a conceptual model one says, "This is how I think my system is." (Hall and Day 1977:17).

It is important that we set the stage, so to speak, for the detailed discussions of various aspects of fragile lands management in the following chapters. We will examine the features of a conceptual framework that will guide us in evaluating existing policies and procedures, and in making recommendations for improvement of fragile lands management to achieve sustainable use over a longer period of time than is currently the case throughout most of the world.

A conceptual framework is a set of assumptions about how things function in the world; it is not itself either a model or a management strategy, but it strongly guides thinking in the choice of variables to include in models and in the formulation of management strategies, both by excluding some possibilities and by promoting others (and by leaving still others unthought of). Ultimately, human actions are based upon the assumptions embedded in our conceptual framework even though they may be implicit and not consciously attended to. How we think things work governs how we act to achieve the results or outcomes we desire.

If the sustainable management of fragile lands and resources is perceived to be a desired outcome, and if the models we are using to pursue this goal are not leading to its achievement, it is time to reexamine the concepts underlying our models of development.

Thinking and Doing

Among the human cognitive abilities that represent the current result of a long and still ongoing process of biological and cultural coevolution are the abilities to conceptualize; to change our

minds; to seek alternative solutions; to conceive of consequences of actions without actually carrying them out (that is, to engage in hypothetical thinking); to make choices; to rationalize[12] our actions; and to engage in self-deception (that is, to act *as if* a certain set of conditions exists [or does not exist] when all evidence points to the contrary). Two of our cognitive abilities are of particular significance in this discussion of a basis for formulating a viable model for sustainable development: conceptualization and rationalization.

Our highly developed ability to conceptualize goals and then consciously manipulate nature to our own ends is an ability that, so far as we know, is only rudimentary at best in any other organisms. Our actions are predicated upon assumptions about what the outcomes are likely to be. We choose among possible courses of action to achieve desired outcomes. It is well known that with reference to development interventions our choices have had unforeseen consequences that are deemed undesirable or may be deemed adverse in the long run. Often the adverse consequences do not directly affect those responsible for the actions but rather they are borne by those who have relatively little power to object. For example, the actions of government officials in Ecuador have resulted in policies that encourage colonization and deforestation in the Amazon. This has adverse consequences for the indigenous peoples who inhabit the area, and for the environment.

Confronted with adverse consequences, even if unintended, those with the power to take corrective action do not always do so. Sometimes the action-takers argue that their actions will, in the end, result in the greatest good for the greatest number — an unprovable argument at best.[13] To pursue courses of action in the face of overwhelming evidence that these actions are harmful and destructive to other humans or the environment can only be done by rationalization. To continue such actions is ultimately maladaptive. A viable model of sustainable development should incorporate means to correct actions that come to be recognized as maladaptive in either sense — harmful to humans or irreparably destructive of ecosystem resources.

Focal Concepts: Fragile Lands, and Growth and Sustainable Development

Fragile Lands

Fragile lands is a descriptive phrase used to focus attention on particular problem areas in environmental management. Fragility itself is a relative condition rather than an absolute quality. As a consequence, the criteria for classifying lands as fragile have been varied. Denevan (1989:11) has argued that land is not naturally fragile; it becomes so under specific uses, and intensities and frequencies of use.[14] One could invert this argument and say that all lands are fragile if mismanaged, as indeed some have (Gow 1989:29). Bremer et al. (1984:3) define fragile lands as

> lands that are highly subject to deterioration under common agricultural, silvicultural, and pastoral use systems and management practices.... [emphasis in original].

Bremer et al. go on to characterize fragile lands as those where "destructive patterns of use" must be "combined with a natural resource base subject to deterioration" (1984:3). On this basis, they exclude three categories of lands. The first is land with "deep fertile soils on well-drained plains" which "are not highly susceptible to deterioration under prevailing use systems." We have no quarrel with this exclusion.

The second exclusion is land that has "a high potential for deterioration ... if there is no immediate threat [of] destructive use." Uncleared tropical rain forest is given as an example. It makes more sense, however, to explicitly recognize rain forest ecosystems and the lands that support them as **fragile** and plan for their appropriate use than to wait until the destruction of the ecosystems and the deterioration of the lands is already taking place before recognizing the inherent fragility of both. Lands that support tropical rain forests are explicitly **not** excluded from our definition of fragile lands.

The third exclusion is "potentially or formerly fragile lands that are managed in a sustainable way. . . . In effect, they are no longer fragile, although they may become so again if the management system changes (Bremer et al. 1984:3)." It is clear that Bremer et al. are here arguing that the condition of fragility is dependent on the management system. This too is wrong, in our view. Just as nonuse of land does not alter its fragility, sustainable use simply means that the technology and management systems in use have taken account of the fragility. Fragile lands that are being utilized in a sustainable way are also not excluded from our definition of fragile lands. In our view, the second and third exclusions represent a very short-sighted view of the nature of the fragile lands problem.

ALL lands are subject to significant deterioration in real (as contrasted with geologic) time if overstressed through human use. Our definition of fragile lands is focused on inherent natural capabilities, and the time variable implicit in other definitions. Imposing a time constraint is a different way of focusing on the management problem. We define fragile lands as **lands with limited inherent capability that will display <u>rapid</u> and significant deterioration (soil loss, nutrient loss, sharp declines in productivity or biodiversity) under all but a highly restricted range of human uses.**[15] By rapid we can specify a time period of 30 years or less. Of course, 30 years is an arbitrary period; but it does seem to be the case that the majority of the Latin America's steep slopes and humid tropical lowlands suffer rapid deterioration and plummeting productivity under human use in a period of less than 30 years. Inherent capability can be determined by applying the analytic methods of the Holdridge life zone classification (Holdridge 1967; Chapter Nine, Appendix, this volume).

Growth and Sustainable Development

Concepts of growth and sustainable development directly affect the development process and thus have a significant impact on the management of fragile lands.

Belshaw (1976), Streeten (1981), and others more recently (Brooks 1990, Daly 1990) have cautioned us not to confuse the terms growth and development for they are not at all synonymous. Growth means an increase in size or scope through the addition of material, and development means the realization of potential or qualitative improvement (Brooks 1990, Daly 1990). Economic growth requires resources. Sustainable growth would require unlimited resources (which is, of course, the assumption of neoclassical economics and thus possibly the principal reason why so many people use the nonsensical phrase "sustainable growth"). The resources of the Earth are finite. Although some resources useful to humankind are renewable and others are not, even the renewable resources cannot be produced in unlimited quantities and therefore must be considered finite, at least from the perspective of ecosystem dynamics. Thus, as Brooks (1990) and Daly (1990) point out, sustainable growth is a contradiction in terms.[16] This does not mean that economic growth is inherently undesirable; it does mean that we must make a serious attempt to understand in all its complexities the implications of growth. Sustainable development can only be achieved by limiting growth. As Daly (n.d.) has so aptly phrased it, "it is impossible for the world economy to grow its way out of poverty and environmental degradation."

The most quoted definition of sustainable development is that of the Brundtland Commission (even though it is often quoted in order to be criticized, as is the case here):

> Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs (World Commission on Environment and Development 1987).

Some would say that this captures the essence of sustainable development; actually, it masks the complexities. Brief reflection reveals that this definition is useless as an operational concept. Beyond minimal life support, there is no agreement currently on what needs are.[17] And certainly we cannot presume to know how future generations may define their needs. Thus, the question of what might actually constitute sustainable development by this definition is intractable.

In a pithy and provocative essay on what sustainable development means, Brooks cites a conceptualization of sustainable development provided in a report of the World Conservation Strategy:

> The emerging paradigm of sustainable development . . . seeks to develop strategies and tools to respond to five broad requirements:
>
> - Integration of conservation and development.
> - Satisfaction of basic human needs.
> - Achievement of equity and social justice.
> - Provision for social self-determination and cultural diversity.
> - Maintenance of ecological integrity.

> These challenges are so strongly interrelated that it is difficult, and indeed unhelpful, to arrange them in hierarchical or priority order. Each is both a goal itself and a prerequisite to the achievement of the others (World Conservation Strategy report, as quoted in Brooks 1990:24).

This conceptualization antedates the Brundtland report, in Brooks' view and ours is superior, and is worth adopting as our own standard. It is clearly commensurate with the DESFIL mandate and with the views expressed by the authors of the other chapters of this study. It is a view that implicitly recognizes that sustainable development is only achievable by placing limits on economic growth.

Any attempt to operationalize the concept of sustainability must respond to three basic questions: What is it that we wish to sustain? For whom? and For how long?

A simple answer to the first question is that we wish to sustain resource production at a level that does little or no damage to the environment (ecological sustainability) and produces acceptable economic gains (economic sustainability). But this glosses over the complexities of the issue. A slash-and-burn agricultural system, for example, may meet the productive needs of a small, nongrowing population without causing irreversible damage to the ecosystem and thus be considered sustainable in both senses. But such a system, geared to production for subsistence rather than the market, clearly will not contribute to the economic needs of a nation that relies for its healthiness on agricultural sector production well beyond the needs of those within that sector. Slash-and-burn agriculture does not meet the economic criterion of sustainability from a national perspective. But for some areas of fragile lands in Latin America, for example, Sumaco in Ecuador (Hanrahan and Pereira 1989), there is a real question as to whether any agricultural system other than slash-and-burn at low population density is ecologically sustainable. This illustrates one of the major dilemmas of development: we cannot simply choose between a healthy economy and a healthy environment for the two are inextricably linked and, ultimately, we cannot have one without the other.

The question of sustainable for whom is equally complex. Most of us might automatically respond "for us, of course." But who is us: Middle class white Americans, native peoples of the Amazon rainforest, all of humankind, or, as the Brundtland Commission would have it, all of us and future generations? The advocates of deep ecology (see below) might tell us that we must strive for sustainability in the sense of preservation of all species. Although such a view ignores the dynamic, ever-changing nature of ecosystems, it does call our attention to the fact that we are a part of Earth's ecosystems. It would be prudent to recognize that we must live with the consequences, good or bad, of our manipulation of ecosystems. Thinking in terms of sustainability of ecosystems as the answer to the "for whom?" question is more likely to result in management that achieves long-term sustainability. Sustainable management of ecosystems sustains our own well-being.

Such an approach will require a shift away from the currently dominant growth mentality with its fundamental assumption of unlimited resources and toward a sustainable development mentality that recognizes the finiteness of some resources and the renewability of others only so long as they are appropriately managed. This will not be an easy shift for the developed nations of the world, and even more difficult for the developing nations, most of which are currently struggling with problems of population growth, food scarcity (actual or impending), declining health of their populations, and massive debts. But it is a shift that must be made. To do otherwise would be to abandon any pretense of working toward economically and ecologically sustainable systems of production and condemn future generations to increasing deterioration of the global environment and the specter of ultimate extinction. The problems we face today are difficult but they appear to be solvable. Those faced by our grandchildren in the not so distant future may indeed prove unsolvable if we continue our present course of resource depletion and environmental destruction. Technological advances and resource substitutions will only postpone the problem. Once a resource is gone, we cannot get it back.

Ideally, the answer to the question of sustainable development for how long should be "forever." But, of course, in practical terms we cannot even know whether **anything** is sustainable forever. Over what period of time, then, should a resource management system remain viable, that is, economically productive and ecologically nondamaging, in order for us to judge it sustainable? Any answer to this question will involve at least two crucial assumptions. First, we must assume that change itself is an inevitable process in the universe, although its rate varies. From all of the evidence currently available to us, this seems a safe assumption. Second, we must assume that we will be able to develop technologies that will permit future generations to continue the process of maintaining a sustainable relationship with the dynamic global ecosystem. In addition to technological improvements — the supply side — it will almost certainly be necessary for future generations to address more seriously then our generation seems to, the issue of limiting consumption — the demand side.

The answers that we decide upon to the questions of what?, for whom? and for how long? are inextricably interdependent; that is, the value of each variable is dependent on the values of the other two. A simple equation containing three unknowns has no unique solution. What we must strive for is the best balance among these variables. Our general goal should be to optimize the relationship between ecosystems and human production systems through time so that levels of production produce benefits without degrading ecosystems. Because economies depend on throughput of resources (matter-energy) (Daly 1990), to be economically sustainable a system will, of necessity, have to be ecologically sustainable in the specific sense of insuring that resource exploitation does not exceed the ability of the ecosystem to continue to provide the resource. Fragile lands are particularly problematic because of their inherently narrow tolerance limits.

MODELS

General Limitations

All models impose a particular set of conditions on reality (Bennett 1976:107). "Models cannot ever replace experience, knowledge and judgement; they can, however, if used properly, augment them significantly (Biswas 1990:3)." Models of complex systems are always gross simplifications of reality. Even in the age of super computers, they can include only a limited number of variables and thus there is always the risk of failing to include key variables and relationships. For precisely this reason, we should frequently check our models against real world data to make sure that they are accurately representing the real world as we understand it or that they are at least misrepresenting it in ways of which we are aware (Hall and Day 1977:8). However, when the application of our models gives us results that we did not anticipate, or when predictions based on our models contradict our observations in the real world, it is not always easy to determine what is wrong. And it is difficult indeed to admit that there may be major conceptual flaws in our understanding of how things work in the world.

Flaws (as well as muddles) in our models do impede development efforts. In Haiti, for example, donors had insisted on channeling resources for agroforestry projects through national public sector institutions that seldom used the funds for the purposes intended. Further, it was thought that insecurity of land tenure was a major obstacle to getting Haitian peasants to plant trees, but Murray showed that most peasants had secure tenure to their land; their concern was with guaranteed exclusive ownership of the trees if they planted them (Murray 1983; DESFIL 1990; Chapter Five, this volume).

Often, to avoid facing the possibility of a major conceptual flaw, we resort to a piecemeal approach in which we attempt to fix little things one at a time in the hope that eventually everything will work the way we want it to. Often the fixes are not appropriate for the goal sought, but only address one aspect of a complex problem, or address symptoms rather than underlying causes. Technological fixes are often advocated when what is really needed is policy reform.

In Ecuador, for example, a combination of factors including poverty, land shortage in the highlands due to serious tenure inequity, a new road, lack of coordination among several agencies all claiming authority over the area, and policy incentives that reward deforestation with land titles has led to the colonization and deforestation of steep fragile lands in a protected reserve near the Sumaco volcano and hardship for native peoples who formerly used the area for hunting and gathering (Hanrahan and Pereira 1989). The agriculture and cattle raising practiced by the colonists is not sustainable. Erosion, nutrient depletion, and soil compaction are rapidly becoming serious problems and production is declining sharply. The solution of the colonist is often to move on and cut more forest. Providing the colonists with instruction in technologies that will improve production and with subsidies to facilitate implementation if they prove beyond the means of the colonists may temporarily improve yields and slow deforestation.

But this solution clearly addresses only one aspect of the problem and treats only symptoms. A lasting solution to the problems of deforestation and degradation of steeplands in Ecuador and elsewhere will require a much more complex set of interventions that would certainly have to include institutional and policy reform.

The further a model departs from accounting for the facts as we perceive them, the more likely it is that there is something wrong with the fundamental assumptions upon which the model is based. New models may be formulated and tested and found to better account for the facts as we know them; but the influence of social, economic, and political factors on the formulation of problems and the shaping of theory may delay the acceptance of a new model with different fundamental assumptions for a very long time. With reference to the physical and biological sciences, the discarding of an old model and the general acceptance of a new one as the fundamental basis for interpretation Kuhn (1970) calls a paradigm shift.

The discarding of the growth-centered causal model and the general acceptance of a sustainability-centered dynamic systems model would represent such a paradigm shift in the field of development.

Humans, Nature, and Development

The view one takes of the relationships between nature and humanity is a basic cultural value orientation. It will always be embedded as a fundamental assumption in any model we construct of development (and in many other models); and it has important consequences for the application of technology, loci of management, policy and planning, and the nitty-gritty of project actions in the field. For example, if one of our central values is that humans must dominate nature, then our approach to development is not likely to respect the integrity of natural ecosystems. If, on the other hand, we believe humans should maintain total harmony with nature, then we are not likely to want to disturb natural ecosystems in any way. The first view is antiecological; the second is antigrowth. Neither of these extreme views really understands the role of humans as functioning organisms *within* Earth's ecosystems and neither is likely to lead to efficient and sustainable use of resources. A model that will help us achieve sustainable development, or a model of narrower scope that will focus on sustainable uses for fragile lands, will have to incorporate a view that is different from both of these — but not necessarily exactly in the middle between them.

Some important changes have taken place in recent years in the scientific understanding of ecosystems as well as in our understanding of social systems and cultural values. This has resulted in contrasting conceptual models of both the functioning of ecosystems and of the relationship of humankind to nature, that is, of how we perceive the world to work in general and what we perceive to be our place in it. These conceptualizations of the relationship between humankind and nature permit us to discuss the possible pragmatic consequences of making decisions about development on the basis of one model or the other. Two of the best known models, those of **frontier economics** and **deep ecology** (see below), present strongly contrasting

views of the humankind-nature relationship as well as other sharply divergent assumptions about how the system works. There are also several variations of these polar models (for descriptions see, for example, Bennett 1976; Botkin 1990; Colby 1990a, 1990b).

Ecosystem Models

The ecologist, Daniel Botkin (1990), distinguishes three schools of thought in regard to the question of the balance of nature at the global level.[18] The first is a view that sees the biosphere as being in a steady-state and, when perturbed in any way, always seeking to return to equilibrium. Botkin points out that this view is consistent with the machine metaphor and the idea of divine order. He argues that most current analyses of the biosphere are based on this view. We add that this steady state view is reflected in most of the literature on sustainable development. The second view sees life itself acting as Earth's thermostat. This view is also consistent with the machine metaphor but can have organic aspects. Botkin points out that Lovelock and Margulis are proponents of this view. Lovelock proposed the Gaia hypothesis, that is, that the biosphere itself is (or at least functions like) a living organism. The third view is that the biosphere

> is always changing and it is this very quality at the planetary level that has allowed life to persist. . . . The earth is not alive, but the biosphere is a life-supporting and life-containing system with organic qualities (1990:146,151).

In his recent book, *Discordant Harmonies* (as well as in other publications), Botkin espouses this latter **dynamic** view of ecosystems. In models based upon this view, change is always occurring, but not at a constant rate. Botkin shows how the facts as we currently know them do not accord with the myth of nature in harmony, balance, equilibrium, order, at any level from single populations to the entire biosphere considered as a single system. He traces the equilibrium myth to our Judaeo-Christian belief in divine design.

Acceptance of a conceptual model of the biosphere as ever changing has interesting consequences for resource management whose goal is sustainability. Some of the contrasts between the old equilibrium and new dynamic models and their consequences for management are presented in Figure 2.1.

Whether our unit of analysis is the global ecosystem (biosphere) or some ecosystem of a smaller scale, proceeding from the adaptive dynamics view, a model of such a system will incorporate certain basic assumptions and concepts. An ecosystem consists of an inanimate (physical or abiotic) environment and living organisms (the biotic assemblage). Interactions take place among the elements of the abiotic environment, among the organisms, and between the organisms and the abiotic environment. This is not to say that each element or organism interacts with every other. But we do presume that the interactions are structured and knowable, although we are still a long way from knowing all of them. The effects or products of interactive processes constitute change. Change may be inexorably slow or cataclysmic. At

some times, changes in an ecosystem may be occurring so slowly that the system appears to be close to stasis. At other times, changes may be occurring so rapidly that the system appears almost chaotic.

There is a growing body of literature on a set of ideas earlier referred to as "far-from-equilibrium theory" (Prigogine, cited in Capra 1982), and more recently as "chaos theory" (Gleick 1987). The ancient and long-respected model of the universe (and all systems encompassed by it) as a system tending toward equilibrium and order, that is, the mechanistic,

FIGURE 2.1. APPROACHES TO MANAGEMENT OF RESOURCES

FEATURES	OLD MANAGEMENT	NEW MANAGEMENT
Basic assumptions of model	biosphere in a steady state	biosphere always changing
Type of management	managed for constancy in terms of uncertainty	managed in terms of uncertainty, change, risk, and complexity
View of meaning of sustainability	sustainable harvest obtainable forever at same rate in every time period	long-term time-averaged yield does not decline but rate of harvest may vary from time period to time period; may have to vary in short run to achieve long-term sustainability
Conservation/Utilization	appeared to be different and in general incompatible goals	goals of conservation and utilization part of one approach

Source: Botkin 1990:155-6.

deterministic model of Descartes and Newton, is giving way to a new and — to some — radical model of the universe as tending toward disequilibrium and uncertainty. Clearly, the model we choose has important implications for the decisions we make and the actions we carry out in our attempts to manage ecosystems. Efforts to achieve sustainable development of necessity must include the management of ecosystems. If we choose a deterministic model, then development projects are likely to display little flexibility with respect to altering either activities or objectives. If we choose a dynamic model that incorporates the assumption of uncertainty, then both actions and objectives will be subject to continuous revision as necessary during the course

of a project in order to deal with the element of uncertainty. Small-scale, community-level projects managed by nongovernmental organizations (NGOs) often incorporate a degree of flexibility consistent with a dynamic systems model. Large-scale projects managed by national governments or international donors are consistently based on deterministic models.

Within the view of continuous change, the goal may be the least undesirable alteration of the ecosystem that is at the same time socially and economically viable. Such a goal would be consistent with management for sustainability. The model that has dominated development efforts contains the assumption, belonging to an earlier time when the consequences of it were not so blatantly evident, that for all practical purposes resources could be considered as existing in unlimited quantity. This assumption made it possible to incorporate in the model the feature of unlimited growth.

Economic growth uses and often consumes resources. This is an inescapable fact (Goodland 1990). When resources are consumed at even a temporarily nonrenewable rate and the desired results — alleviation of poverty and greater equity — are not achieved, it would seem reasonable to question the efficacy of the unlimited growth (frontier economics) model of development. It is highly unlikely that actions based on this model will produce development that is sustainable in all three senses mentioned earlier: economically, ecologically, and socially.

Growth itself is not intrinsically bad; but it becomes bad, truly maladaptive in a biological sense, when it leads to the consumption of presumably renewable resources like forests (and all they contain) at rates much more rapid than those that would permit renewal or replacement.

Environmental Management Models

Colby distinguishes five models of what he calls the "management of the relationship between humans and nature" (1990b:5): frontier economics, environmental protection, resource management, eco-development, and deep ecology.[19] He argues that deep ecology — Boulding's (1971) "spaceship earth" model, developed as a reaction to frontier economics — Boulding's "cowboy" model, and that the other three models represent modifications of the two extremes that incorporate features of both. Although one might quibble about whether Colby's use of the term "paradigm" is appropriately applied to these models, his characterization of them is useful in any attempt to understand the possible consequences of the application of one or another to the development planning and implementation process. However, the contrasts he draws between the resource management and eco-development models seem particularly arbitrary and questionable. These models are currently espoused by some individuals and groups. A table from Colby 1990b is included here for the convenience of the reader.

The 10 dimensions that Colby uses to distinguish the five models can be grouped as **value orientations** (dominant imperative, human-nature relationship, dominant threats, main themes, and fundamental flaws) and resulting **adaptive strategies** (prevalent property regimes, who

TABLE 2.1 Basic Distinctions Between Five Paradigms of Environmental Management in Development ©M.E. Colby, 1990

Paradigm> Dimension	Frontier Economics	Environmental Protection	Resource Management	Eco-Development	Deep Ecology
Dominant Imperative:	"Progress," as Infinite Economic Growth and Prosperity	"Tradeoffs," as in Ecology versus Economic Growth	"Sustainability" as necessary constraint for "Green Growth"	Co-developing Humans and Nature; Redefine "Security"	"Eco-topia": Anti-Growth "Constrained Harmony with Nature"
Human-Nature Relationship:	Very Strong Anthropocentric	Strong Anthropocentric	Modified Anthropocentric	Ecocentric ?	Biocentric
Dominant Threats:	Hunger, Poverty, Disease, "Natural Disasters"	Health Impacts of Pollution, Endangered Species	Resource Degradation; Poverty, Population growth	Ecological Uncertainty Global Change	Ecosystem Collapse "Unnatural" Disasters
Main Themes:	Open Access/Free Goods Exploitation of Infinite Natural Resources	Remedial/Defensive "Legalize Ecology" as Economic Externality	Global Efficiency "Economize Ecology" Interdependence	Generative Restructuring "Ecologize Social Systems" Sophisticated Symbiosis	Back to Nature "Biospecies Equality" Simple Symbiosis
Prevalent Property Regimes:	Privatization (Neoclass.) or Nationalization (Marx.) of all property	Privatization Dominant; Some Public Parks set aside	Global Commons Law (GCL) for Conservation of: Oceans, Atmosphere, Climate, Biodiversity?	GCL + Local Common & Private Property regimes for Intra/Inter- Generational Equity & Stewardship	Private, plus Common Property set aside for Preservation
Who Pays?	Property Owners (Public at Large: esp. Poor)	Taxpayers (Public at Large)	"Polluter Pays" (producers & consumers) (Poor)	"Pollution Prevention Pays" Income-index Envir. Taxes	Avoid costs by foregoing development
Responsibility for Development & Management	Property Owners: Individuals or State	Fragmentation: Development decentralized Management centralized	Toward Integration across multiple levels of gov't. (e.g., fed./state/local)	Private/Public Institutional Innovations & Redefinition of Roles	Largely Decentralized but integrated design & mgmt.
Environmental Management Technologies and Strategies:	Industrial Agriculture: High Inputs of Energy, Biocide, & Water; Monocultures, Mechanized Production Fossil Energy Pollution Dispersal Unregulated Waste Disposal High Population Growth "Free Markets"	"End-of-the-Pipe" or "Business as Usual Plus a Treatment Plant" Clean-up. "Command and Control" Market Regulation: Some Prohibition or Limits, Repair, & Set-asides. Focus on Protection of Human Health, "Land Doctoring" Envir. Impact Statements	Impact Assessment & Risk Management, Pollution Reduction, Energy Efficiency, Renewable Resource/ Conservation Strategies, Restoration Ecology, Population Stabilization & Technology-Enhanced Carrying Capacity, Some Structural Adjustment	Uncertainty (Resilience) Management, Industrial Ecology/Eco-Technologies, e.g: Renewable Energy, Waste/Resource Cycling for Throughput Scale Reduction, Agro-forestry, Low Input Agriculture, Extractive Forest Reserves Population Stabilization & Enhanced Capacity as RM	Stability Management Reduced Scale of Mkt Economy (Inc. Trade) Low Technology Simple Material Needs Non-dominating Science Indigenous Tech. Systems "Intrinsic Values" Population Reduction
Analytic/ Modeling and Planning Methodologies:	Neoclassical OR Marxist Closed Economic Systems Reversible Equilibria, Production Limited by Man-made Factors, Natural Factors not accounted for. Net Present Value Maximization Cost-Benefit Analysis of tangible goods & services	Neoclassical Plus: Environmental Impact Assessment after Design; Optimum Pollution Levels Equation of Willingness to Pay & Compensation Principles	Neoclassical Plus: Include Natural Capital. True (Hicksian) Income Maximization in UN System of National Accounts; Increased, Freer Trade Ecosystem & Social Health Monitoring; Linkages between Population, Poverty, & Environment	Ecological Economics: Biophysical-Economic Open Systems Dynamics; Socio-Technical & Eco-system Process Design; Integration of Social, Economic, & Ecological Criteria for Technology; Trade & Capital flow regulation based on Community Goals & Mgmt; Land Tenure & Income Redistrib.; Geophysiology?	Grassroots Bioregional Planning Multiple Cultural Systems Conservation of Cultural & Biological Diversity Autonomy
Fundamental Flaws:	Creative but Mechanistic; No awareness of reliance on ecological balance	Defined by F.E. in reaction to D.E.; Lacks vision of abundance	Downplays social factors Subtly mechanistic; Doesn't handle uncertainty	May generate false security Magnitude of changes require new consciousness	Defined in reaction to F.E. Organic but not Creative How reduce population?

Frontier Economics (F.E.) Environmental Protection (E.P.) Resource Management (R.M.) Eco-Development (E.D.) Deep Ecology (D.E.)

pays?, responsibility for development and management, environmental management technologies and strategies, and analytic modeling and planning methodologies). The fundamental-flaws dimension is partly a characterization of the models and partly the researcher's overall assessment of the utility of each model.[20]

It will be sufficient for our purposes to briefly characterize only the extremes of Colby's continuum of environmental management models, the frontier economics model and the deep ecology model. We shall do this in our own framework, which in some ways is an adaptation of Colby's and in other ways is a departure from it (see Figure 2.2).

The frontier economics model has dominated western civilization's development and expansion, explicitly or implicitly, at least since the beginning of European expansion in the fifteenth century. However, it was not until the sharp world population increase of the twentieth century and the concentration of economic development efforts in tropical countries (often implemented via inappropriate temperate zone technologies) following World War II (largely funded by temperate zone countries) that the magnitude of ecological devastation resulting from the application of this model began to be realized. The frontier economics model sees the role of humans as one of ever-increasing domination and control over nature. Resources are viewed as unlimited for all practical purposes and progress is equated with infinite economic growth.

FIGURE 2.2. VALUE ORIENTATIONS AND ADAPTIVE STRATEGIES OF FRONTIER ECONOMICS AND DEEP ECOLOGY

DIMENSIONS AND FEATURES	CONCEPTUAL MODELS	
	FRONTIER ECONOMICS	DEEP ECOLOGY
Value Orientations		
View of growth:	Economic growth = progress = well-being	Anti-growth = harmony with nature = well-being
Human-Nature rel:	Domination & control of nature	Humans part of nature, like any organism
System view:	Deterministic, mechanistic, equilibrium	Deterministic, organic whole, equilibrium
Resources:	Infinite–unlimited growth possible	Finite–return to simpler life necessary
Technology:	The ultimate solution to all problems	A limited solution;creates problems if misapplied
Adaptive Strategies		
Technology:	High technology solutions, e.g., heavy use of chemicals in farming, nuclear energy	Low technology solutions, e.g., organic farming
Economy:	Emphasis on capital intensive, high energy, centralized, profit maximization; natural resources as free goods or undervalued	Emphasis on labor intensive, low energy, decentralized (but integrated), maximization of ecosystem stability, natural resources have intrinsic value
Human population:	High growth rates acceptable; technology will compensate	Reduction of population needed now; zero growth later; technology not a solution
Planning & mgmt:	State and corporate emphasis	Grassroots emphasis
Resource control:	Mostly private (neoclassical) or all national (Marx)	Private for use plus common for preservation
Development costs:	Paid for by everyone, disproportionately by the poor	Forego development and avoid costs

The deep ecology model, also called the "spaceship earth" model (Boulding 1971) has been advocated since the late 1960s, and it has even been adopted as the basis for a new lifestyle by small groups. It has not been accepted anywhere as the basis for development planning. This is because its adherents tend to take an extreme conservationist position, often advocate a return to a technologically simpler style of life, and are avowedly antigrowth. The deep ecology model views humans as no different from other organisms in the ecosystem and believes the role of humans should be to live in complete harmony with nature. This model was defined, according to Colby (1990b:8), in reaction to frontier economics.

Human Ecology Models

Bennett (1976: 164ff and Figure 10) discusses five major approaches in human (or cultural) ecology: deterministic anthropogeography, possibilism, stewardian cultural ecology, cultural ecosystemicism, and adaptive dynamics (the last is his own model and that which we shall adopt). These are the approaches that Bennett sees as having influenced research and interpretation in anthropology (and to some extent in other fields) since the late nineteenth century.

Both anthropogeography and possibilism were based on linear-causal models. Anthropogeography saw the environment as the prime determinant or causal force that shaped culture. Possibilism saw culture as determining or causing human use of the environment. Neither of these models have any significant numbers of adherents today — at least in the field of anthropology.

Stewardian cultural ecology, the cultural ecosystemicism of early Geertz (as presented in *Agricultural Involution* 1963), and the adaptive dynamics model of Bennett all incorporate the notion of systemic processes (feedback). Steward's goal was to determine the extent to which similar cultural adaptations occur in similar environments; he viewed environment as limiting but not determining human behavior. He was not concerned with other aspects of feedback "such as the impact of technological activities on the natural environment or on human biology (Bennett 1976:166)."

Geertz's ecosystemicism sees human activities as either upsetting or maintaining natural phenomena, or creating new balanced environments. Geertz viewed culture and environment as interdependent and the system as a whole as always tending toward a state of equilibrium.

Bennett (1976, 1981) introduced the concept of **socionatural** systems as a way of referring to the complex interactions between humankind and nature; he uses **human systems ecology** (see also Smith and Reeves 1989) or simply **human ecology** to refer to the study of socionatural systems. Socionatural systems are those systems in which humans individually, and collectively, interact with other organisms and the physical environment of an ecosystem. Interactions also include those with other socionatural systems (Figure 2.3). His conceptual framework for pursuing understanding of socionatural systems he calls **adaptive dynamics**. It

FIGURE 2.3 SOME BASIC FEATURES OF A SOCIONATURAL SYSTEM

HUMANS:

MAKE CHOICES/DECISIONS, which have a system-wide impact on other organisms, the physical environment, other humans, and those making the choices.

ENGAGE IN PURPOSEFUL ACTIONS vis-a-vis the ecosystem.

LACK THE ABILITY TO FORESEE CONSEQUENCES of actions in all but trivial instances. This creates a lag between recognition (or presumption) of danger and corrective actions. "Humans have no reliable built-in sense of danger (Bennett 1976:245)" regarding the consequences of complex purposeful actions.

PERFORM ACTIONS THAT ARE GOVERNED BY VALUES (conceptions of the desirable) that vary culturally, and change through time as well as because of circumstances and context. (Like other organisms, humans also perform actions governed by biology.)

PERFORM ACTIONS THAT HAVE CONSEQUENCES FOR NATURAL PROCESSES, by which is meant processes that occur in nature without human intervention, such as erosion, precipitation, and organic decomposition.

INTERACT IN PURPOSEFUL, NONTRIVIAL WAYS WITH EACH OTHER. (They also interact in trivial ways.)

INTERACT IN PURPOSEFUL, NONTRIVIAL WAYS WITH NATURE.

NATURE:

CONSTRAINS HUMAN INTERACTION, but the limits are ultimate and absolute, not immediate. Short of total destruction of the global ecosystem, the limits to human action change as the ecosystem (and its subsystems) change, as technology changes, as perceptions of what constitutes a resource change (and our view of resources and their relative values changes in relation to technological change).

is precisely this sense of the purposeful decisions and actions of humans as interacting with and having consequences for varied and changing ecosystems that needs to be emphasized as part of the dominant conceptual framework of sustainable development.

Bennett's model includes a variety of systemic processes or feedback loops between human activity and natural systems and between human social systems. He emphasizes that adaptive dynamics contains an important element of possibilism not included in the systems approaches of Steward and Geertz: "the crucial role of human choice (and therefore, error) (Bennett 1976:166)." It is also clear that Bennett does not conceive of the adaptive dynamics model as an equilibrium model, although he reasonably argues that the socionatural systems may undergo periods of relative stasis.

Colby incorporates the Human-Nature relationship as one of the 10 dimensions of his environmental management models; anthropological approaches in human ecology, and especially the adaptive dynamics approach, focus on and elaborate upon this relationship.

Our model of a socionatural system contains finite resources (both nonrenewable and renewable), and the human variables of politics, policies, rules, laws, economics, technology, education, institutions, organizations, religious and moral judgements, incentives, implemented decisions, and their systemic consequences. A gross simplification of this model can be depicted as three interacting subsystems: the physical environment, nonhuman organisms, and humans and their cultures (see Figure 2.4).

We need to constantly remind ourselves, as we attempt to devise strategies for development that are sustainable over the long term, that **all** of our actions (and inactions) have ecological consequences. Insofar as possible, and realizing that there is much that we do not yet know about the functioning of Earth's ecosystems, we need to predict the consequences (realizing that the predictions are probabalistic at best) in both the short term and the long term before deciding whether or not we should take particular actions. We have generally been successful in ascertaining in advance the short-term consequences of relatively small-scale actions — in determining, for example, the economic costs and benefits of clearing a relatively small patch of forest and establishing pasture. We have been considerably less successful (some would say unsuccessful) in determining long- (or even medium-) term consequences of the same actions. In discussions about how to achieve sustainable development, questions of scale have been largely ignored. What, for example, might be the difference in long-term ecosystemic consequences of clearing 50 contiguous hectares of tropical forest or 500,000?

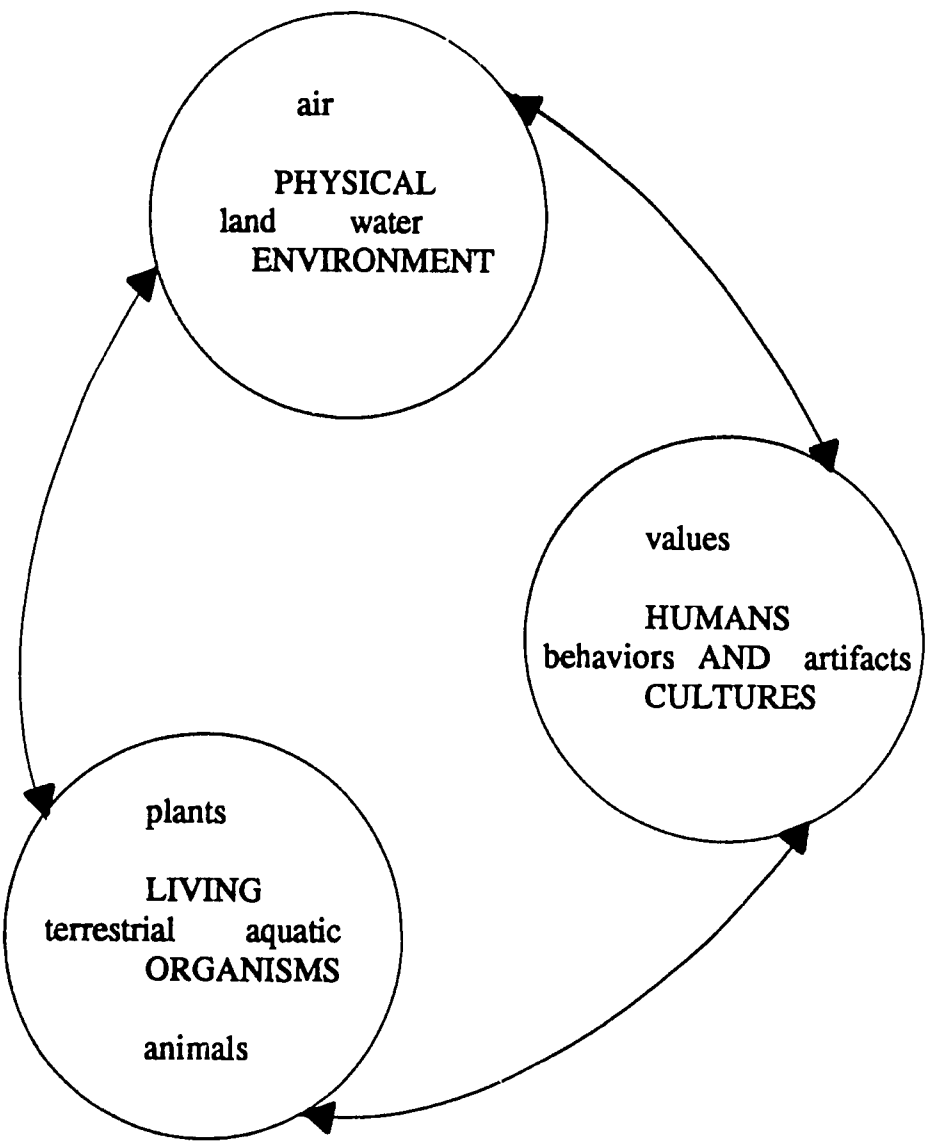
Accumulated Knowledge

The late twentieth century has witnessed enormous advances in scientific knowledge and technology. Our understanding of nature and of ecosystems, particularly tropical ecosystems, although still far from complete, is vastly broader and deeper than it was 50 or even 20 years ago. Unfortunately, whether out of ignorance, indifference, or resistance based on outmoded

western cultural values, much of this new knowledge is not being incorporated into the planning process for sustainable development of fragile — or any other — lands. As Mostafa Kamal Tolba, Executive Director of UNEP has said:

> While interest in environmental issues has increased, commensurate advances in agreement on how to operationalize the concept of environmentally sound and sustainable development have not taken place (quoted in Biswas, Khoshoo, and Khosla, eds. 1990:vii).

FIGURE 2.4. SIMPLIFIED MODEL OF A SOCIONATURAL SYSTEM



Achievement of the elusive goal of sustainable development will depend greatly upon the extent to which relevant accumulated knowledge is used by those responsible for the decisions that guide courses of action for whole countries and regions; it will depend upon the willingness of decision makers to accept and act upon a set of values and assumptions about humankind's relationship to Earth that includes the idea of controlled growth. The new view will, of necessity, be a long-term view — one in which it is quite possible that a disproportionate share of the costs will have to be borne by this generation and those of the near future and a disproportionate share of the benefits will accrue to mid- and distant-future generations. But, if we do not adopt this view and pursue courses of action dictated by it, there may simply be no benefits in the future for there may be no future for humankind.

We believe that DESFIL field activities, research, and the chapters in this volume are a step in the direction of operationalizing sustainable development of fragile lands.

Humans make use of an ingenious variety of adaptive techniques — a cause for optimism. But serious questions remain. Are some processes, such as population growth, already out of control? Can or will humans always act in time to avert catastrophes? Bennett (1976:155, note 17) notes the increasing rigidity of institutional systems, clearly a cause for pessimism. That the resources of our planet are finite, that renewable resources are renewable only so long as the appropriate ecological and social conditions for renewability are maintained — these are facts that have long been available.

It is time that we based our actions on a new model of development, one whose assumptions reflect existing knowledge and realities that are commensurate with long-term sustainability. We can no longer afford to think in terms of one kind of sustainability or another, in terms of economic or agricultural or environmental or ecological sustainability. The sustainability of human life for the future is dependent upon our ability to achieve a general sustainability in our utilization of resources (among other things). We cannot achieve one kind of sustainability at the expense of others. We must realize that sustainability itself will be a moving target, subject to the uncertainties inherent in an ever-changing global ecosystem, and we must be prepared to make adjustments in our resource use when necessary. In terms of spans of time that are both comprehensible and significant to humankind, the sustainable management of Earth's resources must be our imperative.

SUSTAINABLE MANAGEMENT OF FRAGILE LANDS

Solutions to the fragile lands problem will require intelligent resource management. As Botkin points out,

> The rate of use of a resource cannot be increased forever, so in realistic terms a sustainable development must lead through a period of increasing rates of use of a resource to a range of levels that is not exceeded (1990:156).

In some cases, this will involve the improvement through technological innovation of existing patterns of human use (Chapter Three). Institutional strengthening will often be required (Chapter Four). Radical changes in human use patterns may be necessary, for example, from agriculture to protected reserve or natural forest management (Chapter Nine). Local stewardship of resources will be required in many cases to achieve sustainability (Chapter Five). And environmental education at all levels of society will greatly facilitate the process of implementing sustainable forms of management (Chapter Eleven).

Above all, intelligent resource management will require a conceptual framework in which we humans view ourselves as stewards of Earth's resources, not simply as exploiters of them.[21] This simple-sounding perceptual adjustment will not be easily accomplished. It involves a profound shift from a long-standing, culturally ingrained view of the human-nature relationship as one of control and domination to an innovative (but not without historical precedent) conceptual model of human interdependence with the other organisms of the planetary ecosystem and human ethical responsibility to act as stewards. If it occurs, this shift will, we believe, represent a true paradigm shift.

The scientific knowledge upon which a dynamic ever-changing view of ecosystems, and for that matter the entire physical universe, is based has been accumulating since the early decades of this century. Bennett (1976), in analyzing socionatural systems, refers to the model as an adaptive dynamics model. Others have referred to the same (or a very similar) model as a dynamic systems model (Capra 1982, Botkin 1990), a far-from-equilibrium model (Prigogine, as cited in Capra 1982), or a chaos model (Gleick 1987). This model has been accepted by some in such fields of science as anthropology, biology, chemistry, physics, and ecology. But it is not yet the model upon which the majority of humanity, at least in the western world, bases its behavior. The paradigm shift is yet to occur.

When the DESFIL project began, a conceptual framework of adaptive dynamics had not been clearly articulated. However, it was present implicitly in the design of the project and its mandate. As research and field experiences accumulated, a dynamic systems model as the starting point for fragile lands interventions became increasingly explicit (Figure 2.5). For example, the application of the Holdridge Life Zone Classification to the problems of land use planning in Ecuador (Hanrahan and Pereira 1989) represents an "art of the possible" approach within this framework. The development of recommendations for policy formulation and environmental management strategies in Honduras (Daugherty, ed. 1990) is based on the notion of resource stewardship, not domination and exploitation. It is clear from DESFIL evaluations that projects like the Agroforestry Outreach Program in Haiti (DESFIL 1990), the On-Farm Water Management Project in the Dominican Republic (Hanrahan et al. 1990), and the Hillside Agriculture Project in Jamaica (Koehn, Tai, and LeFranc 1989) — projects that incorporate

FIGURE 2.5 ELEMENTS OF A CONCEPTUAL MODEL OF SUSTAINABLE DEVELOPMENT

* Sustainable development occurs within the context of a hierarchy of ecosystems.

* Ecosystems are dynamic: temporary stasis is possible but the system does not tend toward equilibrium nor order; change is always taking place, but at a highly variable rate.

* Relations between and among elements in a system may be linear or nonlinear; in an ecological system they are more likely to be nonlinear and this greatly decreases predictability and increases uncertainty and complexity.

* Exogenous perturbations produce repercussions throughout the ecosystem; such repercussions are measurable but only probabilistically predictable.

* Resources exist in finite quantity.

* Some resources are nonrenewable; their quantity continually decreases through use, eventually to the point where cost to harvest them exceeds their value.

* Some resources are renewable; their quantity fluctuates with use but continual depletion does not occur as long as the systemic conditions for renewability are maintained.

* Purposeful manipulations of system variables (directed change) to achieve desired goals (development) must be periodically adjusted to account for risk, uncertainty, complexity, and unintended and undesirable consequences of previous manipulations.

* Sustainability is determinable only for finite periods of time; not for indefinite periods of time.

* Even for finite time periods, sustainability is probabilistic; as length of time period decreases, probability of predicting a sustainable (or an unsustainable) outcome increases.

notions of stewardship and the flexibility required to deal with uncertainties — are the more successful projects. The same notions underlie actions recommended by DESFIL, for example, in developing a strategy for natural resource management in El Salvador (Daugherty and Sherrill 1990) or in dealing with general themes such as watershed management (Dickinson and Tracy 1989). Although perhaps less evident in some of DESFIL's work, the adaptive dynamics model has been implicit, given that our goal has been to develop **sustainable** systems for fragile lands use.

After much thought about DESFIL's work and experiences and a review of current scientific literature in various fields, we conclude that development models that assume that unlimited economic growth is possible are not viable models. Development interventions based on such models will not produce sustainable resource use on fragile lands. Growth-centered models have driven development in Latin America (and elsewhere) since the beginning of large foreign aid programs in the 1950s. It does not take a specialist to look upon the denuded and eroded slopes in Central America and the Andes and the deforested expanses in the lowlands to realize that something must be wrong with an approach that produces devastation instead of development.

Growth-driven expansion of resource use has not led to sustainable production over the long term; on the contrary, it has accelerated the degradation of fragile lands and the depletion of resources to the point where in some places the reversibility of the process is problematic. Two general and closely related measures are urgently needed to reverse the current trend of massive ecological degradation of the biosphere: we must protect supplies of resources and, in the case of some resources, reduce demand for them (Honadle 1989:15). A radical reorientation to the conceptual framework of adaptive dynamics, with its features of limited growth, stewardship, and adaptability in the face of uncertainty, is urgently needed. The sustainability-centered model of adaptive dynamics must be incorporated into policy decisions about development nationally, regionally and internationally.

Unfortunately, the staunch advocates of growth-centered development do not think that disaster is imminent or even that it will occur in the more distant future. They rationalize their view with the questionable assumption that our technology will continue to provide solutions that will forever pull us back from the brink of disaster. Implicit in technological solutions is the notion of increasing human control over nature. However, as Bennett notes:

> The body of accumulating knowledge on civilizational growth . . . testifies to the instability rather than the stability of large-scale socionatural systems and the increasing uncertainty, rather than control, resulting from technoeconomic growth (1976:147).

There are absolute physical limitations to arable lands and their inherent capabilities; and these limitations are far more severe on fragile lands. If we exceed these limitations too often and for too long, no amount of technology will make things right again.

Korten (1990:1) has characterized the 1980s as a decade of growing crisis, "of dehumanizing poverty, collapsing ecological systems, and deeply stressed social structures." The decade of the 1990s may well be our last opportunity to stave off or reverse the damage. Time is running out.

ENDNOTES

1. Hall and Day state that "A model of an ecosystem normally includes from a dozen to several hundred or even more simultaneous equations and they are as likely to be nonlinear as linear" (1977:9-10).

2. This is not to deny the utility of simple linear-causal models as aids to understanding of complex interactions within systems. Such models have predominated in all branches of science and, until the current computer age, have formed the basis for most of what we claim as scientific knowledge. It is also noteworthy, however, that much earlier "knowledge" has been superseded, and one cause-one effect relations are now considered — at least in biology, physics, and ecology — to be the rare exception in nature, rather than the rule, if in fact they exist at all.

3. Of course, there is variation in rates of change among systems, among variables within systems, and over time. Although all natural systems change, homeostatic processes may also be important in these systems. I thank Jaye Melchor for reminding me of this.

4. For example, in ecology: Botkin 1990, Goodland 1990, and Kormandy 1969; in economics: Boulding 1971, Brooks 1990, and Daly 1990; in anthropology: Bennett 1976, Smith and Reeves 1989; in biology: Ehrlich and Ehrlich 1990; and in physics: Capra 1982 (who cites Heisenberg, Bohr, and Bohm as also subscribing to this view).

5. Cynics may view this more as a trafficking in ideas among disciplines than as a convergence of thought.

6. The causes of species extinctions at the end of the Cretaceous are still not completely understood. There is no doubt, however, that human actions are the cause of the majority of species extinctions today.

7. In Latin America, for example, external debt totaled almost $400 billion in 1987, with Brazil's long-term debt equal to 29 percent of its GNP and Ecuador's a staggering 93 percent. In 1989, annual rates of inflation ranged from 3,700 percent in Argentina to a comparatively mild 60 percent in Ecuador (WRI 1990:36,39).

8. Korten (1990:3) points out that there are two basic flaws in the argument that growth will alleviate poverty: (1) existing economic and political structures channel most of the benefits of growth to the well-off, not to the poor; and (2) a continuation of current patterns of growth will reduce the ability of the global ecosystem to sustain even current levels of economic output.

9. Systems models also are not inconsistent with methodological tools such as logical frameworks, decision trees, and expert systems. A logical framework is a strategic planning tool for monitoring the accomplishment of a series of tasks within a project. Although the interaction of tasks as variables with other variables in the system, such as availability of labor, willingness to cooperate, weather conditions, and so on, may necessitate the alteration of the strategic plan, this does not negate the utility of having a plan. The logical framework is not intended to be an impact assessment tool, although periodic impact assessments using a variety of appropriate methodological tools are normally a part of the strategic plan.

Decision trees depend upon choosing variables and assigning values to them based on available knowledge; then choosing one variable as the dependent variable to begin the decision process. For example, an Andean farmer's decision about *where* to plant (dependent variable) may depend upon such independent variables as what plots are available to him, what he wishes to plant, what soil conditions will be optimal (which may narrow the available plot choices), and how much time he is willing to spend commuting to and from his field. (The distinction between a dependent and an independent variable is not always clear-cut [King 1969]. The same variable may appear in either role in different decision trees.)

Expert systems are computer programs that mimic human decision making within a circumscribed domain of knowledge. The knowledge base consists of facts and rules, usually of the if . . . then . . . variety, and fixed procedures for manipulating the facts and rules (Guillet 1989).

10. Moral, ethical, or aesthetic development is generally not considered to be a part of the development process by development agencies. Apparently, the expectation is that these other types of development, so important to concepts of well-being in some cultures, will just "happen" as economic development proceeds.

11. In the debt-ridden developing countries it is not clear that even the ideology, much less the practice, of sustainable development is being accepted in any but a few instances.

12. We use "rationalize" in the psychological sense of devising superficially plausible explanations or excuses for one's acts, beliefs, or desires. Rationalization is a form of self-deception. The curious thing about self-deception is that no one will (or perhaps can) admit to engaging in it and some will even attempt to rationalize the behavior of others to defend them against charges of self-deception. Many examples of this way of thinking exist. Alcoholics cannot be social drinkers although many believe they can. Smokers cannot quit any time they wish, but many say they can. We all have our own forms of self-deception. Fortunately, unlike the man who was convinced that he could fly, most forms of self-deception are harmless.

Engaging in self-deception might also be termed "acting irrationally." However, except for using the terms "rationalize" and "rationalization" in their psychological sense, it seems best

to avoid using the terms "rational" and "irrational" because they have special — and very different — meanings in the fields of psychology and economics.

13. This has become a standard way of rationalizing actions that disregard the rights of indigenous peoples.

14. Denevan defines as fragile "lands that are potentially subject to significant deterioration under agricultural, silvicultural, and pastoral use systems" (1989:11).

15. It is not necessary to agree with definitions offered, especially of slippery concepts like "fragile lands," but at least, if they are offered, the basis for analysis and interpretation is made more clear.

16. Unfortunately, the phrase continues to muddle our conceptual models. In an otherwise excellent discussion of the role of voluntary organizations in development, John Clark (1990) repeatedly speaks of "sustainable growth."

17. We refer to minimal life support needs rather than use the phrase "basic needs" more common in the literature (for example, Streeten 1980, 1984) because there is not even any agreement on what constitute basic needs.

18. A global focus is often necessary to provide a proper perspective on conditions at the local level. Our understanding of what is happening globally will (or at least should) influence our interpretations of local conditions and our choice of actions we deem appropriate.

19. Colby 1990b contains a summary of the dimensions of these models; Colby 1990a contains an extended discussion.

20. In a later version of the table that displays the dimensions of the models (Colby 1991), three dimensions have been dropped: human-nature relationship, prevalent property regimes, and responsibility for development and management.

21. Although this statement may be seen as a value judgement not inherently linked to our scientific understanding of ecosystems, it is linked to our scientific understanding of human behavior.

REFERENCES CITED

Ack, B. L.
1991 Towards Success in Integrated Conservation and Development: Critical Elements in Design, Management, and Implementation. Wildlands and Human Needs Technical Paper Series No. 1. Washington, D.C.: World Wildlife Fund.

Belshaw, C. S.
1976 *The Sorcerer's Apprentice: An Anthropology of Public Policy*. N.Y.: Pergamon Press.

Bennett, J. W.
1976 *The Ecological Transition: Cultural Anthropology and Human Adaptation*. N.Y.: Pergamon Press.

Bennett, J. W.
1981 "Social and Interdisciplinary Sciences in U. S. MAB: Conceptual and Theoretical Aspects," in E. H. Zube, ed., *Social Sciences, Interdisciplinary Research and the U. S. Man and the Biosphere Program*, pp. 17-39. Workshop Proceedings Nov. 12-14, 1980. U. S. Man and Biosphere Program. Washington, D.C.: U. S. Dept. of State.

Biswas, A. K., T. N. Khoshoo, and A. Khosla, eds.
1990 *Environmental Modeling for Developing Countries*. London & N.Y.: Tycooly Publishing.

Botkin, D. B.
1990 *Discordant Harmonies: A New Ecology for the Twenty-first Century*. N.Y. & Oxford: Oxford University Press.

Boulding, K. E.
1971 "The Economics of the Coming Spaceship Earth," in J. P. Holdren and P. R. Ehrlich, eds., *Global Ecology: Readings Toward a Rational Strategy for Man*, pp. 180-87. N.Y.: Harcourt Brace Jovanovich, Inc.

Bremer, J., T. Babb, J. Dickinson, P. Gore, E. Hyman, & M. Andre
1984 Fragile Lands. A Theme Paper on Problems, Issues, and Approaches for Development of Humid Tropical Lowlands and Steep Slopes in the Latin American Region. Washington, D.C.: Development Alternatives, Inc.

Bromley, D.
1991 Sustaining the Global Commons: Environmental Policies Through International Cooperation. Report prepared for USAID S&T/RD. Washington, D.C.

Brooks, D.
1990 Beyond Catch Phrases: What Does Sustainable Development Really Mean? IDRC Reports, October: 24-25. (Reprinted in DESFIL Newsletter 4(4).)

Capra, F.
1982 *The Turning Point: Science, Society and the Rising Culture.* N.Y.: Simon and Schuster.

Clark, J.
1990 *Democratizing Development: The Role of Voluntary Organizations.* West Hartford, Conn.: Kumarian Press.

Colby, M. E.
1990a "Ecology, Economics, and Social Systems: The Evolution of the Relationship Between Environmental Management and Development." Ph.D. Dissertation, The Wharton School, University of Pennsylvania, Philadelphia.

Colby, M. E.
1990b *Environmental Management in Development: The Evolution of Paradigms.* World Bank Discussion Papers, No. 80. Washington, D.C.: The World Bank.

Colby, M. E.
1991 "Environmental Management in Development: The Evolution of Paradigms." *Ecological Economics* (forthcoming).

Daly, H.
n.d. Sustainable Growth: A Bad Oxymoron (ms).

Daly, H.
1990 Sustainable Development: From Concept and Theory Towards Operational Principles. *Population and Development Review* (in press).

Daugherty, H. E.
1990 *Perfil Ambiental de Honduras 1989.* Bethesda, Md.: Development Strategies for Fragile Lands Project, Development Alternatives, Inc.

Daugherty, H. E. and D. Sherrill
1990 Toward a National Strategy for Natural Resource Management in El Salvador: A Concept Paper. DESFIL Technical Report. Washington, D.C.: Development Alternatives, Inc.

DESFIL
1990 National Program for Agroforestry in Haiti, Vols. 1 & 2. DESFIL Technical Reports. Bethesda, Md.: Development Alternatives, Inc.

Dickinson, J. and F. Tracy
1989 Stream Corridors in Watershed Management. DESFIL Technical Report. Washington, D.C.: Development Alternatives, Inc.

Ehrlich, P. and A. Ehrlich
1990 *The Population Explosion*. New York: Simon & Schuster.

Geertz, C.
1963 *Agricultural Involution: The Process of Ecologcial Change in Indonesia.* Berkeley: University of California Press.

Gleick
1987 *Chaos*. New York: Viking Press.

Goodland, R., ed.
1990 *The Race to Save the Tropics: Ecology and Economics for a Sustainable Future.* Washington, D.C.: Island Press.

Goodland, R.
1990 "Environmental Sustainability in Economic Development--with Emphasis on Amazonia." In R. Goodland, ed., *The Race to Save the Tropics: Ecology and Economics for a Sustainable Future,* pp. 171-189. Washington, D.C.: Island Press.

Gow, D. D.
1989 Development of Fragile Lands: An Integrated Approach Reconsidered. In J. O. Browder, ed., *Fragile Lands of Latin America*. Boulder, Colo.: Westview Press, pp. 25-43.

Guillet, D.
1989 "Expert-Systems Applications in Anthropology." *Anthropological Quarterly* 62(2):57-58.

Hall, C. A. S. and J. W. Day, Jr.
1977 "Systems and Models: Terms and Basic Principles." In C. A. S. Hall and J. W. Day, Jr., eds., *Ecosystem Modeling in Theory and Practice: An Introduction with Case Histories*, pp. 6-36. N.Y.: John Wiley and Sons.

Hall, C. A. S. and J. W. Day, Jr., eds.
1977 *Ecosystem Modeling in Theory and Practice: An Introduction with Case Histories.* N.Y.: John Wiley and Sons.

Hanrahan, M. and J. Pereira
1990a Manejo de la zona del Gran Sumaco Provincia del Napo, Ecuador. DESFIL Technical Report. Bethesda, Md.: Development Alternatives, Inc.

Hanrahan, M., B. Lynch, W. McAnlis, and J. Wolf
1990b Evaluation of the On-Farm Water Management Project in the Dominican Republic. DESFIL Technical Report. Washington, D.C.: Development Alternatives, Inc.

Haviland, W. A.
1990 *Cultural Anthropology, 6th edition.* Chicago: Holt, Rinehart and Winston, Inc.

Holdren, J. P. and P. R. Ehrlich, eds.
1971 *Global Ecology: Readings Toward a Rational Strategy for Man.* N.Y.: Harcourt Brace Jovanovich, Inc.

Honadle, G.
1989 "Putting the Brakes on Tropical Deforestation: Some Institutional Considerations." A discussion paper prepared as part of the Tri-Directorate Initiative on Deforestation; prepared for the Office of Rural and Institutional Development, Bureau of Science and Technology, United States Agency for International Development, Washington, D.C.

King, L. J.
1969 *Statistical Analysis in Geography.* Englewood Cliffs, N.J.: Prentice-Hall, Inc.

Koehn, K. E., E. Tai, and E. LeFranc
1989 Process Evaluation of the Hillside Agriculture Project in Jamaica. DESFIL Technical Report. Washington, D.C.: Development Alternatives, Inc.

Kormondy, E. J.
1969 *Concepts of Ecology.* Englewood Cliffs, N.J.: Prentice-Hall, Inc.

Korten, D. C.
1990 *Getting to the 21st Century: Voluntary Action and the Global Agenda.* West Hartford, Conn.: Kumarian Press.

Kuhn, T. S.
1970 *The Structure of Scientific Revolutions, 2nd edition.* Chicago: University of Chicago Press.

Lewis, R.
1990 "Roderick Nash on America's Relationship to the Environment, A Coversation with Richard Lewis." *Oregon Humanities*, Winter, pp. 11-15.

Murray, G. M.
1983 Agroforestry Outreach: An Approach to Tree Planting in Rural Haiti. Port-au-Prince, Haiti: Pan American Development Foundation.

Overton, W. S.
1977 "A Strategy of Model Construction." In C. A. S. Hall and J. W. Day, Jr., eds., *Ecosystem Modeling in Theory and Practice*, pp. 49-73. NY: John Wiley and Sons.

Peck, R. and J. Bishop
1991 Agroforestación como Alternativa de Producción para Contrarrestar la Deforestación en la Amazonia Ecuatoriana. DESFIL Ecuador Forestry Sector Development Project Report. Quito, Ecuador.

Ramsey, J.
1971 "Wonderland Revisited." In J. P. Holdren and P. R. Ehrlich, eds., *Global Ecology: Readings Toward a Rational Strategy for Man*, pp. 143-146. Reprinted from *Sierra Club Bulletin* 54(10):10-13 (1969)

Smith, S. and E. Reeves
1989 "Introduction." In S. Smith and E. Reeves, eds., *Human Systems Ecology: Studies in the Integration of Political Economy, Adaptation, and Socionatural Regions*, pp. 1-18. Boulder: Westview Press.

Streeten, P.
1980 Basic Needs and Human Rights. *World Development* 8:107-111.

Streeten, P.
1981 *Development Perspectives*. New York: Saint Martins Press.

Streeten, P.
1984 Basic Needs: Some Unsettled Questions. *World Development* 12(9):973-978.

World Commission on Environment and Development
1987 *Our Common Future.* N.Y.: Oxford University Press.

World Bank
1988 *World Development Report, 1988.* Washington, D.C.: World Bank.

CHAPTER THREE

TECHNOLOGY FOR FRAGILE LANDS MANAGEMENT IN LATIN AMERICA

by

Gene C. Wilken

INTRODUCTION

Technology includes tools, procedures, materials, information, and experience — the hardware and software of resource management. It is not an end in itself, but a means of achieving objectives that may be determined as much by social as by environmental conditions. What is appropriate, or efficient, or even feasible is not an attribute of a particular technology, but instead depends on the situation at a particular place and time. From this perspective, the best technology to stabilize an eroding slope might be structural (for example, terraces), cultural (for example, perennial instead of annual crops), social (for example, cooperative conservation organizations), or institutional (for example, laws limiting tree cutting), or a combination of these. The technology could range from simple to complex, and from locally available to imported. With so many variables, choosing and introducing an appropriate technology requires a procedure — a technology of technology so to speak — to maximize chances for success.[1]

This chapter will concentrate on structural and cultural management technologies. A section on principles of degradation is followed by a review of degradational forms, management procedures, and the DESFIL experience in Latin America. A procedure for selecting appropriate technologies ends the chapter.

Populations in Latin America are projected to grow until well into the next century (UN 1988). Land distribution arrangements are slow to change, and the multiple underlying causes of fragile lands problems will persist for some time (Chapter One). The immediate objective is to develop management procedures to minimize degradation of fragile lands and other resources until population growth and other problems can be resolved. The development and application of appropriate technologies is one part of an interrelated set of procedures, including institutional strengthening, policy reform, incentives, and environmental education, that can be used to minimize degradation, potentially increase production, and contribute to the development of truly sustainable uses for fragile lands.

There are many possible objectives for rational management of fragile lands. Conservation to preserve not only soils but also vegetation, water, and biological and aesthetic

resources for present and future use, and production to meet demands from growing urban populations are high on any list of priorities, as are employment for rural populations and general economic development. Managerial approaches will differ depending on objectives, some of which may be in conflict. For example, although the best management for steep slopes is often nonagricultural use, this clearly runs counter to the production objectives of farmers. Establishing an acceptable economic balance is as critical as establishing slope or soil stability. This may be done by reducing costs through minimization of management (for example, nonagricultural production) or by increasing returns, which likely involves increased management.

Investments in land maintenance and conservation, whether in money or labor, are easily reckoned. For example, constructing contour strips or terraces requires a certain amount of materials and labor that must be provided or purchased. Such investments can have immediate, measurable conservation impacts such as reduced soil loss. But production returns from these efforts are not necessarily so apparent or immediately real. Table 3.1 compares yellow yam production on terraced, ditched, or mounded Jamaican fields with traditional, shifting cultivation. Over a four-year period, average production by traditional means was equal or even superior to the treated fields. One would expect that in future years production from treated fields would continue to increase or at least be maintained, whereas production from exhausted traditional plots would decline. But if labor investment and maintenance costs were included, it would be quite some time before farmers could economically justify terrace, ditch, and mound construction.

Ultimately the choice of technology, like the original choice to use fragile lands, is driven as much by economic and social needs as by ecologic considerations and trade-offs are always a factor in the choice. Ideally, the technology chosen should optimize the relationship among these three dimensions (economy, society, and ecology) to produce true sustainability.

The DESFIL Focus

The DESFIL program focusses on two categories of fragile lands in Latin America: steep slopes and humid tropical lowlands. Together, these account for about 35 percent of total land in the tropics in general but probably more in the American tropics (Morse and Ragland 1990). Although degradation of soil resources is a primary concern in both of these groupings, the *nature* of fragility is quite different in each. Steep slopes suffer physical loss of soil through mechanical processes of erosion. Tropical lowland soils also erode but, in addition, tend to lose fertility through hydro-chemical processes. Both types of fragile lands also lose nutrients via the export of harvested biomass. The role of vegetation is critical in both systems but for different reasons. The degradational processes and forms, and management technology, will be reviewed separately.

TABLE 3.1. PRODUCTION OF YELLOW YAMS FROM RUN-OFF PLOTS, JAMAICA (tons/ha/yr)

TREATMENT	YEAR 1	YEAR 2	YEAR 3	YEAR 4	AVG.
Bench terraces					
Total production	35.3	44.2	32.6	37.8	37.5
Salable yield	18.5	30.4	21.0	23.2	23.2
Ditches and contour mounds					
Total production	37.5	44.5	39.8	37.3	40.0
Salable yield	20.5	29.6	26.2	23.2	24.9
Ditches and hills					
Total production	43.2	47.2	37.1	35.3	40.1
Salable yield	24.9	33.3	25.2	23.5	26.7
Traditional method	56.3	53.1	33.1	26.4	40.0
Total production	31.6	37.8	22.0	16.8	26.9
Salable yield					

Source: Rankine 1976, from Sheng and Michaelson 1973.

PRINCIPLES OF FRAGILITY AND DEGRADATION ON SLOPES: SOIL LOSS

Much of Latin America is hilly or mountainous, and most of Latin America lies in the tropics or subtropics where temperatures support agriculture even at high elevations. Intermontane basins and adjacent hillsides have been centers of population since pre-European times (Table 3.2). The relationship has been interactive: fertile alluvial and volcanic soils in the basins and slopes provided the agricultural base to support dense populations, while urban demand encouraged intensive cultivation and development of production and conservation technology. Some ancient achievements, such as the elegant terrace and hillside irrigation systems of Peru and Mexico, are still unequaled as engineering solutions to farming steep slopes.

In the modern era, in response to demands for land by growing rural populations and for farm and forest products by burgeoning urban centers, previously unused hill lands are being pressed into service, or are being cultivated more intensively (Johnson 1983).[2] Many of these lands have poor soils or are distant from population centers.

TABLE 3.2. PROPORTIONS OF NATIONAL AREA, ARABLE LAND, AND POPULATION ON STEEP SLOPES IN TROPICAL AMERICA

COUNTRY	NATIONAL AREA	ARABLE LAND	NATIONAL POPULATION	AGRICULTURAL POPULATION
Colombia	40%	25%	15%	50%
Costa Rica	70	25	20	30
Dominican Rep.	80	15	15	30
Ecuador	65	25	25	40
El Salvador	75	40	30	50
Guatemala	75	30	40	65
Haiti	80	70	50	65
Honduras	80	15	15	20
Jamaica	75	50	15	30
Mexico	45	20	15	45
Panama	80	10	15	30
Peru	50	25	25	50

Source: From Posner and McPherson 1981.

Energy Sources for Degradation

Degrading fragile lands is work and like all work, requires energy. Wind and water are the main agents of erosion. The main forms of water-caused erosion are splash erosion from falling rain, sheet and rill erosion from surface runoff, and stream erosion.

Raindrop impact, a primary cause of soil loss, depends on falling speed (a function of drop size), and intensity (number of drops per unit of time). Runoff occurs when rain falls in greater total amounts or intensities than can be absorbed. The energy available for sheet erosion depends upon amount of water and speed of movement, a function of slope gradients. As surface runoff collects in tiny rills, then in ever-larger streamways, energy is concentrated and performs such in-channel work as gully erosion, bank cutting, and meander formation.

mass movement. Degradational energy is determined more by slope gradients and volume of material in motion than by earthquake magnitudes.

These energy sources are not mutually exclusive. Substrata lubricated by heavy rains are prone to slippage induced by earthquakes. Water erosion quickly attacks wind- or slide-deposited material. All occur within topographic, soil, and vegetational contexts that dramatically influence conversion of energy to work.

Measuring Available Energy

Strong winds or intense rains falling on steep slopes create high-energy surfaces where *soil detachment* and *transport* occur. Since these energy levels must be confronted by management, the first step in designing or evaluating technology is to measure the energy available for land degradation in a particular place. Data are often scarce, and it is helpful to identify the *minimum data* that must be gathered, and other information that can be derived or estimated (Wilken 1988, Byers 1990, Staver et al. 1990). Accounts of local farmers, woodsmen, and other land managers of the characteristics and dynamics of a particular place can be correlated with measured and derived data (USAID 1988, Wilken 1982).

Measuring Erosion

Soil erosion on slopes takes place in three steps: *Detachment*, *transport*, and *deposition*. Detachment and transport are forms of work that require energy. Deposition occurs when carrier (for example, water or wind) speeds and energy levels decline. Measurements of detachment and transport are usually combined, and associated with particular types of erosion. The rate and amount of erosion are products of available energy and characteristics of the eroding surface. Minimum data are obtained directly or indirectly (Byers 1990, Staver et al. 1990).

Measuring Surface Characteristics

The amount of work (erosion) performed on the surface by the various forms of introduced energy is determined in large part by characteristics of the surface itself. Soil particles on loose exposed surfaces require little energy for detachment and transport whereas those in structurally consolidated surfaces shielded and bound by vegetation resist. Thus, the important surface characteristics are soil properties and vegetation.

Although loss of soil usually receives the most attention, *in situ* changes in soil qualities, and impacts on productivity are of equal if not greater importance.

Calculating and Estimating with Minimum Data

Procedures for calculating or estimating and controlling erosion and deposition, and other aspects of fragility are abundant. For example, FAO's many Conservation Guides (14+) and Soils Bulletins (60+) provide an excellent library for soil and watershed management, including detailed treatments for specific conditions. Other manuals, guides, and studies offer results of field testing, and conservation methods suitable for small-farm, Third World conditions (for example, ASAE 1987, Coukis 1983, ILACO 1981, Luchok et al. 1976, Moldenhauer and Hudson 1988, Sheng 1986). Local land managers (such as farmers and woodsmen) can contribute valuable information on traditional management practices in particular regions.

MANAGERIAL OPTIONS IN SLOPE SYSTEMS

Over time, slopes establish states of conditional equilibrium in which soil losses are offset by soil formation. The four main factors of surface equilibrium are climate, slope, soil, and vegetation. Changes in one or more of these factors will upset the equilibrium and trigger system responses, of which erosion and deposition are most important. Changes in plant cover are most common and occur in response to climate changes but, more commonly, to human activities. Once slope equilibrium is disturbed, human management is necessary to reestablish equilibrium or counter system response.

Most human activities disrupt slope equilibrium by altering or destroying vegetation. Farmers remove native plants to create open, high-energy surfaces on which economic plants, most of which are heliophytic, will flourish. Loggers, charcoal makers, and herders remove the vegetation to realize its economic value. The economic value of soil stabilization provided by intact vegetation is often not perceived either by local resource users or policy makers. Maintaining vegetation requires prohibition or restriction of some human activities, developing systems that will permit farming and extraction in combination with protective vegetation, or developing alternative economic activities that are not based so directly on soil use.

Basic Approaches

There are two basic approaches to controlling erosion. The first is to reduce the amount of erosive energy at the surface by reducing the quantity or speed of the transporting media. The second is to decrease the soil's vulnerability to erosion.

Reducing Erosive Energy

Despite the inevitability of weather at the macro- and meso-scale, energy and mass transfers at the climate-surface interface can be managed to a considerable degree. For example, windbreaks and shelter belts introduce turbulence and reduce wind speeds. The impact of falling rain or hail is absorbed by vegetation canopies, or covers such as mulches or arbors. All of these reduce

the amount of energy transferred from atmosphere to surface and thus reduce detachment and transport of soil particles.

Once precipitation reaches the surface, overland and rill flows can be slowed or stopped by micro-topographic barriers such as ridges, dikes, and walls. Closely spaced strips of grasses and shrubs shorten slope length and reduce flow speeds. Slower runoff speeds provide more time for infiltration, which also reduces the amount of water available for overland flow. If the barriers include storage facilities, such as furrows, ditches, or ponds, infiltration times can be stretched out over days or even weeks. Terraces reduce erosive energy by replacing long steep slopes with short, less-steep gradients (although terrace faces are extremely vulnerable to erosion since they are steeper than original slopes). Channelized runoff is slowed with in-stream barriers, such as check dams or vegetation.

Increasing Surface Cohesion

The second approach attempts to increase surface cohesion so that more energy is required to detach and transport soil particles. The great surface binders in nature are the root systems of plants. In fact, the essential difference between geologic and accelerated erosion is whether surfaces are protected by vegetation. Management mostly is aimed at maintaining, restoring, or replicating natural plant covers, over whole surfaces, in strips on slopes and terraces, or in waterways. Other options, such as metal nets on slopes or stone or concrete bank lining to absorb erosive stream energy are expensive alternatives.

Countering Deposition

Deposition occurs when the speed of transport media (wind, water) decreases. It may be nearby, within a few millimeters by splash erosion, or in the same field by overland flows. If runoff is large and unimpeded, deposition will occur in stream channels (for example, sandbars), where it is subject to further detachment and transport (reentrainment). Eventually eroded material reaches a lake, reservoir, or ocean and is deposited as banks and deltas, or distributed as bottom sediments.

The same technologies for reducing erosion also induce deposition. Thus sediments are deposited in the furrows and ditches that slow or impound field runoff. In-stream check dams become silt-trap terraces. Occasionally stream speeds are accelerated to avoid deposition. This does not solve the deposition problem, but only transfers it to another location.

Most problems with deposition arise when sediments choke canals and drains, or reduce storage capacity of reservoirs. Since physical removal of sediments is expensive, the two most common managerial approaches are to reduce sediment contribution to hydrologic systems by reducing erosion, or to divert sediment-laden waters to stilling ponds.

ON-FARM TECHNOLOGIES

Many erosion control measures are relatively independent of scale, and apply equally well to large- and small-scale systems. Plant management is one of the most effective and also cost-efficient approaches to erosion control at any scale. Organic residues (mulches) and crop stubble (stover) shield soils from raindrop and hail impact and maintain soil-binding root systems. Inter- or poly-cropping, cover cropping, and minimum tillage practices produce dramatic reductions in soil losses. Overland flows are reduced by microrelief features, such as furrows or ridges, constructed during field preparation. Contoured vegetation barriers and drainage ditches are common, as are sloping or bench terraces or walls. The forms are identical regardless of scale, and differ only in extent, or in some cases types of tools used in construction.

Farmers usually are less concerned with sedimentation unless they are recipients of deposits brought from outside their farms by the hydrologic system, as happens during floods. Even then the situation is mixed. If stream-borne sediments are fertile and timely they may serve to rejuvenate soils as they do in the *pantles* of Tehuacán, Mexico (Wilken 1987).

Since most conservation procedures and structures require little in the way of external expertise or inputs, they are well within the technical and capital range of even the smallest-scale operation. In fact, farmers everywhere have developed a vast array of surface management techniques and apply them when incentives are adequate. As noted earlier, the critical question is whether returns justify the costs of building and maintaining these structures. Even here it is difficult to generalize. There are abundant examples of farmers devoting substantial amounts of time and labor to conservation efforts even without conclusive evidence that long-term economic benefits will justify the investments. This suggests that farmers may be attaching value to resources in ways not usually measured by economists. (Hanrahan, Chapter Six, discusses issues surrounding the measurement of economic value of natural resources.)

PRINCIPLES OF FRAGILITY AND LAND DEGRADATION IN THE HUMID TROPICAL LOWLANDS: FERTILITY LOSS

Nutrient Loss

Symptoms of soil loss are relatively easy to observe and diagnose, and an array of prescriptive structures and procedures is available. Furthermore, erosion processes are similar (but not identical!) everywhere and to a certain extent research and technology is transferable between latitudes. In contrast, the declines of organic matter and soil fertility that occur under the high temperature and precipitation regimes of the humid tropics are less visible, and perhaps less manageable. In addition, the degradation of lowland soils is distinctive to warm wet regions and has no counterpart in higher latitudes.

On the other hand, the two categories share some common principles. The system dynamics among surface, climate, and vegetation holds true for both environments. Similarly the concept of degradational work performed on high energy surfaces that must be countered by management holds true both for tropical slopes and for humid lowlands. In the case of soil loss, energy is expended in the work of detachment and transport. In nutrient loss, energy is used in chemical reactions and hydraulic processes. In either case, once natural controls are removed, the high atmosphere-to-surface energy transfers can be controlled only with correspondingly high levels of inputs and management.

Vegetation is critical in both soil and nutrient loss processes, although for different reasons. In the case of erosion, plants absorb the direct impact of falling rain and increase soil cohesion with root systems. In the humid lowlands, plants also shield the soil from intense rains and solar radiation and bind the surface with extensive root systems. But, in addition, lowland vegetation plays an offsetting role to the rapid loss of soil organic matter and nutrients.

In the tropics, prodigious, year-round cascades of solar energy flow through humid lowland ecosystems producing high temperatures, evaporation, and plant growth. Lowland forests have the highest rate of biomass production of any of the world's natural ecosystems, rivaled only by swamps and marshes (Whittaker and Lijkens 1975). (It requires commensurately high expenditures of management energy, in the form of labor or machinery, to control unwanted biomass production in the form of weeds.) The standing vegetation represents a huge storehouse of solar energy and nutrients that is gradually measured out as leaf and branch fall to the surface and shallow root zone. As was true on slopes, removing the vegetation disrupts an energetic equilibrium, and system stability becomes dependent on human management.

Measuring Available Energy

Compared to soil loss from slopes, the silent processes of oxidation and leaching in soils are not easily observed or measured. Much of the evidence is circumstantial, based on declining yields and patterns of farm abandonment in lowland tropical areas. Farmers experience reduced harvests and weed growth but cannot directly observe the causes. Most manuals (for example, FAO Soil Bulletin No. 60, 1989; Mohr et al. 1973; Sanchez 1976) are more concerned with management than measurement.

Rather than the mass transfers of soil loss, fertility loss in the humid lowlands is related to *in situ* chemical and hydrologic processes. High solar radiation values and surface temperatures accelerate chemical and biological activity. For example, the weathering potential of water increases five times between 10° and 30°C (Bridges 1978:25, Kalpagé 1974:21). Deep but infertile regoliths are common in the humid lowlands. High temperatures are conducive to rapid organic matter turnover and low soil humus content leading to low carbon-nitrogen ratios (Buckman and Brady 1969:147, 334-335; Kalpagé 1974:21).

Rapid decay of organic residues and release of bases maintain near-neutral soil reactions, which encourage the solubility of silica and retard those of iron and aluminum. With intense oxidation, Oxisols form and some (like laterites) will harden irreversibly if exposed to the atmosphere (Kalpagé 1974:31). Since temperature plays such an important role in the humid lowlands, it must be added to the list of minimum data needed for management.

MANAGERIAL OPTIONS IN LOWLAND SOILS SYSTEMS

Over time lowland soils establish states of conditional equilibria in which nutrient losses from the soil are offset by gains primarily from the vegetation. Reducing or removing the vegetation disrupts this cycle and also destroys a major store of nutrients in the system and the vegetative shield against radiation and precipitation. To achieve sustainable production, management must maintain or replicate these fertilizing, storage, and protecting functions.

Procedures for managing the fragile lands of the lowland humid tropics can be grouped into three general approaches. Each has its advantages and disadvantages.

First, original vegetation can be preserved by nondisruptive or minimally disruptive exploitation, for example, gathering, limited hunting, shifting cultivation, tourism, and controlled logging. Examples of procedures that take this approach and have both traditional and modern expressions follow.

- Preserve original vegetative cover. Traditional sacred or prohibited areas serve this function, although this may not be their culturally recognized function, as do modern protected forest and biosphere reserves.

- Develop alternative economic uses for tropical lowlands that use, but only minimally disrupt, the vegetation. Traditional hunting-gathering and collection of commercial products such as rubber, chicle, and medicinal and exotic plants serve this function, as do modern alternative systems that involve tourism, fishing, and sport hunting.

- Temporarily remove the vegetation from small areas, use available soil nutrients for agriculture until yields decline, then permit reforestation until soil-vegetation nutrient cycles are restored and the vegetation again holds significant amounts of nutrients in storage. Traditional shifting cultivation, a system that is sustainable but only under light population pressure, functions in this way. Modern equivalents, such as the *corridor* systems of Africa, are basically variations on shifting cultivation.

- Harvest trees only in small openings so that soil exposure and impoverishment, and loss of carbon storage are limited spatially, and native vegetation regenerates

quickly. This is approximately the pattern of traditional exploitation around small villages, and characterizes modern efforts to develop sustainable timber yields in tropical lowlands (Hartshorn 1989a, 1989b).

Second, original vegetation can be replaced with economic plants but with replication of forest structure and processes, for example, agroforestry systems and dooryard gardens. The following is a procedure with both traditional and modern expressions that takes this approach.

- Establish some combination of permanent standing vegetation and annual crops, preferably in proportions that approximate the original vegetation structure and biomass production levels. Traditional multistoried dooryard or village gardens and some modern agroforestry systems function in this way.

Third, the original vegetation system can be completely converted and human management substituted for natural ecosystem processes, for example, plantations, pastures, or flooded rice. Some procedures that take this approach follow.

- Add organic or chemical soil amendments to replace those no longer supplied by the vegetation. Since these amendments are rapidly lost in the high precipitation and temperature regimes of the lowland tropics, additions must be continuous, targeted spatially, or timed to coincide with plant demand and uptake for sustained production. This is the principle behind traditional intensive mounded and raised field systems and modern plantation agriculture. Input supply is a major obstacle. Attempts to match the high rates of exchange in tropical soil-vegetation systems can exhaust local sources of organic materials, or require heavy applications of costly, externally supplied chemical amendments. Efficiency may be increased through the selection of high value, low volume crops to minimize nutrient export.

- Replace original forest vegetation with some other protective cover, such as grass. This is only a partial solution. Although grass covers shield the soil from solar radiation, precipitation impact, and runoff, they do not take up nutrients from deep soil layers, and hold relatively minor amounts of carbon in storage. This is the principle behind modern cattle pastures. Since there were no large grazing animals in the American tropical lowlands, there are no traditional forest-to-pasture grass conversion systems. (Artificial savannas may have been created by shifting cultivators, and hunters firing forests to create favorable habitats for game.)

- Completely alter plant environments by removing native vegetation and leveling surfaces; establish total control over water and nutrients. This is the principle behind traditional and modern versions of flooded rice cultivation. Nutrient and moisture cycling and natural soil fertility are of secondary importance. Instead,

the emphasis is on management of field water levels and organic and inorganic soil amendments.

The first two approaches rely more on natural energy and nutrient fluxes; the third uses higher levels of inputs and management. The advantages of the first two are that soil fertility is maintained with minimum disruption and cost, as is biodiversity. The advantage of the third is that production is higher and enterprise options (for example, types of crops or animals) are greater.

The disadvantages of the first two approaches are that many of the systems proposed have yet to prove to be economically viable under modern conditions of high demand, nor have they demonstrated the ability to support agricultural and agro-industrial systems capable of providing employment and income to growing populations. The disadvantages of the third approach are that input and management costs are high, as are risks of resource degradation and ecosystem failure, which limits the feasibility of the approach to certain lands.

Low-input approaches are currently in favor with many groups, largely because they seem less damaging to sensitive fragile environments. For example, in the volume edited by Browder (1989), the papers dealing with lowland humid tropics concentrated on gathered products and lightly managed forests (Alcorn 1989, Anderson and Jardim 1989, Prance 1989, Schwartzman 1989), shifting cultivation and associated agroforestry (Hiraoka 1989, Padoch and de Jong 1989), wildlife management (Nations and Coello Hinojosa 1989), traditional forms of sustainable agriculture (Hecht 1989), and sustained timber yields (Budowski 1989; Hartshorn 1989a, 1989b; Reiche 1989). All stress the ecologic virtues of low-input systems. It is less certain that they offer economic solutions to future exploitation of tropical lowlands.

THE DESFIL EXPERIENCE

With this brief comparison of principles of soil and nutrient loss and managerial alternatives, we turn to a review of the DESFIL experience. DESFIL's original terms of reference were exceedingly broad: to improve ways of addressing fragile lands issues at the policy, strategy, planning, design, and implementation levels (Gow 1989, Plunkett 1987). Although not specifically charged with developing or disseminating technology for fragile lands management, several DESFIL reports devote considerable space to methods and technology.

Seventeen reports completed by or associated with the DESFIL project provide a guide to DESFIL experience.[3] The reports were reviewed and placed in the following categories:

Category	No. of Pubs.
General	2
Methodology	3
Project/Program Review/Evaluation	8
Biodiversity	2
Research	1
Other	1
Total	17

The two papers on biodiversity were project reviews or evaluations but were given separate recognition because of their distinct topic. Two of the papers, the DAI theme paper by Bremer et al. (1984) and the draft report by Hartshorn (1989a) are technically not DESFIL publications.

Geographical coverage of the 17 documents does not necessarily reflect severity of fragile lands problems in Latin America but rather DESFIL response to expressed need from USAID missions.

The DESFIL reports by Staver et al. (1990) and Byers (1990) and a research report by Hartshorn (1989a) contribute most to the discussion of technology for managing steep slopes. Staver et al. (1990) summarize soil loss and sedimentation processes (pp. 9-11) and review procedures for relating climate and soil to erosion. A decision-tree approach (p. 26; also suggested by Bremer et al. 1984:xi; 97-98) and list of techniques for measuring erosion rates and consequences (pp. 76-77) outline a procedure that, if developed, could be helpful for prescribing appropriate technology for fragile lands management. Byers (1990) assesses measurement methods, strategies, and data availability on erosion processes in three countries (Dominican Republic, Ecuador, and Honduras). None of the papers attempts a comprehensive inventory of technology for soil loss management.

Hartshorn's (1989a) paper on forest regeneration in Peru is the only one to offer research results of a promising technology. Hartshorn found that forests in the central *selva* region of Peru regenerated quickly and profusely in narrow, clear-cut strips, and proposes this as a technology for sustainable tropical lowland forestry. The study is limited to the Peruvian experience and does not review the various clear- and selective-cutting experiments that have been conducted elsewhere.

TECHNOLOGY FOR FRAGILE LANDS MANAGEMENT

Suggested Procedure

A procedure for technological support of fragile lands program planning and project design should respond to the following questions:

1. What is the problem?
2. What is the magnitude of the problem?
3. What are the causal factors?
4. What are the relevant social factors?
5. What are the relevant institutional factors?
6. What solutions are available?
7. What are the best technologies for solving the problem?

1. What is the problem?

This apparently simple question masks some complexities. In slopes, the most common answer is erosion. Yet erosion per se is seldom the essential issue. Rather it is the effects of erosion, such as decline of agricultural productivity or sedimentation of streams or reservoirs, that is of concern (ASAE 1985). Although erosion and its consequences are closely related, interventions and monitoring procedures may be quite different depending upon problem identification. For example, erosion-induced decline in soil fertility might be countered by either soil conservation or fertility enhancement. As Bremer et al. (1984:55) point out, the best technology may not be the one that minimizes soil loss, but instead the one that most economically limits degradation.

Similarly, conservation projects commonly report number of trees planted as a measure of progress (for example, Byers 1990). Undeniably, trees, erosion, and productivity are linked. But more accurate measures would include harvest records or stream sediment loads to indicate whether reforestation was actually achieving its true objectives.

Problem identification is further complicated by participant perspective. Progressive loss of hillside forest cover may represent a dwindling source of fuel or income to local residents. Conservationists may be concerned with destruction of wildlife habitat. Project managers may focus on accelerated erosion and sediments clogging reservoirs. It is difficult to imagine a fragile lands problem or solution that is not subject to many differing interpretations, some of which are likely to be contradictory.

2. What is the magnitude of the problem?

Staver (1990:10) gives this question primacy:

> The first question is, how much erosion is occurring? While visual evidence of past and current erosion may be abundant, actual in-country data are usually scarce. Based on a small and often contradictory data base, identification of priority regions and the choice of conservation methods is also subject to debate; discussions can easily turn subjective and emotional. . . . In the absence of reliable data, landscape appearances and informed opinions have often formed the basis of watershed management policy, sometimes resulting in significant misdirection.

As mentioned earlier, it is helpful to identify minimum data for determining actual and potential erosion and factors that contribute to fertility loss. Procedures for estimating and measuring soil losses are abundant in the literature, with the usual caveat that most apply to the mid-latitudes. Procedures for monitoring fertility losses under tropical conditions are scarce.

3. What are the causal factors?

There is little disagreement on the physical processes of soil and fertility losses. But destabilization of slopes or soil-vegetation equilibria usually is a result of human activities that are subject to quite different interpretations. Are forests being destroyed by displaced farmers and, if so, is it because of population growth, inequitable land distribution, or poor government colonization policies? Are lumber companies doing the major damage and, if so, are they driven by corporate greed, lack of effective supervision and control, or policies of a government desperate for foreign exchange (Hecht 1989; Raloff 1988; Repetto 1990)? There is major disagreement on sources of sediments now threatening reservoirs in the Tavera-Bao region of the Dominican Republic, and thus also on corrective measures (Byers 1990:15-17). Choosing effective solutions and technologies depends in large part on correctly determining causal factors.

4. What are the relevant social factors?

In this important step, economic, social, and cultural factors are reviewed. The list of possibilities is lengthy and can only be suggested here. Perhaps the first step is to determine whether **any** technology has a reasonable chance of being cost-effective. That is, will proposed procedures generate high enough returns to justify the investment? Even if conservation is foremost, can production methods be added that will enhance local incomes? If not, or if returns will be delayed, then it is doubtful they will be initiated or maintained without initial and continuing subsidies, which have their own troubled history (Bremer 1984:45 ff.).

Examination of land tenure is essential, not only to determine immediate cost-bearers and beneficiaries of land management, but also to anticipate opposition based on locally perceived threats to loss of rights. Fortmann and Riddell (1985) discuss "bundles of rights" associated with tenure, and comment that land management, especially forest protection and reforestation projects, almost always changes patterns of rights and produces winners and losers who have quite different perspectives. Gamman (1990) has shown how failure to involve all stakeholders in project design and implementation generally results in serious problems if not outright failure of projects. The DESFIL experience has shown that early involvement of local resource users in project design and government willingness to clarify tenure arrangements and institute policy reforms will go a long way toward defusing opposition and achieving the local cooperation necessary to successful management of fragile lands. Perhaps these are not new lessons, but it seems that they have not been learned very well by either developing country governments or donor agencies.

Other important social data include size and availability of the labor pool for system maintenance; traditional gender roles, especially if women are to be involved; history of amicable or hostile relationships between villages; farm size, and relationships between small-scale and large-scale farmers or ranchers; and past good or bad experiences with earlier management efforts ("We tried that 10 years ago and it didn't work").

Appropriate technology is a much-discussed issue. The phrase has come to mean technology that is "decentralized, small in scale, labor intensive, amenable to mastery and maintenance by local people, and harmonious with local cultural and environmental conditions" (Shaikh 1981). The concept is so ill defined as to be almost useless, and is based largely on ex post facto accounts of failed technology transfers. Clearly, there are technologies that are poor (that is, inappropriate) means for achieving certain ends. But they are often inappropriate in relation to specific objectives and not because of inherently inappropriate characteristics.

Many conservation technologies fit Shaikh's description of "small in scale . . . harmonious with local cultural and environmental conditions," or are divisible into components that do. Production technologies have a greater chance of being inappropriate than conservation technologies if only because there is a greater range of fossil fuel and chemical alternatives for production.

5. What are the relevant institutional factors?

Most of the fragile lands in Latin America are managed by small-scale farmers or foresters without benefit of government intervention. Assessing how problems are identified and solved locally is a logical starting point for project design.[4] Thus an early priority is to understand traditional management technology, including local institutions involved with land management. Village organizations, land allocation systems, intervillage ties, and local formal and informal political relationships are as important in land management as the conservation methods themselves.

At the regional or national level, formal organizational structures influence technology evaluation and selection. Ministry support for projects, technical capacity, and competing demands are factors to be considered, as are interministerial relationships and rivalries. Fragile lands projects often cross institutional lines of authority and open possibilities for competition and friction.[5]

6. What solutions are available?

There are two great pools of technology, which might be categorized as modern and traditional although these are arbitrary distinctions (Brush 1983). Modern technologies have been tested in laboratories or field experiments, as contrasted to traditional technologies that have evolved by trial and error in the countryside. Modern practices have the cachet of scientific method, traditional practices are time- and field-proven. Modern procedures tend to be general and

widely applicable, traditional procedures are often highly site-specific. Neither process can claim a monopoly on efficacy.

Another distinction is that modern practices usually are accompanied by abundant written material that covers not only construction and operation, but also costs and benefits. With few exceptions, traditional technology remains unrecorded, at best described in general terms and likely in ethnographic, rather than technical, literature. This makes systematic inventory and assessment more difficult, and puts traditional practices at a disadvantage in comparison with modern methods. On the other hand, farmers are better able to evaluate the effectiveness of familiar, traditional methods.

Sources of Information: Soil Loss from Steep Slopes

Enough is known about energy transfers and erosion processes to develop suitable management programs for almost any type of hill slope situation. To be sure, each site is different. But a wide range of structural and biological procedures have been designed and tested, and reported in the literature in sufficient detail to allow confident recommendations under a wide variety of conditions. Some DESFIL publications (for example, Byers 1990, Hanrahan 1987, Staver et al., 1990) review principles and local practices. In addition there are many field guides (for example, Coukis 1983; FAO Conservation Guides; Watershed Management Field Manuals and Soils Bulletins; ILACO 1981; Sheng 1989, 1986) that can be supplemented with technical works (for example, Anderson and Ingram 1989, Sanchez 1976), and collections of papers (such as Browder 1989, Luchok et al. 1976, Moldenhauer and Hudson 1988, Novoa and Posner 1981). Even detailed studies of traditional practices in particular regions are available (for example, Allan 1965; King [1911]; Klee 1980; Wilken 1987, 1976).

Sources of Information: Fertility Loss in Tropical Lowland Soils

The body of literature on tropical lowland soils is relatively small compared to slope process management. Only a few DESFIL publications (such as Hanrahan and Pereira 1990) deal extensively with the lowlands. Field guides and technical manuals are limited (for example, Anderson and Ingram 1989; FAO #60, 1989; Greenland and Lal 1977; Kalpagé 1974; Mohr et al. 1973; Nye and Greenland 1960; Sanchez 1976), and most general works (like Buckman and Brady 1969, Singer and Munns 1987) have relatively weak coverage of tropical soils. Although reports of traditional management are growing (for example, Hecht 1989), the number of technologies and regions for which reports are available is still limited.

WHAT ARE THE BEST TECHNOLOGIES FOR SOLVING THE PROBLEM?

Successful project design is a major objective of technology evaluation, recommendation, and transfer. The outline presented here suggests some main steps in this process. Much of the data and procedures already are available, although a major task remains of collecting relevant

material and reducing it to usable form. The arenas where fragile lands are managed are specific sites, for which there can hardly be too much detail. As Mayer (1989:6-7) remarks:

> A developmental constraint is that technological change also has a patchy mosaic-like impact. Thus, the advantages of economies of scale, of specialization, and the impact of a single technological innovation with a broad and rapid impact are not easily available.

At the same time it could be argued that there is already too much detail! The technical literature on soil loss and conservation is almost overwhelming, that on fertility loss is growing. Project designers need procedures that will identify a few feasible alternatives from the universe of possibilities. Staver et al. (1990:26) and Bremer et al. (1984:xi, 96-98) suggest a decision-tree approach using climate, soil, and slope information as a basis for choosing soil conservation techniques (such as, micro-relief, terraces, or biological barriers). The approach has promise, especially since it lends itself to computer inventories and matching techniques.

The site-specific nature of fragile lands and the number of factors that contribute to the success or failure of management technology reinforces the idea that electronic databases are tools that should be better utilized in the management process. The agroforestry inventory program of ICRAF (Nair 1983) serves as a useful precedent. Agricultural databases such as **AGRIS** (FAO) and **AGRICOLA** (USDA) offer deep sources of information in usable format. Beyond that, the growing concern for degradation of tropical fragile lands is producing a veritable *tsunami* of studies, some focused on soil properties, others on modern and traditional management procedures, that will add to the store of information, and ability to diagnose and prescribe for specific situations (for example, Lathwell and Grove 1986, Vitousek and Sanford 1986).

Several DESFIL writers suggest the role DESFIL could play in developing methods and approaches to fragile lands, and ensuring that projects have fragile lands provisions. The progressive decision-making (decision-tree) approach previously mentioned (Staver et al 1990:26; Bremer et al. 1984:xi, 96-98) shares many characteristics with the successive steps suggested here. Hanrahan (1987:I,2) evokes the idea of inventories by arguing that the principal objective of DESFIL is to develop a pool of knowledge and experience on strategies and appropriate technologies. Byers (1990) calls for alternatives not limited to those found in Latin America. With its emphasis on human resources in fragile lands management, DESFIL should play a central role in the gathering and dissemination of social and institutional data not currently abundant.

The dangers of limiting options cannot be overstressed. Staver (1990:1) remarks that designers of a project in Ecuador "tended to select, *a priori*, a package of conservation practices which did not necessarily take into consideration the biophysical conditions prevalent in the target area." Byers (1990:99) feels that an emphasis on a particular technology (rock terraces and barriers) was "probably related to standards established in other countries, past donor

experience, and focus of international training courses in which . . . technicians have participated." One solution to this problem is to make technical data and supporting information on alternatives readily available so that project designers can match problems with solutions drawn from a broad spectrum of experience.

The prospects for incorporating traditional technology in the management of fragile lands are particularly bright. As has been noted, many procedures for controlling soil and fertility loss are small scale. Many do not require extensive external inputs or expertise, but instead are well within the technical and financial capability of small-scale farmers. Several DESFIL writers (such as Hanrahan 1987, II:13ff) have stressed the importance of including local perspective and technology in the planning process. Wilken (1989) has reviewed some characteristics of traditional technology and outlined a procedure for incorporating it into development planning.

A cautionary note is in order. Few technologies, modern or traditional, should be adopted unmodified. Fragile lands are site specific, and the societies that will use and protect them are time specific. Each situation is unique, and calls for distinctive choices and technologies.

RESEARCH AND DEVELOPMENT FOR THE FUTURE

Rather than focus on particular technologies, the preceding discussion has emphasized problem identification, including not only biophysical factors of fragile lands management but also economic and social elements. A major task remains of matching problems with solutions. What is needed is an analytical framework, and an inventory of conditions and technologies to develop best-fit solutions for specific situations. Combining the decision-tree and inventory concepts with projected needs suggests a logical next step. Major effort should be invested in developing systematic procedures for fragile lands management. A six-step program is suggested:

1. Establish an inventory of site characteristics using principles of minimum data. Entries in the inventory should include enough data on physical and socioeconomic elements so that reasonable environmental analogues can be identified.

2. Establish an inventory of fragile land management technologies. Entries in the inventory should be detailed enough with respect to labor, tools, and procedures so that particular techniques could be applied by others generally familiar with fragile land management. This inventory should include discussion of direct as well as indirect consequences of particular technologies, including negative or adverse possibilities and potential goal conflicts (for example, reforestation may encounter resistance from local land managers who fear loss of exploitation rights; vegetation barriers may significantly reduce the crop area of small fields).

3. A matrix formed of these two inventories would reveal a range of land management techniques for specific physical and socioeconomic situations, and would support the decision-tree process for identifying best alternatives.

4. Incorporate worldwide project experience in the inventories, and also identify gaps in coverage, either of environmental situations or of technologies.

5. Issue guides for appraisal of land management situations, and selection of appropriate technologies under conditions common in Latin America. In addition to specific technologies, the guides should contain procedures for evaluating alternatives.

6. Respond to specific problems with specific recommendations based on accumulated data, experience, and analysis.

The accomplishments of the DESFIL project to date provide a broad base on which to build such a program. A problem-solving approach to management and technology recommendations would go far toward helping donor agencies, host governments, and local resource users achieve rational use of fragile lands.

ENDNOTES

1. Such a procedure is often referred to as technology assessment.

2. Numerous other factors such as demand for resources by developed countries, pressure to produce agricultural exports to reduce debt burdens, and inappropriate application of temperate zone technologies and practices also contribute to the misuse of hill lands as well as lowlands.

3. These are listed in the references cited as Bremer et al. 1984, Brokaw 1989, Brown 1989, Byers 1990, Dickinson et al. 1988, Duvall 1990, Gow 1988, Gow et al. 1988, Hanrahan et al. 1990, Hanrahan 1988, Hanrahan and Pereira 1990, Hartshorn 1989a, Koehn et al. 1989, Meyer 1989, Pierce 1988, Staver et al. 1990, and York and Dickinson 1989.

4. See Chapter Five for a discussion of local level fragile lands management.

5. See Chapter Four for a discussion of national (and international) institutions in fragile lands management.

REFERENCES CITED

Alcorn, J. B.
1989 An economic analysis of Huastec Mayan forest management. In J. O. Browder, ed., *Fragile lands of Latin America: Strategies for sustainable development.* Boulder: Westview Press, pp. 182-206.

Allan, W.
1965 *The African husbandman.* Edinburgh: Oliver & Boyd.

American Society of Agricultural Engineers (ASAE)
1987 Optimum erosion control at least cost: Proceedings of the National Symposium on Conservation Systems. St. Joseph: American Society of Agricultural Engineers.

American Society of Agricultural Engineers (ASAE)
1985 Erosion and productivity: Proceedings of the National Symposium on Erosion and Productivity. St. Joseph: American Society of Agricultural Engineers.

Anderson, A. B., and M. A. G. Jardim
1989 Costs and benefits of floodplain forest management by rural inhabitants in the Amazon estuary: A case study of Acai palms. In J. O. Browder, ed., *Fragile lands of Latin America: Strategies for sustainable development.* Boulder: Westview Press, pp. 114-129.

Anderson, J. M., and J. S. I. Ingram, eds.
1989 *Tropical soil biology and fertility: A handbook of methods.* Wallingford: C.A.B. International.

Bremer, J., T. Babb, J. Dickinson, P. Gore, E. Hyman, and M. Andre
1984 Fragile lands: A theme paper on problems, issues, and approaches for development of humid tropical lowlands and steep slopes in the Latin American region. Washington, D.C.: Development Alternatives, Inc. (DAI).

Bridges, E. M.
1978 *World soils.* New York: Cambridge University Press.

Brokaw, N. V. L.
1989 Tropical forestry action plan: Belize conservation issues and recommendations. DESFIL Technical Report. Washington, D.C.: Development Alternatives, Inc.

Browder, J. O., ed.
1989 *Fragile lands of Latin America: Strategies for sustainable development*. Boulder: Westview Press.

Brown, M. T., ed.
1989 The Southeast Peninsula Project in St. Kitts. Vol I: Resource management plans. DESFIL Technical Report. Washington, D.C.: Development Alternatives, Inc.

Buckman, H. O., and N. C. Brady
1969 *The Nature and Property of Soils* (7th ed.). New York: Macmillan Co.

Budowski, G.
1989 Developing the Chocó region of Colombia. In J. O. Browder,ed., *Fragile lands of Latin America: Strategies for sustainable development*. Boulder: Westview Press, pp. 273-279.

Byers, A. C., III
1990 Erosion processes in tropical watersheds: A preliminary assessment of measurement methods, action strategies, and information availability in the Dominican Republic, Ecuador, and Honduras. DESFIL Technical Report. Washington, D.C.: Development Alternatives, Inc.

Coukis, B.
1983 Labor-based construction programs: A practical guide for planning and management. Washington, D.C.: World Bank (Oxford University Press).

Denevan, W. M.
1989 The geography of fragile lands in Latin America. In J. O. Browder, ed., *Fragile lands of Latin America: Strategies for sustainable development*. Boulder: Westview Press.

DESFIL
1988 Memoria de la conferencia usos sostenidos de tierras en laderas, Tomo I. DESFIL Technical Report. Bethesda, Md.: Development Alternatives, Inc.

Dickinson, J., and F. Tracy
1989 Stream corridors in watershed management. DESFIL Technical Report. Washington, D.C.: Development Alternatives, Inc.

Dickinson, J. C., M. Painter, M. Ehrlich, E. C. French, and J. Oosterkamp
1988 The Associated High Valleys Project in Cochabamba, Bolivia. DESFIL Technical Report. Washington, D.C.: Development Alternatives, Inc.

Duvall, L.
1990 The national program for agroforestry in Haiti: The agroforestry component. In DESFIL, National Program for Agroforestry in Haiti, Vol. 2, pp. 49-78. DESFIL Technical Report. Bethesda, Md.: Development Alternatives, Inc.

Ewel, J. J.
1986 Designing agricultural ecosystems for the humid tropics. Annual Review of Ecology and Systematics 17:245-271.

Flanders, L. S.,ed.
1988 Indigenous peoples, environmental protection, and sustainable development. (Based on a paper by S. H. Davis) International Union for Conservation of Nature and Natural Resources.

Food and Agriculture Organization of the United Nations
FAO Conservation Guides (1-14+; selected):

1. Guidelines for watershed management (1977).
2. Hydrological techniques for upstream conservation, (1976).
4. Special readings in conservation techniques (1977).
7. Environmental impact of forestry (1982).
8. Management of upland watersheds: participation of the mountain communities (1983).
12. Incentivos para la participación de la comunidad de conservación (1985).
13. FAO Watershed Management Field Manuals (8 scheduled):
    1. Vegetative and soil treatment measures (1985)
    2. Gully control (1986).
    3. Slope treatment measures and practices (1988)

    (Others to be issued)
14. Strategies, approaches, and systems in integrated watershed management (1986).

FAO Soils Bulletins (1-60+; selected):

13. Land degradation (1971).
30. Soil conservation for developing countries (1976).
33. Soil conservation and management in developing countries (1977).
34. Assessing soil degradation (1977).
44. Watershed development with special reference to soil and water conservation (1979).
50. Keeping the land alive: Soil erosion - its causes and cures (1983).
53. Improved production systems as an alternative to shifting cultivation (1984).
60. Soil conservation for small farmers in the humid tropics (1989).

Fortmann, L., and J. Riddell
1985 *Trees and tenure: An annotated bibliography for agroforesters and others.* Madison: University of Wisconsin, Land Tenure Center & Nairobi: International Council for Research in Agroforestry.

Frére, M., and G. F. Popov
1979 Agrometeorological crop monitoring and forecasting. Rome: Food and Agricultural Organization of the United Nations, FAO Plant Production and Protection paper 17.

Gamman, J.
1990 A Comparative Analysis of Public Policies Affecting Natural Resources and the Environment: Interest Group Politics in the Eastern Caribbean. DESFIL Technical Report. Bethesda, Md.: Development Alternatives, Inc.

Gow, D.
1989 Development of fragile lands: An integrated approach reconsidered. In J. O. Browder, ed., *Fragile lands of Latin America: Strategies for sustainable development*. Boulder: Westview Press.

Gow, D.
1988 Beyond the project: The quest for sustainability in the Third World. DESFIL Technical Report. Bethesda, Md.: Development Alternatives, Inc.

Gow, D., K. Clark, J. Earhart, M. Fujita, J. Laarman, and G. Miller
1988 Peru: An assessment of biological diversity. DESFIL Technical Report. Bethesda, Md.: Development Alternatives, Inc.

Greenland, D. J., and R. Lal
1977 Soil conservation and management in the humid tropics.

Hanrahan, M., B. Lynch, W. McAnlis, and J. Wolf
1990 Evaluation of on-farm water management project in the Dominican Republic. DESFIL Technical Report. Bethesda, Md.: Development Alternatives, Inc.

Hanrahan, M. S., ed.
1988 Sustainable Uses For Steep Slopes, Vol II, Synthesis Report. DESFIL Technical Report. Bethesda, Md.: Development Alternatives, Inc.

Hanrahan, M. S., and J. Pereira
1990 Manejo de la zona del Gran Sumaco Provincia del Napo, Ecuador. DESFIL Technical Report. Bethesda, Md.: Development Alternatives, Inc.

Hartshorn, G. S.
1989a Natural regeneration of trees on the Palcazú demonstration strips. San José: Tropical Science Center.

Hartshorn, G. S.
1989b Sustained yield management of natural forests: The Palcazú production forest. In J. O. Browder, ed., *Fragile lands of Latin America: Strategies for sustainable development*. Boulder: Westview Press, pp. 130-138.

Hecht, S. B.
1989 Indigenous soil management in the Amazon Basin: Some implications for development. In J. O. Browder, ed., *Fragile lands of Latin America: Strategies for sustainable development*. Boulder: Westview Press, pp. 166-181.

Hicks, J. F., with H. E. Daly, S. H. Davis, and M de Lourdes de Freitas (collabs.)
1990 Ecuador's Amazon Region. Washington, D.C.: World Bank Discussion Paper 75.

Hiraoka, M.
1989 Agricultural systems on the floodplains of the Peruvian Amazon. In J. O. Browder, ed., *Fragile lands of Latin America: Strategies for sustainable development*. Boulder: Westview Press, pp. 75-99.

International Land Development Consultants (ILACO)
1981 *Agricultural compendium for rural development in the tropics and subtropics*. Amsterdam: Elsevier Scientific Publishing Co.

Johnson, D. V.
1983 Agriculture on Slopelands of Tropical America: Problems and Prospects. *Culture and Agriculture* 18:1-8.

Kalpagé, F.C.S.P.
1974 *Tropical soils*. New York: St Martin's Press.

King, F. H.
[1911] *Farmers of forty centuries: Permanent agriculture in China, Korea, and Japan*. Emmaus: Rodale Press, Inc.

Klee, G. A.
1980 *World systems of traditional resource management*. New York: V. H. Winston.

Koehn, K. E., E. Tai, and E. LeFranc
1989 Process Evaluation of the Hillside Agriculture Project in Jamaica. DESFIL Technical Report. Washington, D.C.: Development Alternatives, Inc.

Lathwell, D. J., and T. L. Grove
1986 Soil-plant relationships in the tropics. *Annual Review of Ecology and Systematics* 17:1-16.

Luchok, J., J.D. Cawthon, and M. J. Breslin, eds.
1976 *Hill lands: Proceedings of an international symposium*. Morgantown: West Virginia University Books.

Mayer, E.
1989 Steps toward a coherent policy for Andean peasant agriculture. DESFIL Technical Report. Washington, D.C.: Development Alternatives, Inc.

Miller, D. H.
1977 *Water at the surface of the earth: An introduction to ecosystem hydrodynamics*. New York: Academic Press.

Mohr, E. C. J., F. van Bareen, and J. van Schuylenborgh
1973 *Tropical soils: A comprehensive study of their genesis* (3rd ed.). The Hague: Mounton-Ichtiar Baru-Van Hoeve.

Moldenhauer, W. C., and N. W. Hudson, eds.
1988 *Conservation farming on steep slopes*. Ankeny: Soil and Water Conservation Society/World Association of Soil and Water Conservation.

Morse, W., and J. Ragland
1990 Proposed process for making sustainable agriculture an effective tool for development in the LDCs. BIFAD/USAID memo of 20 Feb.

Nair, P. K. R.
1983 A global inventory of agroforestry systems: a project. *Agroforestry systems* 1:269-73.

Nations, J. D., and F. Coello Hinojosa
1989 Cuyabeno wildlife production reserve. In J. O. Browder, ed., *Fragile lands of Latin America: Strategies for sustainable development*. Boulder: Westview Press, pp. 139-149.

Novoa B., A. R., and J. L. Posner, eds.
1981 Agricultura de ladera en America tropical: Memoria del Seminario Internacional realizado en Turrialba, Costa Rica, Dic. 1980. Turrialba: CATIE/Rockefeller Foundation.

Nye, P. H., and D. J. Greenland
1960 *The soil under shifting cultivation.* Farnham Royal: Commonwealth Agriculture Bureaux, Commonwealth Bureau of Soils, Technical Communication No. 51.

Padoch, C., and W. de Jong
1989 Production and profit in agroforestry: An example from the Peruvian amazon. In J. O. Browder, ed., *Fragile lands of Latin America: Strategies for sustainable development.* Boulder: Westview Press, pp. 102-112.

Pierce, T. H.
1988 Watershed management in Haiti: The STAB experience. DESFIL Technical Report. Washington, D.C.: Development Alternatives, Inc.

Plunkett, H. S.
1987 USAID's fragile lands initiative in Latin America. *Mountain Research and Development* 7(2):173-174.

Poole, P.
1989 Developing a partnership of indigenous peoples, conserationists, and land use planners in Latin America. Washington, D.C.: World Bank, Latin America and the Caribbean Technical Department, Working Paper.

Posner, J. L., and M. F. McPherson
1981 *The steep sloped areas of tropical America: Current situation and prospects for the year 2000.* New York: Rockefeller Foundation.

Prance, G. T.
1989 Economic prospects from tropical rainforest ethnobotany. In J. O. Browder, ed., *Fragile lands of Latin America: Strategies for sustainable development.* Boulder: Westview Press, pp. 61-74.

Raloff, J.
1988 Unraveling the economics of deforestation. *Science News* 133:366-367.

Rankine, L. B.
1976 Economic evaluation of food crop production on hillsides - the Caribbean experience. In J. Luchok, J. D. Cawthon, and M. J. Breslin, eds., *Hill lands: Proceedings of an international symposium*, pp. 242-254. Morgantown: West Virginia University Books.

Reiche, C.
1989 Socioeconomic analysis of agroforestry systems applied on demonstration farms in Central America. In J. O. Browder, ed., *Fragile lands of Latin America: Strategies for sustainable development*. Boulder: Westview Press, pp. 280-286.

Repetto, R.
1990 Deforestation in the tropics. *Scientific American* 262(4):36-42.

Repetto, R., W. Magrath, M. Wells, C. Beer,and F. Rossini
1989 Wasting assets: Natural resources in the national income accounts. Washington, D.C.: World Resources Institute.

Sanchez, P. A.
1976 *Properties and management of soils in the tropics*. New York: John Wiley & Sons.

Schwartzman, S.
1989 Extractive reserves: The rubber tappers' strategy for sustainable use of the Amazon rainforest. In J. O. Browder, ed., *Fragile lands of Latin America: Strategies for sustainable development*. Boulder: Westview Press, pp. 150-165.

Shaikh, R.
1981 Commentary: Reflections on appropriate science in India. *Science for the People* 13(2):26-27.

Sheng, T. C.
1989 Soil conservation for small farmers in the humid tropics. Rome: FAO-UN, FAO Soil Bulletin 60.

Sheng, T. C.
1986 Watershed conservation: A collection of papers for developing countries. Fort Collins: The Chinese Soil and Water Conservation Society/Colorado State University.

Sheng, T. C.
1982 *Soil erosion and conservation in the tropics*. Madison: American Society of Agronomy/Soil Science Society of America, ASA Special Publication No. 43.

Sheng, T. C., and T. Michaelson
1973 Run-off and soil loss studies in yellow yams: Forrest development and watershed management in the uplands region, Jamaica. Rome: United Nations Development Program/Food and Agriculture Organization of the United Nations.

Singer, M. J., and D. N. Munns
1987 *Soils: An introduction*. New York: Macmillan Publishing Co.

Staver, C. P., A. C. Ravelo, A. C. Byers, III, and J. C. Dickinson
1990 Refining soil conservation strategies in the mountain environment: The climatic factor. DESFIL Technical Report. Washington, D.C.: Development Alternatives, Inc.

United Nations (UN)
1989 *Prospects of world urbanization, 1988*. New York: UN Population Studies No. 112.

U.S. Agency for International Development (USAID)
1988 Erosion, productivity, and sustainable agriculture: Report of a workshop held at Texas Tech University 25-26 July 1988. Washington, D.C.: USAID/International Center for Arid and Semiarid Land Studies, Texas Tech University.

Vitousek, P. M., and R. L. Sanford, Jr.
1986 Nutrient cycling in moist tropical forest. *Annual Review of Ecology and Systematics* 17:137-167.

Whittaker, R. H., and G. E. Likens
1975 The biosphere and man. In H. Leith and R. H. Whittaker, eds., *Primary productivity of the biosphere*, pp. 305-328. New York: Springer Verlag.

Wilken, G. C.
1990 Sustainable agriculture. Washington, D.C.: USAID-BIFAD Occasional Paper (in press).

Wilken, G. C.
1989 Transferring traditional technology: A bottom-up approach for fragile lands. In J. O. Browder, ed., *Fragile lands of Latin America: Strategies for sustainable development*. Boulder: Westview Press, pp. 44-57.

Wilken, G. C.
1988 Minimum climate data for comparative analysis in agriculture. Invited paper, AAAS annual meeting, Boston, Symposium on the study of agrarian systems: Minimum data sets for comparative analysis (in press).

Wilken, G. C.
1987 *Good farmers: Traditional agricultural resource management in Mexico and Central America*. Berkeley: University of California Press.

Wilken, G. C.
1982 Agroclimatic hazard perception, prediction, and risk-avoidance strategies in Lesotho. Boulder: Natural Hazard Research, Working Paper #44.

Wilken, G. C.
1976 Traditional slope management: An analytical approach. In J. Luchok, J. D. Cawthon, and M. J. Breslin, eds., *Hill lands: Proc. of an international symposium*, pp. 416-422. Morgantown: West Virginia University Books.

Williams, J. R., C. A. Jones, and P. T. Dyke
1984 The EPIC model and its application. ICRISAT (International Crops Research Institute for the Semi-Arid Tropics). *Minimum data sets for agrotechnology transfer*, pp. 111-121. Patancheru: Proceedings of the International Symposium at ICRISAT Center.

Wischmeier, W. H., and D. D. Smith
1958 Rainfall energy and its relationship to soil loss. Transactions, American Geographical Union 39:285-291.

York, E. T., and J. C. Dickinson
1989 Elements of a sustainable agriculture strategy for the Inter-American Institute for Cooperation on Agriculture (ms).

CHAPTER FOUR

INSTITUTIONS IN FRAGILE LANDS MANAGEMENT

by

Karen LeAnn McKay

INTRODUCTION

Many third world countries rely heavily on their natural wealth of resources for sustenance and economic development, and, as the end of the twentieth century approaches, their supplies are dwindling. It is only through wise management of its natural resources that a country may achieve sustainable development. Institutions are central to wise management. This chapter discusses the diverse institutions that may be involved in fragile lands management, examines their strengths and weaknesses, presents useful examples of how institutional problems have been overcome, and suggests what must be done to strengthen institutional development in fragile lands management.

Effective fragile lands management requires the identification of trade-offs between short-term gains and long-term sustainability, and between local needs and national priorities. Institutions (see definition below) are the means through which these tradeoffs are weighed and balanced. This extremely difficult task, carried out imperfectly throughout the world, calls for effective institutions to generate and analyze information and then find ways to use the information wisely in decision making.

Institutions are necessary (but not by themselves sufficient) to fragile lands management, to natural resources management (NRM), and to economic development in general. Many people think of institutions as large bureaucracies such as the Department of Energy or the Ministry of Foreign Affairs. Many social scientists define institutions as "sets of rules" and use the term "organization" to refer to the entities that are here called institutions. Definitions are shaped by a writer's interest or purpose. Economists discuss institutions in economic terms; political scientists in political terms. For the discussion in this chapter, VanSant's broad definition is appropriate:

> An institution is defined as an entity (or group of related entities) having a legal framework, an organizational structure, operating systems, staff, and resources, and constituted to fulfill a set of related functions valued by a client or constituent group (1989:2).

VanSant makes a functional distinction between an institution and an organization:

> To fulfill these functions, an institution incorporates, fosters, and protects normative relationships, rules, and action patterns. To the extent that an organization succeeds over time in demonstrating the value of its functions and has them accepted by others as important and significant, the organization acquires the status of an institution. The line between an informal group or organization and an institution is, of course, not sharply defined. The key factor is a recognized, continuing and valued role at some level of the society (1989:2).

Most of the fragile lands of Latin America — and for that matter, of the world — are located far from the urban centers where the institutions charged with their management are most often headquartered. The link between these institutions and the fragile lands they manage is often neither direct nor obvious. Inappropriate research, underfunded or misdirected extension services, and short-sighted policies are example indicators of fragile lands management by weak or inappropriate institutions. But (urban-based) institutions, however imperfect, affect fragile lands management for better or worse by affecting the behavior of the people and organizations who actually use these lands. Regulations, policies, subsidies, provision of services (or lack thereof), imposition of technologies, tenure arrangements, and allocation of rights to exploit specified resources are some of the ways in which distant institutions affect fragile lands management at the local level.

The long-term nature of fragile lands management and its dependence on actors in remote areas calls for some specific institutional considerations:

- Investments in fragile lands management must be long term and consistent to be effective, and this requires long-term institutional commitment either directly or through support given to smaller management groups and individuals;

- The diverse nature of fragile lands management requires a diversity of institutions, public and private, large and small, to address the complex, interrelated issues involved;

- Institutions must exercise management controls where the private good threatens the public good. This is obvious but worth stating as the fundamental role of public institutions in the management of a country's natural resources, including fragile lands. The management or mismanagement of fragile lands can have off-site and far-reaching effects. Farming a watershed or hunting a species to extinction may be seen as economically rational and beneficial (at least in the short term) by the farmer or hunter, but costs may outweigh benefits for the public at large, even in the short term; and

- Private or individual alternatives to institutional management may be called for when recurrent costs are high.

If it is extremely expensive for large, centralized institutions to carry out activities in remote areas, it may be best to turn over responsibility to local organizations or individuals. It is sometimes argued that effectiveness is decreased through such decentralization (by effectiveness is meant number of trees planted, terraces constructed, and so forth) (Bremmer, et al. 1984). In a systems view, this is probably rarely the case. If a centralized institution cannot get the job done, the effectiveness of decentralized management cannot be judged against the theoretical number of trees the centralized management institution might have planted or the number of kilometers of irrigation canals it might have constructed. The On-Farm Water Management Project in the Dominican Republic (Hanrahan, Lynch, McAnlis and Wolf 1990) provides a good example of the greater effectiveness of decentralized management.

FRAGILE LANDS MANAGEMENT BY INSTITUTIONS

Fragile lands management, as a coherent area of study, activity, and policy, is a new area. Institutions that deal exclusively and holistically with fragile lands management issues do not currently exist in Latin America. Instead, there is a potpourri of public and private, local, national, and international institutions that address different aspects of fragile lands management.

This diversity of institutions is at once a strength and a weakness for the management of fragile lands. The weakness lies in the difficulty of achieving the coordination and communication necessary for rational management, given the number of players, their sometimes different objectives, and often their competition for funds. But there is also strength in this diversity. Fragile lands management is a complex, multifaceted affair with a need for everything from scientific research to long-range planning, policy formulation and implementation, and action from local community to international levels. This range of needs cannot be dealt with effectively by one or even a few institutions.

Our discussion relates primarily to national, regional, and international institutions: national and international nongovernmental organizations; governmental institutions such as ministries of agriculture, planning, and natural resources (and their subdivisions); bilateral and multilateral donor agencies and banks, which influence national institutions; and, to a more limited extent, private institutions such as parastatals and companies involved primarily in resource exploitation and utilization. The roles of local (community) institutions and organizations, also critically important to fragile lands management, are examined in detail in Chapter Five of this volume and so will not be discussed here.

The Public Sector

In this chapter, the public sector refers to the national government. Although one can refer to the public sector as a single institution, this is not useful except for the broadest of generalizations. In reality, the public sector is made up of numerous and diverse institutions, many of which affect fragile lands management, but none of which are exclusively charged with fragile lands management (at least in Latin America). The roles of public sector institutions and the services they provide are very important to fragile lands management: extension, research, regulation, policy formulation and implementation, general development activities including the provision of basic infrastructure, and project implementation.

National governments normally allocate responsibilities to sector-specific ministries or their structural equivalents. Some ministries, such as agriculture, fisheries, and natural resources, are directly involved in the management of a country's soil, water, plant, and animal resources. Other ministries, such as population and health, planning, and rural affairs, have less direct although often considerable impact on fragile lands management and NRM.

Ministries are subdivided into departments, secretariats, subsecretariats, and other configurations that take on institutional characteristics as well. It is fairly common to find a department or subsecretariat for forestry with a ministry of agriculture, as in Ecuador. Proceeding down the chain of command, one may find a directorate for parks and protected areas under the subsecretariat for forestry. The structural relationships among institutions will often affect the way they operate and the priorities they set.[1] For example, philosophical and institutional tensions can result between those posted to jobs in the countryside and those in the capital. Although forestry guards and forest economic planners may be a part of the same institution, the situations they face and hence their priorities may be radically different. This reality has the potential to cause significant problems for policy implementation and institutional effectiveness.

Another type of national institution to consider in the context of fragile lands management is the special commission, coordinating committee, or board that is established permanently or temporarily and is often, but not always, an interministerial coordinating body. Although these are not usually institutions as defined above, they often play an extremely important role in setting priorities, building consensus, and coordinating activities at the national (and sometimes at the local) level.

Provincial, local-level government institutions can be critical links in the management of fragile lands, and are often far removed from the capital and the immediate attention of central government. A strong local government can be an effective advocate for fragile lands management because it is normally more responsive to local needs and can translate national policies into constructive, on-the-ground actions. Local government institutions can also be partners in the activities of nongovernmental organizations active at the local level.

There are also problems that may arise at the local level that cannot be ignored. Local elites often control local government just as national elites control national governments. In countries where inequitable landholding is the norm, as is the case in most Latin American countries, local government can be manipulated by large landholders to the detriment of smaller holders. This situation, a form of institutional ineffectiveness at the local level, contributes to the fragile lands problem because it often forces smallholders and the landless to exploit lands that are at once fragile and marginal.

Several types of organizations, although public or largely public, do not fit easily into the above characterization of public institutions. These include research institutes, water and electricity boards, and parastatals. When an effort is made to integrate their activities, these institutions can play a useful role in fragile lands management because of their specialized knowledge and resources.

The Private Sector

The private sector includes both private for-profit and not-for-profit institutions. Although the former are certainly important actors affecting fragile lands, their profit motive often means that sustainable management of resources (as opposed to extraction or utilization) is not their primary objective. Currently, some for-profit firms have shown interest in better fragile lands management and are willing to try new approaches to resource utilization. Whether this springs from genuine environmental concern or simply a desire to maintain good public relations varies depending on the firm. The potential for for-profit firms to apply their considerable managerial, financial, and technical resources to fragile lands management issues is significant and as yet largely unrealized in Latin America.

Here the focus will be on not-for-profit NGOs.[2] As noted earlier for public sector institutions, NGOs of interest here generally focus on the environment or some issues concerning it or aspects of it. Their focus is seldom exclusively on fragile lands management per se, although, as in the case of the Rainforest Alliance, the focus may be on a fragile ecosystem.

In the West, the environment has long been a playing field for NGOs. But it is only recently that external and internal demands have led to a rapid increase in environmental NGOs, both international and indigenous, in developing countries. Before environmental NGOs came upon the scene, development NGOs and in some areas relief and humanitarian NGOs were active. Church organizations were among the first NGOs active in development. They continue to play an active role in most developing countries and some have expanded their scope of activity to include environmental and natural resource issues.

The distinctions among different types of NGOs (conservation, development, research, policy) are becoming less clear as conservation NGOs become more aware of and active in development, and development groups become more aware of the importance to development of sustainably managing the natural resource base. Perhaps the final frontier is the issue of

protected areas, an issue that still produces clashes over fundamental principles among biologists, anthropologists, and technical specialists in a variety of other disciplines from both the developed and the developing countries.

Even though many NGOs are attempting to broaden their scope, NGOs are not, nor are they likely to become, a homogeneous group. Some development groups work to strengthen local institutions — often local NGOs. Others work directly with local communities and individuals. Among conservation NGOs, some focus on research and building the information base while others deal with highly political economic and policy issues such as debt-for-nature swaps, and with direct involvement in NRM in developing countries. Still others work directly with local communities to develop sustainable activities in buffer zones surrounding protected areas.

Well-established international NGOs, each with its own history and set of goals and strategies, tend to be strongly institutionalized and stable. They raise money and garner support on the basis of their publicized goals and so are tied to them, often to a considerable extent. Just as the World Wildlife Fund cannot abandon the panda, Save the Children cannot abandon starving children. However, the international NGOs have proven sufficiently flexible to accommodate to the framework of conservation and development and have often shown themselves to be innovative in their approaches to fragile lands development.

Local NGOs in developing countries, on the other hand, are small, often led by strong, charismatic personalities, tend to be less institutionalized, and often are in close touch with local views and perceived needs. On the positive side, these characteristics may result in innovation, experimentation, and flexibility. On the negative side, however, these same characteristics may result in the inability to achieve sustainable outcomes on a scale that makes a difference at the national level, limited replicability of project activities and outcomes, and isolation from the development activities of other private and public institutions. Most local NGOs in Latin America do not have broad-based support and many are short-lived.

By operating at different scales and at different levels, a variety of institutions should occupy a variety of niches in fragile lands management. In theory, these institutions, by bringing different strengths to bear, can satisfy a wide range of needs from research to hands-on tree planting, for example. In reality, the institutional links in the chain of fragile lands management that includes technology, economics, policy, and so forth may be among the weakest and most difficult to strengthen.

INSTITUTIONAL CONSTRAINTS

Nations must turn to institutions, both public and private, to make the hard decisions concerning fragile lands and resource management and then be willing to implement the decisions. This is not a task that can be safely entrusted to the judgement of individuals acting alone. The problem

is that there are significant issues of research priorities and information availability (see, for example, Byers 1990), the application of appropriate technologies (Chapter Three, this volume), economic policy (Binswanger 1989; Chapter Six, this volume), legislative reform, and human resources development that are not being adequately addressed by appropriate institutions. What are the constraints that limit the ability of institutions to effectively address fragile lands management issues?

Institutional shortcomings result from both internal and external factors. Institutions themselves may be mismanaged, corrupt, underfunded, or understaffed. They may lack needed technical expertise. They may lack a clear mandate, a coherent set of policies, or the ability to enforce them; or they may have policies that result in the mismanagement of fragile lands. Institutions are also subject to the external forces of donor politics and the international marketplace that influence their policies, agendas, and ability to address fragile lands management issues.

The complaints leveled against institutions, both private and public, are many: lack of coordination, inability to get things done, corruption, inefficiency, too big, too small, and too many. Some have argued that the principal constraint to sustainable fragile lands management and NRM is weak institutions (Hanrahan 1988).

At the DESFIL-sponsored workshop, Sustainable Uses for Steep Slopes (DESFIL 1988; Hanrahan 1988), eight papers dealt in large part with institutional and policy aspects of the types of institutions described in this chapter. The authors of these papers found that the effectiveness of institutions was seriously constrained because they lacked long-term continuity, flexibility, and a sharp focus on sustainable land use. They often worked at cross purposes because of overlapping and contradictory responsibilities, policies, and activities. These authors also regarded the recent proliferation of institutions as counterproductive because it diluted authority and exacerbated the above problems.

Proliferation of Institutions

The complaint that there are simply too many institutions is a common one. In Ecuador, Mejia (1988) found over a dozen institutions involved in fragile lands management in the public sector alone. The Honduras Environmental Profile of 1989 included the participation of 23 governmental and nongovernmental institutions (Daugherty, ed. 1990; Valencia 1989).

International interest in the environment has helped foster this proliferation of institutions, both public and private. Meyer (1989) traces some of the proliferation to donor organizations, which have often created institutions either to fit their latest development approach or because of their frustration with existing institutions, particularly in the public sector. According to Meyer, over the past 40 years donors have pursued a zigzag course of development strategies from community development to increased production to integrated rural development to privatization. Institutions in developing countries have been created, nourished, and abandoned

according to the latest donor trend. Meyer argues that to the extent that governmental institutions in developing countries have been fashioned in response to donor-driven agendas (that for which donors are willing to pay), it should not be surprising that these institutions respond poorly to internal demands such as those generated at the local level.

As Meyer (1989), VanSant (1989), and others point out, there is a distinct danger in this "create an institution" method of dealing with institutional problems. Although it may serve to increase participation at some levels, beyond a certain point the more institutions involved in fragile lands management, the more difficult it becomes to coordinate or learn from their activities. Limited pools of personnel and resources are stretched thin, creating rivalry and often fostering attempts by government to restrict and control the development of private sector institutions.

Institutional Sustainability

The proliferation of institutions raises many questions, among them the question of institutional sustainability. In the context of integrated rural development projects, VanSant argues for "the need for large-scale, pre-existing institutions to assume project responsibilities" (Honadle and VanSant 1985:80). He goes on to say that project sustainability is jeopardized by donor (and one might add international NGO) attempts to bypass government agencies. VanSant's example is an agricultural research project in Thailand. A.I.D. created a regional agricultural research center and placed it in an agency outside of the Ministry of Agriculture and Cooperatives, which had traditional responsibility for research. Shortly after the end of the project, this center was stripped of its resources and authority because it had no institutional support and was seen as competing with the Ministry of Agriculture and Cooperatives for resources and personnel.

NGOs, primarily international NGOs, are one vehicle some donors are using to bypass overly bureaucratic and often corrupt government institutions. But NGOs themselves can only function with some sort of government approval and must often rely on government personnel, such as agricultural extension staff or park employees, for the long-term continuance of their activities. In Haiti, for example, the government perceived that NGO activities were becoming too independent and too well funded by donors, thus competing with government, and so curtailed their activities, a not atypical response (Pierce 1988).

Conversely, large donors such as the World Bank and the FAO have often avoided or neglected to include NGOs, especially local NGOs, in the World Bank-led Environmental Action Plan (EAP) exercise and the FAO-led Tropical Forestry Action Plan (TFAP) exercise. Both the implementation and the effectiveness of these macrolevel plans have been hampered by the exclusion of appropriate NGOs that could bring practical, local concerns as well as considerable expertise to the table. Winterbottom, in his assessment of the TFAP process after five years, says:

> More direct participation of local NGOs and the people they represent is essential . . . to better articulate the rights and interests of forest dwellers and other groups omitted from the planning process (1990:10).

Another issue in institutional sustainability relates once again to donor agendas and both donor and international NGO funding. The condition of the environment is a hot issue at the moment and is receiving a great deal of attention and funding, particularly from bilateral and multilateral donors and from international NGOs that get their money from donors and from the public in developed countries. Although it is likely to remain an important issue, funders (both public and private) may become disillusioned by a lack of immediate and visible results or preoccupied by other crises and shift their financial support elsewhere. The challenge for institutions riding the current wave of interest in environmental issues is how to survive the next shift of donor interest. This may not be difficult for large, broad-based, international NGOs such as the World Wildlife Fund (WWF) and the Nature Conservancy (TNC), but it may prove to be a significant problem for local NGOs in developing countries.

Inappropriate Models and Professional Biases

Models for environmental management throughout the developing world have come from the economically developed nations, which generally have done an abysmal job of protecting their own environmental resources. It is not surprising that, given the ever-increasing pressures on the natural resource base in developing countries, conventional models of and technologies for NRM are inadequate. Developing countries are working under unprecedented temporal, economic, demographic, and resource constraints that traditional models of development and environmental management (see Chapter Two) do not take into account. In addition, the vicissitudes of the international marketplace and unprecedented debt burdens (ratio of debt to GNP) have introduced factors that were not faced by the more developed countries in the course of their own development. We will briefly examine here three models that have influenced institutional development as it relates to fragile lands management and NRM. All three are inappropriate if the goal is sustainable fragile lands management.

The first model is that of the **short-term project approach**. This model is particularly inappropriate for institutional development. The pressure from donors to spend money on a predetermined schedule and come up with measurable, verifiable achievement within a short span of time results in institutions oriented largely toward short-term objectives and strategies and provides little incentive for long-range strategic planning (see Chapter Eight). And, it almost goes without saying, sustainable fragile lands management is a long-term process, the results of which are not likely to be verifiable for several years. The pressure of the short-term project model also changes the constituency for the programming of resources: the client for government programs (in other words, the entity that must be satisfied) becomes the donor, not the country's people who are presumably the intended beneficiaries of fragile lands management.

Several scholars who have conducted analyses of institutions have pointed out the shortcomings of the short-term project model (Meyer 1989; Lacroix 1985; Uphoff 1986; Gow 1988). The short-term approach is detrimental to institutional development and fragile lands management. Conserving soil, planting trees, and managing forests are all long-term activities and meaningful results can rarely be achieved in a few years. Without continued institutional support, a three-year project often leaves farmers wondering what to do with the trees, how to continue or extend soil conservation activities, or how to market new forest products. Furthermore, there is no way, in such a short time span, to determine if a particular fragile lands management system is sustainable. At best it may be possible to determine that a particular system or technology is not sustainable.

A second inappropriate model, inherited in part from the West and in part from other cultural traditions, we label **gender-blind development model** (Dankelman and Davidson 1988). This model assumes that men are the sole managers of fragile lands (and, for that matter, most other resources). Yet, in Sub-Saharan Africa, women produce more than 80 percent of the food; in Asia 50-60 percent; in Latin America more than 30 percent; and in the Caribbean 46 percent (Dankelman and Davidson 1988:9). Women constitute the majority of subsistence farmers, participate heavily in cash-crop production, and are often the primary stewards of the land and the resources of forests and fields. The gender-blind model has had very real and counter-productive effects on the development of institutions concerned with fragile lands management, NRM, environmental education, research, and extension.

The third inappropriate Western model is the **technology-fix** model. (This is perhaps more an approach or a belief than a model in the formal sense; but we will refer to it as a model.) In agriculture and forestry, the high-technology version of this model translates into more chemicals, more machines, and more hybrids, all of which are often inappropriate to sustainable fragile lands management. The low-technology version (often called appropriate technology) has also encountered problems in some instances because of the failure to take into account the range of needs and uses that the existing technology may satisfy. "Improved" wood stoves, for example, although truly more fuel efficient, often do not meet the range of needs of rural women and so are not adopted. This model has led to the creation of institutions that place undue reliance on technology alone to solve problems and also place a disproportionate value on the laboratory researcher to the detriment of the field worker who often must attempt to translate inappropriate technologies into useful field techniques. This is not an argument against technology per se, but against its inappropriate application in fragile lands management and against the idea that technology alone will provide adequate solutions to problems of fragile lands management.

These inappropriate models have an impact beyond the institutional level. Education, reward structures, personnel policies, social and economic policies, incentives, and relationships between the bureaucrat in the capital and his or her rural constituents are all influenced by the choice of development model and these in turn affect the effectiveness of fragile lands management.

Professional and bureaucratic biases are often reflected in personnel policies. Are field people rewarded for good extension work or is the field seen as a congeries of low-level positions? How often are field people transferred? What are the rewards for institutional and technical innovations? Where is the priority placed for training and other benefits? The answers to these questions for any particular institution will reveal much about the relationship between the city and the countryside and will strongly influence the relationship between field workers and those ultimate stewards of fragile lands, the rural inhabitants.

Unfortunately, government bureaucracies often undervalue the field worker and ignore her/him in policy making and long-term planning. Gow (1988), citing a litany of these problems, characterizes the field worker as similar to the farmer. Both adopt risk-aversion strategies to survive, the farmer to assure a minimum harvest, the field worker to please superiors. In extreme cases, a field assignment is seen as a punishment for anything from alleged incompetence to being on the wrong side of the political fence.

Educational systems also engender professional bias, as revealed in reward structures that promote laboratory research and technological innovation to increase production at any cost. Agronomists and livestock specialists want "clean" fields and pastures, neglecting the value of shrubs and trees, agroforestry, and silvopastoral systems to fragile lands management. Foresters have been taught to "save" the forest and the trees from local people, ignoring the real need local people have to use forest resources, instead of working with them to develop sustainable management systems. Although there have been changes in attitude among professionals in the developed world in recent years, in Latin America institutional structures are still permeated by socioeconomic and political elitism. This is reflected in professional biases and strained relationships between institutional personnel and farmers that continue to hamper the development of sustainable systems for fragile lands management.

A final, but highly significant, aspect of professional bias is the conventional domination of the disciplines related to natural resource management by male scientists and technicians with a focus on production. This has relegated women, important managers of fragile lands throughout the world, to a marginal role. Attend any agronomy, forestry, or livestock meeting anywhere in the world and count the number of women. Go to any rural village and repeat the count. Those setting the fragile lands management agenda are predominantly men. Those who must carry it out are predominantly women. As Hanrahan points out:

> Education, training, credit, extension, and other programs for degradation control are directed at men, who are frequently absent from the community. Similarly, programs such as training often take place outside the community, where women are unable to attend because of their other daily obligations (1988:19).

Staffing and Institutional Development: Demand versus Supply

As institutions attempt to shift direction and overcome the problems outlined above, they encounter yet another constraint: limited human resources. Problems related to institutional management of personnel have been an issue primarily for governments, but are becoming more serious for NGOs. It is only recently that the management of fragile lands has received attention. Before population growth and technology, coupled with persisting tenure inequities, pushed people and their economic activities onto these lands, they were often sparsely inhabited, not threatened with rapid degradation, and so ignored by institutions under whose purview they fell. Fragile lands management has not received the attention and training resources that have been devoted to more traditional forms of agriculture and animal husbandry. Consequently, there is a serious shortage of well-trained people specifically equipped to deal with fragile lands management issues. As fragile lands management and the environment in general receive more and more attention, there is a much larger demand for qualified people than can be supplied from the current pool of professionals.

In several countries, the growth of the NGO sector and the often stifling nature of large bureaucracies have combined to attract talented people away from the public sector and into the NGO sector. The consequences of this are particularly serious in developing countries with an extremely small pool of qualified professionals. In Haiti, for example, the expansion of the NGO sector and donor funding of it led to friction between NGOs and the government, ". . . over the use of different technical approaches and the allegation that NGOs hired the best agronomists away from ministry projects with higher salaries and other benefits" (Pierce 1988:9).

The weaker government institutions become as they are drained of talented staff, the harder it will be to work with them, which, in the final analysis, everyone must do. The problem of luring government personnel away may create resentment on the part of the government, as in the case of Haiti, and lead to efforts to clamp down on NGO activities.

Interinstitutional Conflict

Competition for qualified staff is just one issue that can bring institutions into conflict. Conflict can also be jurisdictional, philosophical, or economic, and often it is based on a combination of these. Institutions in developing countries, whether governmental or nongovernmental, are competing for scarce funds, often from external sources such as donors, international NGOs, and banks. This also is a potential source of conflict.

Some governments have looked upon their national NGOs as yet another way to attract foreign money, but governments generally want to control NGO activities so that the NGOs promote governmental agendas. In Cameroon, for example, the government is clearly interested in using NGOs to further its own development priorities by tapping additional resources. The dominant theme in a nationwide seminar for NGOs was how NGO activities conformed to the

directions of the national development plan and what responsibilities NGOs had for national development (McKay and Gow 1990). But care needs to be exercised in the government-NGO relationship. Carrying out someone else's agenda can interfere with the independence of NGOs and weaken their ability to promote local participation, to be flexible, and to engage in experimentation. In countries such as Haiti where increased funding for NGO activities is seen as directly competing with government programs for scarce foreign resources, the consequence may be an undesirable increase in government regulation of NGO activities.

Other types of institutional conflict involve overlapping or unclear jurisdiction that finds one ministry or department vying with another for policy making, control of resources, and similar authority. In Peru, the Ministry of Agriculture and the Ministry of Fisheries each claimed authority over otters and turtles and each promulgated regulations regarding their management. In Ecuador, the Subsecretariat for Forestry and Natural Resources and the National Institute of Colonization exercise competing jurisdictional claims over some of the forested areas of the Amazon and have different land use policies for these areas. With the environment receiving increased attention and money, jurisdictionally based institutional conflicts are likely to increase if institutional reform is not undertaken.

Lack of coordination among institutions concerned with similar issues, in this case fragile lands management and NRM, is an oft-cited source of conflict. No one coordinates: donors, NGOs, and government ministries all seem to lack the capacity or the will to coordinate. And there are precious few incentives to stimulate coordination. Bilateral donors such as France and the United States have strong political agendas that drive their decisions. Institutional egos, the desire to create and "own" a project or program, the need to point to successes in order sustain morale and keep the money flowing all militate against true coordination and collaboration.

Institutions charged with NRM, such as departments of forestry or national parks, are traditionally weak vis-a-vis other governmental institutions and thus are not in a good position to serve as coordinators. They are often marginalized by the larger staffs and budgets of ministries or departments of agriculture, livestock, and so on. Other organizations that might be in a better position to coordinate fragile lands management and NRM programs, such as ministries of planning, inter-institutional committees or consortia, often lack the necessary technical credibility and consequently are unable to influence the implementors.

Finally, coordination can be difficult even when the political will exists. DESFIL's experience in working with public and private sector institutions on the development of the Honduras Environmental Program illustrates this. The ministries and agencies involved, after some initial reluctance, did second competent professionals to participate in the research and writing of the Environmental Profile of Honduras 1989 (Daugherty, ed. 1990). However, the effectiveness of the coordination was impaired by the fact that these people were not relieved of any of their regular duties in their respective institutions. Conflicting remuneration policies also caused problems.

This long list of institutional failings and sources of conflict can be dispiriting. It is tempting to throw up one's hands and decide that fragile lands management can be successfully accomplished only by avoiding national institutions and working directly and exclusively with local people and community organizations. But such an approach, by ignoring the systemic linkages between, for example, policies promulgated by national institutions and the behavior of people at the local level, would be ineffective. Institutions are an important feature of the fragile lands management landscape. Our efforts should be directed toward improving their capacity for fragile lands management, not toward finding ways to circumvent them when implementing projects.

OVERCOMING INSTITUTIONAL CONSTRAINTS

Despite the long history of disappointments, there is cause for hope in improving institutional effectiveness and collaboration in fragile lands management. Certain institutional arrangements and techniques for capacity building have been successful. The following examples will relate directly only to some of the problems outlined above. There are still areas that need to be addressed that are not being addressed or, as in the case of increasing the pool of qualified professionals, that can only be remedied over time and with a redirection of educational resources. The following are promising areas that, if taken into consideration, can improve institutional capacities for fragile lands management.

Establishing Credibility

Establishing institutional credibility, which is critical to influence others and get things done, occurs on many levels. Institutions new to a country, such as recently created NGOs, must convincingly demonstrate their capacities to government and the public. Older established institutions such as government ministries, which are entering a new field such as fragile lands management, must demonstrate their ability to assume these new responsibilities. Ministries not directly involved in fragile lands management or NRM, such as ministries of planning or rural development, must also establish their credibility to become effective actors.

Institutional credibility is also an issue when new coordinating committees are established. This is happening more and more in fragile lands management as the FAO's TFAPs, the World Bank's EAPs, and the large natural resource management projects of other donors like USAID's Maya Biosphere Project (MAYAREMA) in Guatemala (McCaffrey, comp. 1991) require the cooperation of many different institutions.

The development of the Environmental Profile of Honduras 1989 within the context of the Honduran Environmental Program (Daugherty, ed. 1990; Valencia 1989) provides a useful example of establishing credibility. The Department of Environment of the Territorial Planning Division of the Secretariat of Planning (SECPLAN) was designated as the coordinating institution for the elaboration of the Profile. Originally this department had its own ideas about

how the Profile should be developed. However, it needed credibility among the professionals and technicians of many other agencies to gain their cooperation and establish the basis for implementation of recommendations made in the Profile. This realization led to the adoption of a more collaborative approach that ensured that institutions and organizations with technical credentials played a prominent role in the research, writing, and presentation of technical recommendations. In the end, more than 100 professionals from all government institutions involved in environmental management and from universities participated with SECPLAN in the process.

In Haiti, the Technical Secretariat for Watershed Management (STAB) positioned itself well to establish the credibility of a new coordinating committee in a tense atmosphere of conflict among government, donors, and NGOs. By carrying out extensive field surveys to gather solid background data, the Committee established personal contact with field-based implementors, collected the data necessary to argue their case in Port-au-Prince, and thereby established credibility both in the capital and in the rural areas (Pierce 1988).

In St. Kitts, the recently formed Southeast Peninsula Land Development and Conservation Board, entrusted with overseeing the development of tourism on the pristine southeast peninsula, will have to develop its credibility to deal effectively with well-financed private developers. The arguments of the Board will require the backing of competent and recognized professionals to hold their own against the counter arguments of professionals working for developers.

> The Board is particularly likely to need help when a developer's assertion that proposed action will not harm the environment is cast in doubt. For example, is the proposed marina really compatible with protection of near-shore marine life? And will it really not increase beach erosion? (Noble 1989:13).

Links Among Institutions

Although institutions themselves need strengthening, many experiences have shown the importance of establishing formal and informal links among institutions. This is certainly the message of the successful experiences with coordinating committees.

The Bicol River Basin Development Program Office in the Philippines, set up as a regional planning and coordinating unit, was designed to support, not compete with, sectoral ministries in project implementation (Honadle and VanSant 1985:84). Similarly, the Technical Secretariat for Watershed Management in Haiti was designed to coordinate and strengthen existing watershed management institutions. Part of its success was due to the role it played as the glue holding together the various pieces.

It is time-consuming not only to bring institutions together and keep them together but to get them to adopt and adapt to new ideas. Inevitable time lags are involved in this process.

This is one of the reasons why interinstitutional approaches are sometimes avoided, particularly in projects of short duration.

An important consideration in promoting interinstitutional cooperation is a sensitivity to the need of each institution, be it governmental or NGO, to benefit bureaucratically from the experience. This means paying attention to professional recognition of contributions, sharing of information, and other bureaucratic rewards. In other words, successful cooperation requires the provision of appropriate institutional incentives (incentives are discussed in Chapter Seven).

Internal versus Process Capacity

Strengthening the links between institutions requires something else as well — an ability and willingness to delegate responsibility for specified activities. This is essential, particularly if the link between government and the private sector, including local people, is to be productive. In this regard, VanSant makes a useful distinction between internal and process capacity:

> If institutional capacity is separated into the ability to do something (internal capacity) versus the ability to get something done by someone else (process capacity), the strengthening of the ability of public institutions to obtain services from private organizations can receive more emphasis (Honadle and VanSant 1985:86).

The Southeast Peninsula Land Development and Conservation Board of St. Kitts is a perfect example of an institution well placed to obtain services from both private developers and environmental NGOs, if it is able to develop its capacity to do so (Noble 1989).

Fitting the Institution to the Situation

Part of the challenge in mobilizing and facilitating diverse institutions to address a problem is recognizing the array of institutions available and the particular strengths and weaknesses of each. It is necessary to look beyond conventional arrangements to institutions that may be very well placed but are not usually thought of as addressing fragile lands management.

In Ecuador, for example, the water district authority for Quito, not traditionally an institution involved with environmental issues, has emerged as an important supporter of private efforts to protect and manage the Antisana Reserve area. The Antisana area happens to be the principal watershed serving Quito.

In the Dominican Republic, the transfer of irrigation system responsibilities from central government to local organizations, which are more responsive to the needs of users, improved irrigation operation and management. Organizations such as workers unions, private firms, and indigenous groups are all examples of groups with potentially useful roles to play in fragile lands management (see discussion in Chapter Five).

CONCLUSIONS AND RECOMMENDATIONS

Institutional Sustainability

We know relatively little at this point about institutional sustainability, particularly of the new, environmentally focused institutions such as indigenous NGOs, environmental review boards, and the like.

The question of institutional sustainability should be more thoroughly explored and accorded more importance in fragile lands management projects. Techniques such as debt-for-nature swaps, endowments, creation of foundations, interministerial committees, and the conditions under which they function should all be examined carefully. Foundations and endowments are new ideas in fragile lands management that may be sustainable as institutions while raising issues of accountability and authority.

Another requirement of institutional sustainability is appropriate professional staffing. This will require a commitment to strengthening national training and educational facilities. The oft-repeated complaint that graduate study in the United States provides little of relevance for developing country professionals must be addressed. Sustainable and self-sufficient fragile lands management in developing countries will necessitate strong educational and training institutions in those countries. Relatively long-term projects like DESFIL are well positioned to contribute to this effort.

Working with Existing Institutions

Institutions of long standing such as government ministries have already proven their staying power and must be recognized as important players in fragile lands management. However, such institutions need not remain static. New or restructured departments, new policies and mandates, and new operating procedures may all be necessary in order for such institutions to effectively take on responsibility for fragile lands management. What is required in each instance is a realistic assessment of strengths and weaknesses — all institutions have both. For example, does the NGO proposed to carry out an institutional strengthening project view this as an important feature of its mandate and does it have the qualified personnel and experience to accomplish the task? Is the government agency entrusted with the management of national forests committed to production or protection? Is there an agency that would be particularly appropriate to carry out a designated activity or should the skills of several institutions be drawn upon? Choosing the appropriate institution or combination of institutions within which to house a fragile lands management project may be as much as half the battle.

Just as there are no simple technical or socioeconomic solutions to problems of fragile lands management, there seem to be no simple institutional solutions either. fragile lands management must be addressed at several levels: local, provincial, national, regional, and international. It must be addressed by national governments, international organizations, and

local people. To rely too heavily on either public or private sector institutions in seeking solutions is to lose the advantage of using the strengths of both sectors.

Institutional Links

To realize the full potential of different groups working on the same issues requires an appreciation of the links (or lack thereof) among the groups. Efforts must be made to establish and strengthen such links. When DESFIL assumed responsibility for management of the Forestry Support Project in Ecuador, DESFIL staff found that after six years there was rivalry and distrust among the many institutions and organizations working on different components of the project. Much of the rivalry and distrust quickly dissipated during a team building workshop that provided all parties the opportunity to openly discuss their common concerns about forest management. It became clear to all that for any one of the organizations to realize the full potential of its component of the project, open communication and links with those responsible for all other components was essential.

Although a range of individual institutions will continue to be critical to fragile lands management and each will need to be supported in its own right, the links among them should be articulated and strengthened. The process through which this occurs may also serve to reduce duplication of effort and encourage complementarity. For example, this will entail working with existing NGO consortia as well as encouraging NGOs to form such collaborative groups. It will involve the continuation of efforts like the DESFIL-sponsored professional conferences on sustainable uses for steep slopes and on development strategies and natural resource management in the humid tropical lowlands, which brought people together from different institutions and a variety of disciplines to exchange views on common concerns. Fruitful collaborative arrangements are often born at such interdisciplinary conferences. Bringing people together through training workshops and study tours is another way in which DESFIL and similar projects can contribute to awareness raising among institutional representatives about the issues and priorities of other institutions.

Time and Process

All of these laudable goals — working within existing institutions, forging links among institutions, working with a variety of institutions — require time spans that normally extend well beyond the time frames of most development projects. Time is necessary to develop the human resources and institutional capacity needed for effective management of fragile lands. Time is needed for old established institutions and managers to learn new methods and ways of doing things, accept them, and make them a part of their practice and institutional policy. The production of the *Environmental Profile of Honduras 1989* did more than just produce a profile, a task that would have been simpler and quicker had fewer people and institutions been involved. The time-consuming process of bringing people together and helping them work together was an accomplishment that will pay major dividends in the future. The process took two years and the Hondurans have a document. But more importantly, they have something far more valuable

and enduring. They have in place the beginning of a more cooperative approach to environmental problems among numerous qualified professionals from several institutions and a variety of disciplines.

It is imperative that the problem of short project time frames be solved if sustainable fragile lands management and NRM are to be achieved. Both fragile lands management and NRM are continuous processes operating within dynamic systems, not time-limited events with a fixed beginning and end. Consequently, the building of appropriate fragile lands management institutional capacities and linkages must also be viewed as a continuous process and means must be sought to strengthen donor support for the process. With the current emphasis on measuring project success almost exclusively in terms of tangible, quantifiable outputs, the importance of long-term processes to the achievement of truly sustainable development seems to have been forgotten. Sustainable fragile lands management requires that we place at least as much emphasis on the process as on the product of institution building.

ENDNOTES

1. See Honadle 1989 for a more thorough discussion of this point and an interesting analysis of the institutional factors related to tropical deforestation.

2. NGOs are also called Private Voluntary Organizations (PVOs) in the United States. This is a legal classification that refers to nonprofit groups legally registered with the U. S. government that receive voluntary contributions from private groups and individuals. We will use the term NGO to refer to both international PVOs and indigenous NGOs.

REFERENCES CITED

Binswanger, H. P.
1989 "Brazilian Policies that Encourage Deforestation in the Amazon." World Bank Environmental Department Working Paper No. 16. Washington, D.C.: The World Bank.

Bremmer, J., T. Babb, J. Dickinson, P. Gore, E. Hyman, and M. Andre
1984 "Fragile Lands: A Theme Paper on Problems, Issues, and Approaches for Development of Humid Tropical Lowlands and Steep Slopes in the Latin American Region." Contract study for USAID, Bureaus of Science & Technology and Latin America and the Caribbean. Washington, D.C.: Development Alternatives, Inc.

Byers III, A. C.
1990 "Erosion Processes in Tropical Watersheds: A Preliminary Assessment of Measurement Methods, Action Strategies, and Information Availability in the Dominican Republic, Ecuador, and Honduras." DESFIL Technical Report. Washington, D.C.: Development Alternatives, Inc.

Dankelman, I. and J. Davidson
1988 *Women and Environment in the Third World: Alliance for the Future*. London: Earthscan Publications, Ltd. in association with the International Union for the Conservation of Nature and Natural Resources (IUCN)

Daugherty, H., ed.
1990 *Perfil Ambiental de Honduras 1989*. Secretaria de Planificación, Coordinación y Presupuesto de Honduras, DESFIL, and USAID. Washington, D.C.: Development Alternatives, Inc.

DESFIL
1988 "Memoria de la Conferencia Usos Sostenidos de Tierras en Laderas," Quito y Salcedo, Ecuador, 19-24 de septiembre de 1987. Tomo I. DESFIL Technical Report. Washington, D.C.: Development Alternatives, Inc.

Gow, D.
1988 "Beyond the Project: The Quest for Sustainability in the Third World." DESFIL Working Paper. (Presented at the symposium Sustainable Development: In Search of Lasting Solutions, John F. Kennedy School of Government, Harvard University.) Washington, D.C.: Development Alternatives, Inc.

Hanrahan, M.
1988 "Sustainable Uses for Steep Slopes," Workshop Proceedings. Vol. II: Synthesis Report. DESFIL Technical Report. Washington, D.C.: Development Alternatives, Inc.

Hanrahan, M., B. Lynch, W. McAnlis, and J. Wolf
1990 "Evaluation of the On-Farm Water Management in the Dominican Republic." DESFIL Technical Report. Washington, D.C.: Development Alternatives, Inc.

Honadle, G. and J. VanSant
1985 *Implementation for Sustainability: Lessons from Integrated Rural Development.* West Hartford, Conn.: Kumarian Press.

LaCroix, R.
1985 "Integrated Rural Development in Latin America." World Bank Staff Working Papers, No. 716. Washington, D.C.: The World Bank.

McCaffrey, D., comp.
1991 "Maya Biosphere Project Paper." DESFIL Technical Report. Washington, D.C.: Development Alternatives, Inc.

McKay, K. L. and D. Gow
1990 "Enhancing the Effectiveness of Governmental and Non-Governmental Partnership in Natural Resources Management." Study funded by the Natural Resources Management Support Project (NRMS) of USAID.

Mejia Vallejo, L.
1988 "El Impacto de la Acción Institucional en Tierras Frágiles de Ladera en Algunas Zonas del Ecuador," in DESFIL 1988:175-94.

Meyer, C. A.
1989 "Institutional Disequilibrium in Rural Development: A Problem of Donor-Recipient Behavior." George Mason University Working Paper.

Noble, J.
1989 "Strategy for Conservation and Development of the Southeast Peninsula of St. Kitts. DESFIL Technical Report. Washington, D.C.: Development Alternatives, Inc.

Pierce, T. H.
1988 "Watershed Management in Haiti: the STAB Experience." DESFIL Technical Report. Washington, D.C.: Development Alternatives, Inc.

Uphoff, N.
1986 *Local Institutional Development: An Analytical Sourcebook with Cases.* West Hartford, Conn.: Kumarian Press.

Valencia, I.
1989 "Managing the Honduran Environment," DESFIL Newsletter 3(4):4, 6-7.

VanSant, J.
1989 "Institutional Self-Reliance: A Framework for Assessment." Paper prepared for the United Nations Development Program. Washington, D.C.: Development Alternatives, Inc.

Winterbottom, R.
1990 "Taking Stock: The Tropical Forestry Action Plan After Five Years." Washington, D.C.: World Resources Institute.

CHAPTER FIVE

RESOURCE STEWARDSHIP AT THE LOCAL LEVEL[1]

by

David D. Gow
and
Philip D. Young

> Under the best of circumstances, anywhere in the world, the process of group formation amongst marginal and/or disenfranchised people is inherently political, grounded — as it must be — in interlocking notions of cooperation, collective action, constraint analysis, autonomy, and empowerment (Lowenthal 1990:44).

INTRODUCTION

At the top of the development agenda for the 1990s there are two critical challenges: protection of the environment and the reduction of poverty. Efforts to protect the environment attract global interest and concern because of the implications of a deteriorating natural resource base for our well-being and the well-being of future generations. Efforts to reduce poverty are driven by the fact that the lives of nearly 2 billion people — 40 percent of the world's population — still are controlled by extreme poverty (World Bank 1988). The vast majority — over 85 percent — live in Africa, Asia, and Latin America. Of these, at least 80 percent live in rural areas.

Land, the provider of last resort in rural areas, is also the ultimate provider for all resource-based production and development. Lacking jobs to give them purchasing power, the rural poor turn to land for food, fuelwood, and income. Forced to retreat to marginal lands, they often degrade these meager and fragile environments in an effort to make ends meet. This situation is further exacerbated by the lack of secure tenure or user rights that might provide the incentive to manage for the future. Lands at risk are increasingly populated by people at risk (Little, Horowitz, and Nyerges 1987). However, the impoverished rural peoples of developing countries are hardly the sole source of environmental degradation. The destructive practices and policies of urban citizens, governments, and corporations and their increasing demand for

resource-based products contribute significantly to environmental degradation and exacerbate the fragile lands problem.

Redclift phrases the general question that must be addressed in environmental planning:

> Is it possible to undertake environmental planning and management in a way that does minimum damage to ecological processes without putting a brake on human aspirations for economic and social improvement? (1987:33).

The issue is not new. The growing understanding of the close linkages among the environment, the natural resource base, poverty, and sustainability is both recent and encouraging.

Impoverished people's dependency on the natural resource base for their daily subsistence creates a critical linkage between the twin development challenges of environmental protection and poverty reduction. Beneficiary participation in the development process (participatory development) can help break the cycle of impoverishment and environmental degradation. Local organizations can play a key role in the process in general and in natural resource management and the achievement of sustainable production on fragile lands in particular. After years of work, the Institute of Development Anthropology stated that its most important finding was

> the necessity of involving local populations in the planning, design, implementation, and evaluation of development activities intended for their benefit (Horowitz 1988:2).

Chambers (1983) comes to the same conclusion. The issue is how to best achieve local participation.

This chapter focusses on local participation in the stewardship and sustainable use of natural resources. Local, mostly community-level, organizations are examined in terms of their appropriateness to the task of managing fragile lands and natural resources. In the course of the discussion, consideration is also given to the prospect of individuals and families as fragile land managers, based on the premise that local organizations have not always lived up to expectations, are not always culturally appropriate, and do not always result in successful resource management. Local actors, whether as individuals or organized in groups, are in the best position to understand local conditions, have a storehouse of knowledge about local resources, and therefore constitute a vital link in the process of achieving sustainable management of fragile lands.

A recent study of 25 agricultural and rural development projects funded by the World Bank underscores the importance of involving local populations. Twelve of the 25 projects appear to have successfully achieved long-term sustainability. These 12 share a common construct: participation by local organizations. The involvement of these local organizations included participation in project decision making and continuing identification of the project

activities with local needs. The participating local organizations also were characterized by a high degree of autonomy and self-reliance, accountability of their leaders, and continuing identification of the project activities with local needs (Cernea 1987).

When compared to nonlocal organizations (public or private), local organizations offer a number of potential advantages:

- Knowledge of local social networks;
- Knowledge of and ability to respond to local needs and desires;
- Good relationships with local people;
- Flexibility and adaptability;
- Autonomy;
- Agricultural extension experience;
- Effectiveness as coordinators; and
- Ability to provide immediate benefits (Gregersen, Draper, and Elz 1989: 180-181; Avina 1990).

But local organizations do not always live up to expectations. They suffer from several pervasive "vulnerabilities." Among the more important are:

- Their formation is actively resisted from various sources;
- They fall under the control of powerful outsiders;
- They succumb to factionalism and internal politics;
- They lack expertise in the necessary political, organizational, and technical skills; and
- They have corrupt organizational leaders who betray them (Esman and Uphoff 1984:181-202).

That local organizations come with problems should merely serve as a reminder of the complexity of human organizations and a warning against promoting panaceas. Local organizations can provide a source of stability and continuity when national regimes change. As a collective voice, they can serve as advocates for the political and economic rights of impoverished peoples. And by combining the risks and benefits of an entire community, they can maximize the use of the natural resources available to them. By assuming the role of resource steward, local organizations can be the means to achieve development that is both productive and sustainable.

LIVELIHOOD SECURITY AND EMPOWERMENT

Livelihood Security

There is a growing realization of the close relationship between resource degradation and poverty, a consequence of lack of access by poor households to productive resources to meet their basic needs. This has been a major factor in recent years in the extensive expansion of rural peoples onto fragile lands. The issue is one of **livelihood security.**

> Livelihood is defined as adequate stocks and flows of food and cash to meet basic needs. Security refers to secure ownership of, or access to, resources and income-earning activities, including reserves and assets to offset risk, ease shocks and meet contingencies. Sustainable refers to the maintenance or enhancement of resource productivity on a long-term basis. A household may be enabled to gain sustainable livelihood security in many ways — through ownership of land, livestock or trees; rights to grazing, fishing, hunting or gathering; through stable employment with adequate remuneration; or through varied repertoires of activities (Food 2000 1987:3).

There is much evidence that people living on fragile lands, where resources are subject to rapid degradation and yields subject to dramatic fluctuation (due to natural and human-induced causes), respond with a high degree of flexibility and a variety of coping strategies, according to the gravity of the situation (Waddell 1983). In the semiarid tropics of Northern Nigeria, for example, farmers have developed a hierarchy of coping mechanisms for dealing with inadequate rainfall (Watts 1983). These include intercropping, water conservation, the exploitation of several microenvironments, and, in cases where early rains are followed by drought, the replacing of their millet and sorghum with different, quick-maturing cereals. After a poor harvest, villagers know that cereal prices will increase exponentially. Accordingly, they try to generate cash income to buy grain through wage labor and craft activity. Even in conditions of moderate poverty, many households invest off-farm.

If all this is insufficient, they will seek support through the "economy of affection," the networks of support, communication, and interaction among different groups connected by blood, kinship, community, or religion (Hyden 1983). Should this in turn prove insufficient, then they will begin to dispose of their productive assets, such as smallstock, or seek a loan from a local merchant.

Elsewhere, trees may be regarded in the same way as livestock — as a bankable asset. In Haiti, for example, crop failure is so frequent and the market for wood and charcoal so secure, that farmers prefer to leave their trees as a bank against future emergencies (Murray 1987).

What these brief examples illustrate is that local control of resources permits a range of practical responses in the face of threats to livelihood security. To the extent that local people do not control their resources, their adaptive responses to adversity are limited. The development issue is how to improve the livelihood security of people occupying fragile lands without jeopardizing the resource base on which their livelihood depends. The conventional development approach is to try to provide farmers off-farm employment, training, or some new asset that supposedly will provide for all or almost all their needs. A more viable alternative may be to strengthen their existing strategies and institutions, in which productive assets often play a key role (Chambers and Leach 1987). This may be accomplished through institutional development, that is, the strengthening of local organizations and, under appropriate circumstances, the creation of such organizations.

Providing people with the necessary base on which to build and create for the future is a prerequisite for good stewardship (Chambers 1988:3):

> Secure tenure and rights to resources and adequate livelihoods are prerequisites for good husbandry and sustainable management. Moreover, sustainable livelihood security is a predisposing condition for a stable human population in the long-term, for when livelihoods are secure it becomes rational for poor people to limit family size. Enabling poor people to gain secure and sustainable livelihoods in resource-poor and forest areas is, thus, the surest protection for the environment. The poor are not the problem; they are the solution.

In practice, this means that development interventions should concentrate on assisting local people to achieve greater control over their productive resources and use them more efficiently. Where these resources are limited or insufficient, often the case on fragile lands, it may first be necessary to help people meet basic survival needs (in other words, increase short-term gains) and then develop programs of resource use to insure steady, adequate yields over the long term (or establish sustainable livelihood security over the long-term). Agrarian reform that results in greater tenure equity, tenure security (ownership or usufruct), rejuvenation of degraded lands, and diversification including nonagricultural activities are all possibilities to improve the lot of the rural poor.

The focus should be on improving livelihood security, not on preserving the environment. In a study financed by USAID to address NRM in the Sahel, 70 successful NRM initiatives — many small scale and localized — were visited in Gambia, Mali, Niger, and Senegal (Shaikh et al. 1983). The interventions with the greatest impact were found to be those that resolved the problems of the local population — rather than those of the environment per se.

Empowerment

Strengthening livelihood security at the local level can further the goal of **empowerment**. This emotional concept requires some clarification. The political dimension of empowerment

and, by association, the participation of local organizations cannot be overemphasized. Broader participation is likely to change the use and allocation of scarce resources among social groups; indeed, this is often the reason why such participation is advocated in the first place (Uphoff, Cohen, and Goldsmith 1979:284). Active resistance to control by local organizations often centers on empowerment. Desirable as such empowerment may be, there is often an element of wishful thinking involved that ignores political realities and the political economies in which rural people survive, subsist, and struggle (Thomas 1985).

Although rural people have a variety of strategies to deal with economic and environmental uncertainty, they also have a set of informal political weapons to deal with the demands made on them by those in power, including donors and development projects. These everyday forms of rural resistance are the weapons of the powerless. They include foot dragging, dissimulation, false compliance, feigned ignorance, slander, arson, and sabotage. They require little or no coordination or planning; they often represent a form of individual self-help; and they typically avoid any direct symbolic confrontation with authority (Scott 1985:29). But such weapons do defend the interests of rural people. Much of the development rhetoric on the role of incentives can be viewed as a bureaucratic attempt to overcome this resistance.

Historically, the goal of many popular protest movements of the rural poor has not been a radical belief in equality of wealth and landholding but the more modest claim of a right to subsistence. This "moral economy of the peasantry" is directly related to sources of subsistence. For a small farmer, the claim might include continued access to the land. For a tenant, it might involve a secure lease. For a landless laborer, it might involve guaranteed employment, gleaning rights, and also access to common property resources (Scott 1976:179). Livelihood security can be viewed as a contemporary manifestation of this moral economy.

By furthering livelihood security, whether in the form of strengthening strategies, securing productive assets, or some combination of the two, the poor can be empowered. Rural people, once they have satisfied their daily survival and subsistence needs, will then have the necessary resource base — and the security — with which to plan for the future and make increasing demands upon the system. With greater control over their own lives and the natural resource base they use, they will be in a better position to bargain, negotiate, and make demands upon the system (Gow 1990). Local organizations can be the means through which to accomplish these goals.

LOCAL ORGANIZATIONS, THE COMMONS, AND PRIVATIZATION

Whereas strong arguments have been made in favor of private property, such individual ownership does not guarantee better stewardship of the resources in question — despite the "tragedy of the commons" argument calling for privatization. There are many examples of sound and sustainable communal management of water, forest resources, and rangelands. Such management often involves traditional institutions that play a central role in controlling access

to these resources. Schemes to place communal resources under private management, through titling for example, often overlook the dependence of certain groups, including women and the poor, on communal lands. Changes in the status of communal lands can therefore work to the detriment of those who rely upon such areas for food, fuel, shelter, and income.

When forest, water, and other resources are held in common, it has been argued that individuals have potentially powerful incentives to exploit the resource for their personal gain at the expense of others. Hardin (1984) calls this "the tragedy of the commons." He describes a situation where herders are grazing cattle on a common pasture. If an individual increases the size of his herd, this reduces the overall amount of forage available. But the loss to each herder, when divided across the group, is minuscule, and much less than the individual benefit to be derived from grazing more cattle. Hence, he argues, the incentive exists for all herders to continue adding more cattle until the level of overgrazing degrades and perhaps destroys the common resource.

But this is a deductive, not an empirical account of collective behavior that unjustifiably assumes that the free-rider is the only rational actor and that the other herders are all irrational — and will continue to work for the collective good (Sanford 1983:118-127). This approach confuses a common property regime with an open access regime: the former limits access to those who are members and is characterized by use rights, exchange rights, distribution entitlements, a management subsystem, and authority instruments as means of management; in contrast, an open-access regime is characterized by unrestricted entry and unregulated use (Bromley and Cernea 1989). However, many traditional forms of common property resource management have weakened or collapsed under increasing population pressure, greater commercialization, public policies, technological change, and environmental pressure (Arnold 1989).

Unfortunately, Hardin's model has been applied blueprint-style to various commons in the Third World. In the case of common grazing systems, profound questions concerning its relevance have been raised (Gow 1987). For example, is it true that herders are such self-serving maximizers? The "economy of affection" postulated by Hyden — the moral pressures that individuals feel to fulfill certain obligations and commitments to their families, villages of origin, and the poor — would argue against its universal application. Even if they are "self-serving maximizers," do herders always have the necessary resources available to increase herd size in the manner predicted?

Schemes to privatize communal pastures assume that this will lead to better range management and reversal of the process of environmental degradation. Neither the historical nor the contemporary record substantiates this claim. What the record does substantiate is that privatization of communal lands favors the larger farmers. In the case of eighteenth century England, the enclosure movement meant that innumerable peasants lost their rights on the commons to the larger landlords (Moore 1967).

In the United States, access to public grazing lands came under government control with the passing of the Taylor Grazing Act, the federal government's version of enclosure. Because access was restricted to property owners, many longstanding range-users — primarily sheepherders and part-time cattlemen — were excluded from the public range (Fairfax 1984). Prior to 1934, these publicly owned rangelands were open to uncontrolled communal use by graziers. Their enclosure did not necessarily change this. Although it reduced the number of users, it did not necessarily reduce the stocking rate — the number of animals on a given pasture for a stated time period (Sanford 1983:122). Similar situations have occurred in developing countries. In the Third World, privatization eliminates the herders' principal defense against sudden changes in resource availability — their mobility. Land titling often favors the entrenched and powerful at the expense of newcomers and the poor and powerless. In societies where women had rights to land under traditional systems, male-dominated governments (and aid agencies) have given full rights to the "head of the household" (automatically assumed to be male) and left women with no recourse or claim to land (Boserup 1970).

That resources are private does not necessarily mean that their owners will be highly motivated to invest in long-term improvements or use the resources in a sustainable fashion. In the United States, where private owners have installed land and grazing improvements on a substantial scale on their own ranches, it has often been by using public funds in the form of grants or loans on very favorable conditions (Sanford 1983:127). In a Nova program on public television on August 13, 1991, examining the issue of continued cutting of old growth timber in the Pacific Northwest, it was pointed out that of the old growth present in Lewis and Clark's time 92 percent is now gone. The remaining 8 percent is all on public land. No old growth remains on private land. This does not bode well for the currently popular argument that privatization will save the forests.

A cautionary note is in order. It is wishful thinking to assume that resource users living in traditional social settings are necessarily able and willing to manage forests, soil, and water productively, equitably, and without conflict. Under certain circumstances, traditional forest peoples can use dynamite and chain saws just as destructively as the most recent settlers. And the fact that some communities do not manage their resource base well does not necessarily imply that they are unaware of the problem. Where traditional roles and forms of organization are relatively intact, local institutions appear to have the capacity to manage natural resources effectively (Siy 1982). Diminished capacity often accompanies the decline in traditional institutions, such as those operated by chiefs and councils of elders (Roe and Fortmann 1982).

Livelihood security and empowerment through ownership or control of resources do not guarantee good stewardship by the community (or the commons). They are necessary, but not sufficient, conditions. What they offer to the poor are some alternatives, the opportunity to choose, and the chance to adapt the alternative chosen to their own needs.

LOCAL ORGANIZATIONS AND FRAGILE LANDS MANAGEMENT

Resource Characteristics

Three key characteristics of resource management are **resource renewability, seasonality of labor requirements**, and **user perceptions of the resource** (Uphoff 1986:30-32). The less renewable the resource (or the longer the renewal time), the greater the risk that productivity will rapidly decrease under poor management. Resource renewal time varies greatly. Grass on a range may reappear after a few weeks; trees in a forest can take 20 years and longer. Resource management by local organizations and even by individuals or families is normally a viable option when resource renewal time is brief. Lengthy renewal time, as in the case of forests, makes complete local control more problematic. For some resources such as irrigation systems the issue is one of maintenance rather than renewal time, and the question is whether more effective management can be achieved through centralized or local (decentralized) control.

Seasonality of labor requirements may have a powerful effect on organizational options. The flow of local activity is generally tied to a traditional cycle of activities. Centralized government institutions charged with resource management often do not take local work cycles into account. For example, in Niger during the time when a government-managed community forestry project required the most involvement from villagers, they were busy planting their field crops and unable or unwilling to assist the Forestry Department in tree planting operations (Brechin and West 1982). Local community participation in project design permits the anticipation and resolution of such problems prior to project implementation.

The way natural resources are perceived by users is also an important managerial consideration. Of particular importance is whether users perceive a resource to be a public or a private good, to be managed for collective or for individual benefit. In principle, if a resource has been improved, either by individuals or groups, a right has been established to the ensuing benefits. If others cannot be excluded from reaping the benefits of the resource, there is little incentive to develop or protect it. In Haiti, for example, before farmers would plant trees on their own land, it was necessary to convincingly dispel the notion that such trees belonged to the state and might eventually be used as a pretext for expropriating the land. With the understanding and guarantee that the planter had exclusive ownership of the trees came the willingness to plant tress for individual gain, both economic and environmental (Murray 1987).

User Characteristics

In many instances, resource users are individuals and families with no existing mechanism for making or enforcing managerial decisions beyond the family level (at least with respect to the resources in question). When quantity and availability of resources are relatively stable and highly predictable, individual and family management may be quite effective. As quantity and availability of resources become increasingly unstable and unpredictable, their management by

organizations becomes more important for reducing risk, focusing more on insurance and welfare functions than on productivity (Uphoff 1986:26-27).

Other user characteristics important to consider are **interdependence, competition**, and **tradition.** To the extent that resource users are dependent upon one another for their livelihood and even survival, the incentives for making local organizations work well are greater.

Certain resource management technologies may require interdependence and, therefore, the existence of some sort of organization to manage that interdependence. If irrigation systems are to provide a reliable and equitable water supply, their management cannot be left to individual users. If bench terraces are constructed to control soil erosion, there must be cooperation in constructing toe drains and waterways to carry away the runoff. If reforestation is to be effective in watershed management, then a high percentage of local residents must participate in an organized fashion, since a shotgun approach — with random, haphazard, widely dispersed participation — may actually exacerbate the problem.

The tasks of local organizations are greatly simplified when there is no competition among users. Competition may occur between different groups of users who perceive different uses for the resource, as in the case of pastoralists and farmers competing for the same fragile lands in semiarid environments, or indigenous peoples and settlers competing for the same land in the humid tropical lowlands (MacDonald 1988). It may also occur within a single group of users whose members wish to use the same resource for mutually exclusive purposes such as shade for animals versus charcoal production. Multiple uses may also be complementary, of course, as in the case of trees being used for soil retention, shade, and the harvesting of fuelwood, but such complementary uses do not pose the management problem of competition. A more invisible but common competition for different resources on the same land often arises between men and women.

Competition and conflict over resource use is less likely when cultural traditions cause users to see themselves as unified by kinship, occupation, geographical location, class, or some other common characteristic. But where such traditions of group identity do not exist, have disappeared, or have become ineffective, local administration or local government may be needed to reach or mediate decisions. When scarce, valued resources are at stake, the incentive is great for one set of users to attempt to control them. Compliance with decisions and regulations is rarely achieved through coercion. Processes of consultation and consensus are far more effective and far more likely to be achieved by local organizations than by central government.

Uphoff has argued that different types of resources have distinct organizational and management requirements, a consequence of the differing relationships local users have with these resources (1986:21-22). Organizational, management, and decision-making forms are often deeply embedded in cultural tradition. This presents a dilemma when traditions conflict with what is needed to manage a resource sustainably. This is seldom the case where traditional

cultures continue to use resources in traditional ways without outside interference or influence. But such instances are few and far between in the modern world where all traditional cultures have been impacted in some way by the forces of development. The dilemma most often occurs when:

- People are new to an area and attempt to manage resources in the new area in the same manner as they managed resources in their area of origin — even though the resources may be different, as in the case of colonists from the highlands along the eastern slopes of the Andes;

- Resource supplies drop below a level that was sustainable under traditional forms of management, because of population growth, exploitation by others, or some other cause; and

- Development projects attempt to introduce new resources or new uses for old resources that are not compatible with existing cultural traditions that affect resource use.

Decisions to undertake development activities that change the nature, management or control of a natural resource are likely to favor one user over another — particularly if one is less powerful and not organized. Local organizations, such as women's groups, and water users organizations are often the means by which less powerful members of a society make their voices heard in decisions about natural resources management. However, like everything else in the realm of development, local organizations are not a panacea. Under some cultural circumstances they may not prove appropriate, effective, or efficient; or they may require so much time and effort to establish that the costs greatly outweigh the potential benefits to be derived from their establishment.

CASES OF RESOURCE MANAGEMENT AT THE LOCAL LEVEL

Case materials are presented below that illustrate the strengths and weaknesses of local organizations as entities for the management of natural resources and fragile lands. From these cases as well as ancillary materials we will draw some conclusions about when local organizations are needed for fragile lands management, when they are appropriate, when they may be unnecessary or inappropriate, and what advantages they may provide over individual or family control.

Agroforestry in Haiti

The number of agroforestry activities conducted in Haiti render it a particularly valuable country for a case study. In an assessment of 25 years of reforestation and erosion control

measures in Haiti, Murray (1979, 1983) concluded that the overall failure of these efforts resulted from three critical deficiencies in planning:

- **Poor technical choices.** Although the trees provided to farmers were ecologically appropriate, they were generally slow-growing varieties in which commercial returns were too far down the road to be of much interest;

- **Poor microeconomic planning.** If the tree was viewed by the small farmer as neutral to his own cash needs, then it would be politely ignored. If the tree was perceived as negative to his economic interests, then it would be firmly rejected. The usual incentive consisted of appeals to the farmer to plant trees for Mother Haiti, for his grandchildren, or to preserve the soil on his plots of land. These messages emphasizing long-term payoffs were simply unconvincing to a small farmer on the hillsides of Haiti with serious short-term food and income needs. The emphasis on ecologically sound technology for the hillsides rather than on economically sound incentives for the hillside cultivator simply had not worked; and

- **Poor institutional planning.** Donors had insisted on entrusting resources to national public sector institutions that, in Haiti as in many other places, proved unable or unwilling to use donor funds for the purposes intended. This truly devastating weakness, a chronic failure in the domain of institutional planning, gave the coup de grace to reforestation efforts in Haiti.

Murray recommended concrete actions that could be taken to program and manage reforestation activities effectively and these formed the basis of the Agroforestry Outreach Program (AOP). It was clear that the project needed to promote trees in response to the peasants' need for cash in the short term. As a result, the planting and harvesting of trees was promoted as a cash crop. Thus, the central design issues became:

- Ensuring that benefits accrued in a timely manner to the farmers;

- Finding ways that trees could be planted on smallholdings without interfering with agricultural production; and

- Ensuring that the peasants, and not the government or the project, would be seen as the sole owners of the trees with unlimited rights to harvest the wood whenever they wished.

The technical approach was adapted to respond to these design issues.

Another issue that had to be resolved was institutional strategy and means of implementation. In the case of Haiti, it had become clear that "governmental involvement

condemned a project to certain paralysis and possible death" (Murray 1987). Thus, this project was implemented through international and local NGOs. In 1981, grants were awarded to CARE and The Pan-American Development Foundation (PADF). CARE operated directly with farmers in the northwest and established its own nurseries and extension network. PADF worked with a network of local NGOs in most of the rest of the country, helping them to establish nurseries and extension programs of their own (DESFIL 1990, Vol. 1). These NGOs comprised both regional and community-level organizations, had existed prior to the project, and were engaged in a variety of religious, secular, and developmental activities.

The Haiti AOP has been an unprecedented success, far exceeding the targets set by project planners; between 1982 and 1986, approximately 110,000 farmers planted more than 25 million seedlings. In early 1985, the project was extended and a contract awarded for applied research on technical and socioeconomic factors related to small-farmer tree planting. By the end of 1989, after eight full years of implementation, the AOP had produced and distributed more than 50 million trees to 200,000 peasants, 30 percent of whom are repeaters planting for the second time. On average, 40 percent of the trees survive outplanting.

In 1989, a DESFIL team evaluated the AOP and designed a follow-on project, the National Program for Agroforestry in Haiti (NPA). The team recommended that the NPA refine and build upon the successful AOP interventions, and institute only those new activities that were closely related to the old project, such as improved soil conservation and agroforestry techniques.

The DESFIL design team did not encourage the creation of new organizations, partly for political and cultural reasons and partly because a farmer can take advantage of the services offered simply as an individual (DESFIL 1990). Group formation is an inordinately difficult task in the Haitian rural context. As Lowenthal points out:

> Haitian rural society has always been highly individualized. While event-specific cooperation of many kinds occurs in both secular and religious contexts, no enduring, corporate groups, managing a common economic resource over time, have emerged as part of indigenous peasant social organization. . . . Where extrahousehold groups do occur in contemporary rural Haiti, they are invariably the result of...interventions by exogenous institutions [and] are fraught with difficulties, even where they ultimately succeed, for they essentially run counter to prevailing cultural dispositions towards individual and household autonomy (1990:11).

In those rare instances where some measure of success has been achieved in group formation, it has been linked to identifiable characteristics and capacities of the implementing agency:

- A relatively small-scale operation;
- Community organization as the preeminent goal, rather than as an intermediate step, in the development process; and
- A commitment to avoid all material resource-transfer activities for an extended initial period, in the service of organizational maturity and self-reliance (Lowenthal 1990:43).

In the Haitian context, sustained coordinated group activity beyond the household level is alien to existing cultural values and is unworkable except where the formation of local organizations has been successfully accomplished by exogenous organizations; and even then interventions using such local organizations are risky.

Haitian farmers manage trees for multiple uses in association with other plants and animals, often in small, fragmented areas. In other words, they practice true agroforestry. Getting them to do so has been possible by attending to their values and forms of organization and working within that framework. The lessons of Haiti are that community agroforestry projects can be successfully carried out by individual farmers and that attempting to do so through local organizations is, in the rural Haitian cultural context, a high risk proposition fraught with difficulties and not cost-effective.

A recent World Bank publication discusses the importance of social factors and social units in forestry activities and emphasizes that:

> Perhaps the most important factor in designing a social strategy for a forestry program is identification of the units of social organization that are likely to participate in the program and evaluation of their ability to do so. The operational challenge is to disentangle the broad term "people" and to identify which units of social organization or groups of people can and will grow trees, in which ways, and for what purposes (Gregersen et al. 1989:132).

In rural Haiti, the significant unit of social organization, *par excellence* is the farm household.

On-Farm Water Management in the Dominican Republic

Local organizations for managing irrigation water are probably the most common and best known, partly because the resource in question is known and predictable and the users form an identifiable, coherent group. User groups, supported by technical and financial resources provided through a department of irrigation, have a crucial role to play in irrigation management, especially in relatively small-scale systems. In the case of small-scale irrigation systems, attempts at centralized control by national governments have often had infelicitous

results. By the same token, large-scale irrigation cannot be managed by national institutions without strong local institutional capability (Uphoff 1986:39-40).

The On-Farm Water Management Project (OFWMP) in the Dominican Republic, financed by USAID, was implemented through the Instituto Nacional de Recursos Hidraulicos (INDRHI) of the Dominican Republic. At the request of USAID/Santo Domingo, the project was evaluated by a DESFIL team in 1989 (Hanrahan et al. 1990). Instituted in 1983, the project's objectives are to strengthen the planning and management capacity of INDRHI, to increase the productivity of irrigated agriculture, and to improve lands affected by waterlogging. The areas targeted are the Azua and Santiago irrigation systems, which total 14,000 ha and serve 6,000 farm families.

Under Dominican law, INDRHI is charged with construction, operation, and maintenance of irrigations systems of all kinds from dams and major impoundments to farm-level distribution structures; the allocation and scheduling of water deliveries; and the collection of user fees.

Before OFWMP began, the Azua irrigation system experienced a host of problems. Farmers at the upper end took a disproportionate share of the water. As a result, farmers at the middle and lower end of the system received sporadic and unreliable water supplies, making crop production uncertain. At the head end, overirrigation resulted in salinization and waterlogging. Users had little voice in the allocation of water. Rather than paying scheduled, per-hectare user charges to INDRHI, some farmers paid INDRHI-appointed water distributors directly to deliver water to their individual fields. Revenues from water-user fees covered only 10-15 percent of operations and all maintenance costs were covered by the government. The result was a highly subsidized system. Large parts of the 10-year-old system had never been completed and had deteriorated badly because of lack of maintenance. The Santiago system was newer and in better condition than the Azua system but was experiencing similar problems.

By the early 1980s, INDRHI recognized the need to turn over portions of the irrigation systems and their management to users, but attempts to do so did not fare well. In 1986, USAID shifted the efforts of OFWMP to emphasize the formation of local water-user organizations as a prerequisite to transfer of management responsibilities. To facilitate the process, OFWMP made improvements to the irrigation and drainage infrastructure in the two systems, assisted in the formation of local organizations, and facilitated the turnover of operation and maintenance responsibilities from INDRHI to the local user associations.

This project, a pioneering effort to transfer large irrigation delivery systems to local water-user groups, required that a 75-year pattern of increasing state control over all aspects of small farmer agricultural production be reversed. OFWMP has successfully organized groups of farmers to manage these systems and facilitated the transfer of control from INDRHI to these groups. This achievement is particularly remarkable, given the presence of an entrenched bureaucracy, and the heterogeneity of the project area in land tenure, land quality, crops produced, and farmers' prior experience with irrigation.

The local irrigation associations are broad-based, representative groups that ensure equitable water delivery, collect fees (which the government allows to be used by the local user groups), manage conflict, and reduce violations of system rules. By substituting volunteer ditchtenders nominated by their peers for the poorly paid and corruptible ditchtenders on the public payroll, the user organizations have made significant strides toward achieving equitable water delivery and generating internal support for turnover.

It is important to note that, unlike Haiti, there was apparently no cultural tradition among Dominican farmers that would present staunch resistance to the formation of local organizations. There was also a clear need for such cooperative effort on a long-term basis if the irrigation problems confronting the farmers were to be solved. Irrigation systems cannot be successfully maintained and operated on an individual, piecemeal basis. The water-user organizations of the project are still young and fragile, in spite of their already impressive achievements. They are likely to require outside attention for some time to come.

The following lessons may be drawn from this experience (Hanrahan et al. 1990:28-34):

- Organizational forms may differ depending on local circumstances, but represent a compromise between the need to manage the systems efficiently and the need to ensure that all water users in the systems are served adequately. The organizations have included large landowners; small, agrarian reform settlements; and private holdings. They have organized democratic elections and imposed sanctions to prevent illegal use of water and destruction of infrastructure;

- By ensuring more equitable water delivery, the organizations have been able to reduce conflict. This has been facilitated by two factors: first, there is an ample supply of water; and, second, mechanisms exist for managing the conflicts that do arise;

- Timely and adequate water delivery to users in all parts of the irrigation system is the sine qua non for organizational viability. Farmers will continue to pay fees only if the water service meets their needs; and

- Although the organizations hold considerable promise, they are young and still dependent upon outside support for legal status, institutional collaboration, and human and financial resources. This outside support is needed to build the inside support — the continued participation and involvement of members — that is a prerequisite for organizational viability.

Much of the literature on local organizations stresses the importance of building local capacity. The literature on water-user organizations provides specific guidelines. Accumulated experience from Southeast Asia reinforces and supplements the lessons of the Dominican

Republic. Based principally on their experience with the National Irrigation Administration in the Philippines, Bagadion and Korten (1985:80-82) emphasize the following:

- **Authority.** The authority given an irrigators' association can range from cleaning the ditches to having full responsibility for operating and maintaining the entire system. The less authority the local association has, the weaker it is likely to be. Its power resides in the agreement among members that rewards and punishments will be employed in certain specified ways to get members to do what they would not otherwise do (Freeman and Lowdermilk 1985:100);

- **Existing organizations.** Although these groups do not always operate as effectively as the government would like, they have often withstood the test of time and developed useful traditions and leadership roles not easily replaced. Existing organizations have the usual advantages that accrue to any incumbent and efforts to introduce new organizations will be competing for people's resources, time, and loyalties. Existing organizations should be assessed for their capacity and appropriateness on a case-by-case basis (Uphoff 1986:205-206);

- **Resource contribution.** Obtaining a resource commitment from organizational members is desirable because it establishes some feeling of ownership on their part and also provides some leverage with the implementing agency, not available in the case of a government handout; and

- **Participation in planning, layout, and construction.** A common assumption is that there is no reason to develop an irrigators' association until there is water running in the canals. The experience worldwide underlines the importance of early involvement to developing the capacities of irrigators' associations to manage and maintain their systems (Siy 1982). Recent experience in Pakistan with the Command Water Management Project reinforces this emphasis on preconstruction organizing (Betts et al. 1989).

Watershed Management and Soil Conservation in San Martin Jilotepeque[2]

Integrated watershed management is the process of formulating and implementing a course of action involving natural and human resources in a watershed, taking into account the social, political, economic, and institutional factors operating within a watershed and other relevant regions to achieve specific social objectives (Dixon and Easter 1986). For watershed management, questions about the appropriateness of different organizational forms, styles, and performance have rarely been asked. Upper watershed management typically falls under a national agency charged with management of forests, hydroelectric power generation, or soil conservation that views the local population as an obstacle to achieving its goals (Gibbs 1986).

Often there are several resources involved. Rehabilitation of deforested watersheds demands not only watershed forestry and massive planting of trees but also flood control and soil conservation, using both mechanical and vegetative means. There many be changes in rights to land, in rules of inheritance, in settlement patterns, and in the number of inhabitants. Since the work required is usually beyond the scope of what individual farmers can do on their own, group action of some sort is required — as well as support from technical agencies (Cernea 1985).

Because upper watershed areas typically cannot support much agriculture, they are usually less densely populated — making organizational development and maintenance all the more difficult. The population living in upper watersheds is often culturally and economically marginal, having been pushed out of the more productive lowland areas at some time in the past. Desirable as it may be, watershed management offers weaker incentives for collective action (Gibbs 1986:100-101, Uphoff 1986:49).

Most experience in watershed management indicates that the cooperation of the people cannot be effectively commanded or compelled from outside. According to Spears (1982), in Nepal there has been a more favorable response to watershed management in the more remote areas where there has traditionally been more reliance on indigenous local institutions and less central government capacity for direction.[3]

There is considerable overlap between forest management, watershed management, and soil conservation, as well there should be. Two important but interrelated problems with soil conservation projects have been, first, persuading farmers that the proposed technical interventions will provide worthwhile economic benefits in both the short- and medium-term (Murray 1987); and, second, persuading farmers that these interventions may be more effective and more profitable if implemented by a group rather than on an individual level (Hanrahan 1988).

One well-known soil conservation/watershed management project in which the local organizational component played an important role is the San Martin Jilotepeque project in the highlands of Guatemala (Gow et al., Vol. 2, 1979:153-170). This project, supported by World Neighbors and OXFAM, was designed to meet the following long-term goals: agricultural development, human resources development, health and family planning, and road construction. As the project evolved, increasing emphasis was placed on agricultural production. But the most crucial aspect of the intervention strategy was the creation of a credit union cooperative and a small input supply store that provided loans in agricultural inputs, livestock, land purchase, small business, housing, and consumption.

San Martin was chosen as the target area because its residents were probably the poorest in the department of Chimaltenango and the most traditional in their attitudes towards change. Since data collected showed that maize yields were among the lowest in the country, the project concentrated its efforts on doubling yields of participating members in five years and reversing

the decline in fertility caused by erosion. Local farmers were selected to serve as paraprofessional promoters of the conservation and production practices developed by the project.

Because the technical emphasis was two-fold — increasing yields and soil fertility — the production gains were cumulative. After using the technical package for five years, participating farmers recorded average increases in yield of 600 percent for beans and 1,100 percent for maize. Such was the popularity and effectiveness of this soil conservation program, with its strong organizational and technical components, that it was singled out for attention during the period of heightened political repression during the late 1970s and early 1980s. Several of its leaders were assassinated and, at the present time, World Neighbors personnel cannot visit the area for fear they will be physically harmed.

Nevertheless, the San Martin experience provides some valuable lessons for organizing farmers for soil conservation activities — some of which are drawn from World Neighbors' experience and impressive track record in various parts of the world (Bunch 1982):

- Needs and priorities of the local population are surveyed prior to the intervention, and the project focuses on meeting specified needs;
- The strategy begins on a small scale, introducing a few innovations, which are then modified, extended, and expanded upon gradually. This is particularly true for the technical interventions;
- Project beneficiaries are trained as promoters, thereby contributing to technical sustainability;
- The cooperative is run as a business, its services are profitable, and its reserve accounts substantial; and
- External resources are kept to a minimum and every effort is made to minimize cost, including the withdrawal of expatriate staff once the project is operating smoothly, thereby avoiding a dependency relationship.

Kuna Conservation Efforts in Panama

Protected wildlands such as parks, forests, wetlands, mangrove swamps, and other areas of great natural beauty and scientific interest pose particular management problems because their protection often pits them against the needs of local people for their resources. The valid arguments about the value of biodiversity, endangered species, and vanishing tropical rain forests, which have become the basic tenets of the conservationist critique, have failed to arrest the alarming patterns of natural resource destruction that persist in many developing countries today (Browder 1988).

Nonetheless, in the last few years, both development and conservation professionals have begun to explore people-oriented benefits of protected areas. When such areas are protected, potential economic activities include research, nature tourism, natural-forest management, game cropping and sustainable yield harvesting of forest products, and several other enterprises (Gow et al. 1988:59).

Often areas designated as protected are the ancestral lands of indigenous groups and their traditional use of the resources may be in jeopardy due to new government laws and policies. Under such circumstances, it may not be enough simply to promote local participation. Planners and policy makers must specify participation by whom, under what sorts of institutional arrangements, and with respect to which resources.

Under some circumstances, the establishment of protected areas can serve as a means to protect traditional indigenous use rights to resources. In one unusual instance, the indigenous people themselves promoted protected status for a part of their traditional territory, although with a less successful outcome than they had hoped to achieve, at least up to now.

In the early 1980s, the Kuna Indians of Panama set aside an area of virgin forest at Udibiri, along the southern border of their territory, and transformed it into a wildlife reserve, with assistance from outside donors and a modicum of cooperation from the Government of Panama. The Kuna are one of the few indigenous groups in all of the Americas to have maintained considerable cultural and political autonomy despite almost 500 years of European contact. Today, their territory encompasses a thin band of jungle running some 200 kilometers along the Atlantic coast east to the Colombian border, and including dozens of near-shore islands where most of their villages are located (Chapin 1985). Resisting would-be conquerors and subjugators, they remain the sole masters of their territory, legally designated by national law as a reserve (*comarca*). According to Panamanian law, no non-Kuna can hold claim to land within the reserve and all tourism is locally controlled and regulated (Breslin and Chapin 1988).

The Kuna decided to establish a wildlife reserve within their territory when the building of a branch road from the Pan American highway brought a gradual influx of settlers who opened farms along the borders of their lands. Since these lands were unoccupied at the time, the Kuna decided that, if they wished to maintain control over them, they should establish a presence. In 1975, they founded an agricultural colony at Udibiri. Although the Kuna planted a variety of crops, including both field and tree crops, none did very well because of the cool, wet climate. Advice from for Tropical Agricultural Research Center in Costa Rica confirmed that the land was unsuitable for agriculture and should be left in its virgin state.

Over the next two years, the Kuna decided to make the entire top of the ridge at Udibiri — a premontane rain forest near the summit of the San Blas mountains — into a park. During this period, they consulted with scientists, foresters, and technicians from a wide variety of institutions. The activities contemplated included an environmental education component,

agroforestry and other forms of sustainable resource use, and the design of nature trails and field stations throughout the jungle.

There were also plans to use the area as a research center for scientists carrying out long-range studies and as a site for nature tourism. The Kuna had already established a viable working relationship with the Smithsonian Tropical Research Institute, which has offices in Panama City. The Kuna had prior experience running tourist hotels in the coastal area, an experience gained only after they had forcibly ejected all the foreigners who dominated the business. The hotel owners, now all Kuna, are subject to Kuna law and benefits remain in the region.

But the nature tourism business has not worked out (Chapin 1990). This is in part due to lack of easy transportation to the park, which is three hours' drive from Panama City. More important, however, is the wider national context. Unlike Costa Rica, there is no tourist infrastructure developed around natural areas in Panama. No travel agencies in Panama City are equipped to handle ecotourism, and Panama does not advertize its natural beauty on a national or international scale. As a result, the Kuna park remains wet, cloudy, and unvisited on the crest of the Continental Divide, and threatened by the unwelcome encroachers whom the Kuna continue to have difficulty keeping out.

In the Kuna case, despite a long history of successful resource management by local village organizations and experience with tourism, outside support appears necessary to prevent further intrusions by cattle-oriented *campesinos* from Panama's eroded and denuded central provinces. Lack of support from government for infrastructure maintenance and from the tourism industry has caused the project to languish.

In a recent review of development alternatives for the tropical rain forests of Latin America, Browder (1989) discusses the advantages and disadvantages of various approaches to natural forest management, including the establishment of reserves and protected areas. He makes the crucial point that the implementation of such strategies relies heavily on restrictive land use zoning, often in areas where surrounding land uses are incompatible with intended forest management activities. Under such circumstances, reserves must be treated as one component of a larger land use strategy that accommodates the competing land uses surrounding them. He concludes with this warning (Browder 1989:127-128):

> Establishing low-use-intensity reserves favorable to one group of people in areas undergoing rapid land use transition may unfairly discriminate against others, resulting in social conflict. "Extractive reserves" — in which lands are set aside especially for the harvesting of tree products (e.g., nuts, rubber) but not for tree cutting — can work, but only if cattle ranchers, landless peasants, and other forest land users pressing at the edges are simultaneously incorporated into complementary solutions to their respective needs for land and forest resources.

This of course presents the ideal. In reality, as the rubber tappers in the Amazon have discovered, the economics and politics of resource use in Latin America are highly charged and often fatal.

LESSONS LEARNED AND GUIDELINES FOR THE FUTURE

There is no blueprint for the creation and maintenance of local organizations for the management of fragile lands and natural resources. Instead, there is a collection of lessons learned from many experiences in various parts of the world, most of which must be adapted and modified to meet the needs and demands of the specific locality. Development at the local level is, by its very nature, site specific. One of the initial problems of community forestry approaches in the late 1970s and early 1980s, for example, was that development planners made assumptions about the ability of communities to implement collective activities on communal land. Often, these assumptions proved false. Communities were found to be stratified and split into factions rather than homogeneous; interests of community members often differed so radically that unified action was impossible; community land was often limited and its tenure status often uncertain; and communities were often not organized as joint producers in any other respect (Gregersen et al. 1989:133-4).

In evaluating local organizations either in terms of their potential for sustainable management of local resources or in terms of the job they are doing after a period of time, certain key organizational characteristics should be carefully examined. These include:

- Type of governance and broadness of leadership base;
- Type(s) of decision-making process(es);
- Style of authority structure;
- Type of allocation of management responsibilities;
- Principal motivations of leadership and membership;
- Degree of sensitivity to local needs and capacity to meet them;
- Ability to promote broad-based participation;
- Level of development of management skills;
- Need for financing, available sources, and financing strategy; and
- Cost-effectiveness (Avina 1990:7-13).

In an evaluation of eight Inter-American Development Foundation projects using these and numerous other indicators, Avina concluded, among other things, "that there is no single form of participation that works best in all instances," and that "a common and potentially troubling issue is dependence on one strong leader" (6 of 8 cases) (1990:30,37). Avina lists four factors that appear to be good indicators of institutional sustainability of local organizations:

- Capacity to continue to meet local needs;
- Local participation in project implementation;
- Existence of management and accounting skills at the levels needed to carry out the organization's program; and
- Involvement of diverse leaders (1990:36-37).

On the basis of the information presented here, the most relevant lessons with regard to resource stewardship at the local level include — but are by no means restricted to — the following:

- Development interventions should concentrate on assisting local people to achieve livelihood security by developing their productive resources and, in cases where resources are limited or insufficient, assisting them to create new resources;
- By furthering livelihood security through ownership or local control of resources, the poor can be empowered, and, although empowerment does not guarantee good stewardship, it does offer the poor some alternatives from which to choose;
- Local organizations can play an important role in the process of empowerment but they must be adapted to the characteristics of the resource in question and the cultural traditions and values of the users;
- Linkages with nonlocal organizations and agencies, both public and private, is important to the institutional strengthening of local organizations; but,
- External resources should be kept to a minimum and every effort made to minimize cost through the generation of local resources in both cash and kind — a strategy that will reduce external dependency;
- Local organizations may not always be necessary, appropriate, or cost-effective vehicles through which to work, and attempts to create them may engender antagonism due to deeply ingrained cultural values (as in the case of Haiti);

- Management by local organizations may be required for some types of resources, such as irrigation systems;

- Studies of existing local organizations should be made to determine their suitability for particular resource management tasks;

- When existing local organizations do not exist or are not deemed appropriate for particular development activities, great care should be exercised in promoting the formation of appropriate local organizations to ensure that people feel comfortable with the approach and that existing allocations of power and resource control are not preempted or interfered with;

- Even if appropriate local organizations exist for the tasks at hand, programs of institutional strengthening may be necessary prior to project implementation;

- When development activities are channeled through local organizations, a process approach incorporating the flexibility to modify project strategy and goals as new information is obtained is a *sine qua non* of project success; and

- Appropriate incentives can be crucial to the successful creation or strengthening of local organizations (see Chapter Seven), and care should be taken to insure that they respond to local needs, desires, agendas, and interests.

ENDNOTES

1. Karen McKay and Molly Phee of DAI contributed a substantial amount of time and thought to the reorganization of the original draft of this chapter, as well as extensive comment on its substance. We greatly appreciate their efforts.

2. This discussion assumes a region with considerable relief. Watersheds also exist on nearly level land. In such instances, the upper watershed may be similar to the lower.

3. A statistical analysis of 150 local organization case studies indicated that organizational performance is not adversely affected by unfavorable environments such as mountainous terrain and poor infrastructure — in fact, there is some indication of a positive correlation (Esman and Uphoff 1984:106-112). In such environments, the rural poor are most likely to be found, and a local organization may be able to attract and provide scarce development resources that would be otherwise unavailable (Gow et al,, Vol. 1, 1979:108). Equally important, local residents in such disadvantaged circumstances may conclude that if they do not help themselves, nobody else will (Esman and Uphoff 1984:111). This has certainly been the case in the West African Sahel where local organizations, both traditional and newly evolved, have become the backbone of environmental management and restoration activities.

REFERENCES CITED

Avina, J. M.
1990 Evaluating the Impact of Grassroots Development Funding: An Experimental Methodology Applied to Eight IAF Projects. Issues in Grassroots Development, Monographs and Working Papers of the Inter-American Foundation. Rosslyn, Va.: IAF.

Arnold, J.E.M.
1989 People's Participation in forest and Tree Resource Management: A Review of Ten Years of Community Forestry. A report prepared for the Policy and Planning Service, Forestry Department, FAO. Draft. Oxford, U.K.: Oxford Forestry Institute.

Bagadion, B.U. and F.F. Korten
1985 Developing Irrigators' Organizations: A Learning Process Approach. In M. M. Cernea, ed., *Putting People First: Sociological Variables in Rural Development.* New York, N.Y.: Oxford University Press, pp. 52-90.

Betts, R.H., M.I. Chishti, T. Husain, P. Reiss, and G. White
1989 Midterm Evaluation of The Command Water Management Project. Volume One: Findings and Recommendations. Washington, D.C.: Irrigation support Project for Asia and the Near East (ISPAN).

Boserup, E.
1970 *Women's Role in Economic Development.* New York: St. Martin's Press.

Brechin, S., and P. West
1982 Social Barriers to Implementing Appropriate Technology: The Case of Community Forestry in Niger, West Africa. *Humboldt Journal of Social Relations* 9(2):81-94.

Breslin, P. and M. Chapin
1988 Conservation Kuna-Style. In S. Annis and P. Hakim, eds., *Direct to the Poor: Grassroots Development in Latin America.* Boulder, Colo.: Lynne Rienner Publishers, pp. 73-82.

Bromley, D.W., and M.M. Cernea
1989 The Management of Common Property Natural Resources: Some Conceptual and Operational Fallacies. World Bank Discussion Paper 57. Washington, D.C.: World Bank.

Browder, J.O.
1988 Symposium on Fragile Lands. The DESFIL Newsletter 2(1):1-4.

Browder, J. O.
1989 Development Alternatives for Tropical Rain Forests. In H.J. Leonard and contributors, *Environment and the Poor: Development Strategies for a Common Agenda*. Overseas Development Council. New Brunswick, N.J.: Transaction Books, pp. 111-133.

Bunch, R.
1982 *Two Ears of Corn: A Guide to People-Centered Development*. Oklahoma City, Okla.: World Neighbors.

Cernea, M.M.
1985 Alternative Units of Social Organization Sustaining Afforestation Strategies. In M.M. Cernea, ed., *Putting People First: Sociological Variables in Rural Development*. New York, N.Y.: Oxford University Press, pp. 267-293.

Cernea, M. M.
1987 Farmer Organizations and Institution Building for Sustainable Development. *Development Dialogue* 8(2):1-24

Chambers, R.
1983 *Rural Development: Putting the Last First*. New York, N.Y.: Longman.

Chambers, R.
1988 Sustainable Rural Livelihoods: a Key Strategy for People, Environment and Development. In C. Conroy and M. Litvinoff, eds., *The Greening of Aid: Sustainable Livelihoods in Practice*. London, U.K.: Earthscan Publications, pp. 1-17.

Chambers, R., and M. Leach
1987 Trees to Meet Contingencies: Savings and Security for the Rural Poor. IDS Discussion Paper 28. Brighton, U.K.: Institute of Development Studies.

Chapin, M.
1985 Udirbi: An Indigenous Project in Environmental Conservation. In T. MacDonald, Jr., ed., *Native Peoples and Economic Development: Six Case Studies from Latin America*. Cambridge, Mass.: Cultural Survival, Inc., pp. 39-53.

Chapin, M.
1990 The Silent Jungle: Ecotourism Among the Kuna Indians of Panama. *Cultural Survival Quarterly* 14(1):42-45.

DESFIL
1990 National Program for Agroforestry in Haiti, Vols. 1 & 2. DESFIL Technical Reports. Bethesda, Md.: Development Alternatives, Inc.

Dixon, J.A. and K.W. Easter
1986 Integrated Watershed Management: An Approach to Resource Management. In K.W. Easter, J.A. Dixon, and M.M. Hufschmidt, eds., *Watershed Resources Management: An Integrated Framework with Studies from Asia and the Pacific.* Boulder, Colo.: Westview Press, pp. 3-31.

Esman, M.J., and N.T. Uphoff
1984 *Local Organizations: Intermediaries in Rural Development.* Ithaca, N.Y.: Cornell University Press.

Fairfax, S.K.
1984 Coming of Age in the Bureau of Land Management: Range Management in Search of a Gospel. Developing Strategies for Rangeland Management. Report prepared by the Committee on Developing Strategies for Rangeland Management, pp. 1715-1766. Boulder, Colo.: Westview Press.

Freeman, D.M. and M.L. Lowdermilk
1985 Middle-level Organizational Linkages in Irrigation Projects. In M.M. Cernea, ed., *Putting People First: Sociological Variables in Rural Development.* World Bank. New York, N.Y.: Oxford University Press, pp. 91-118.

Gibbs, C.J.N.
1986 Institutional and Organizational Concerns in Upper Watershed Management. In K.W. Easter, J.A. Dixon, and M.M. Hufschmidt, eds., *Watershed Resources Management: An Integrated Framework with Studies from Asia and the Pacific.* Boulder, Colo.: Westview Press, pp. 91-102.

Gow, D. D.
1987 Sustainable Development of Fragile Lands: The Case of Extensive Livestock Production in Africa. *Agricultural Administration and Extension* 24:3-32.

Gow, D. D.
1990 The Moral Economy of Sustainable Development: Institutions, People, and Natural Resources. A report prepared for World Wildlife Fund. Draft. Washington, D.C.: The Osborn Center for Conservation and Development.

Gow, D.D., et al.
1979 Local Organizations and Rural Development: A Comparative Reappraisal. 2 vols. Washington, D.C.: Development Alternatives, Inc.

Gow, D. D., et al.
1988 Environmental Assessment for the Northern Zone Consolidation Project in Costa Rica. 2 vols. DESFIL Technical Reports. Washington, D.C.: Development Alternatives, Inc.

Gregersen, H., S. Draper, and D. Elz
1989 People and Trees: The Role of Social Forestry in Sustainable Development. EDI Seminar Series. Washington, D.C.: World Bank.

Hanrahan, M.S.
1988 "Sustainable Uses for Steep Slopes" Workshop Proceedings. Volume II: Synthesis Report. DESFIL Technical Report. Washington, D.C.: Development Alternatives, Inc.

Hanrahan, M., B. Lynch, W. McAnlis, and J. Wolf
1990 Evaluation of the On-Farm Water Management Project in the Dominican Republic. DESFIL Technical Report. Washington, D.C.: Development Alternatives, Inc.

Hardin, G.
1984 The Tragedy of the Commons. In D.C. Korten and R. Klauss, eds., *People-Centered Development: Contributions Towards Theory and Planning Frameworks*. Hartford, Conn.: Kumarian Press, pp. 84-96.

Horowitz, M.M
1988 Anthropology and the New Development Agenda. *Development Anthropology Network* 6(1):1-4.

Hyden, G.
1983 *No Shortcuts to Progress: African Development Management in Perspective*. Berkeley, Calif.: University of California Press.

Little, P.D., M. M Horowitz, and A.E. Nyerges, eds.
1987 *Lands at Risk in the Third World: Local-Level Perspectives*. IDA Monographs in Development Anthropology. Boulder, Colo.: Westview Press.

Lowenthal, I.
1990 Social Soundness Analysis of the National Program for Agroforestry. In DESFIL National Program for Agroforestry in Haiti. DESFIL Technical Report. Bethesda, Md.: Development Alternatives, Inc., Vol. 2, pp. 1-48.

Macdonald, T.
1988 Another View: Indigenous Perspectives. The DESFIL Newsletter 2(1):8-12.

Moore, B. Jr.
1967 *Social Origins of Dictatorship and Democracy: Lord and Peasant in the Making of the Modern World.* Boston, Mass.: Beacon Press.

Murray, G.M.
1979 Terraces, Trees, and the Haitian Peasant: An Assessment of 25 Years of Erosion Control in Rural Haiti. Report submitted to USAID/Haiti. Port-au-Prince, Haiti: A.I.D.

Murray, G. M.
1983 Agroforestry Outreach: An Approach to Tree Planting in Rural Haiti. Port-au-Prince, Haiti: Pan American Development Foundation.

Murray, G. M.
1987 The Domestication of Wood in Haiti: A Case Study in Applied Evolution. In R.M. Wulff and S.J. Fiske, eds., *Anthropological Praxis: Translating Knowledge into Action.* Boulder, Colo.: Westview Press, pp. 223-240.

Redclift, M.
1987 *Sustainable Development: Exploring the Contradictions.* New York, N.Y.: Methuen.

Roe, E., and L. Fortmann
1982 *Season and Energy: The Changing Organization of the Rural Water Sector in Botswana.* Ithaca, N.Y.: Cornell University, Center for International Development, Rural Development Committee.

Sanford, S.
1983 *Management of Pastoral Development in the Third World.* Chichester, U.K.: John Wiley and Sons.

Scott, J.C.
1976 *The Moral Economy of the Peasant: Rebellion and Subsistence in Southeast Asia.* New Haven, Conn.: Yale University Press.

Scott, J. C.
1985 *Weapons of the Weak: Everyday forms of Peasant Resistance.* New Haven, Conn.: Yale University Press.

Shaikh, A. et al.
1988 Opportunities for Sustained Development: Successful Natural Resources Management in the Sahel. 4 vols. Washington, D.C.: E/DI.

Siy, R.
1982 *Community Resource Management: Lessons from the Zanjera.* Quezon City, Philippines: University of the Philippines Press.

Spears, J.S.
1982 Rehabilitating Watersheds. *Finance and Development* 19(1):30-33.

Thomas, T.
1985 Reorienting Bureaucratic Performance: A Social Learning Approach to Development Action. In J-C. Garcia Zamor, ed., *Public Participation in Development Planning and Management: Cases from Africa and Asia.* Boulder, Colo.: Westview Press, pp. 13-30.

Uphoff, N.T.
1986 *Local Institutional Development: An Analytical Sourcebook with Cases.* West Hartford, Conn.: Kumarian Press.

Uphoff, N.T., J.M. Cohen, and A.A. Goldsmith
1979 Feasibility and Application of Rural Development Participation: A State-of-the-Art Paper. Ithaca, N.Y.: Cornell University, Center for International Studies, Rural Development Committee.

Waddell, E.
1983 Coping with Frosts, Governments and Disaster Experts: Some Reflections Based on a New Cuinea Experience and a Perusal of the Relevant Literature. In K. Hewitt, ed., *Interpretations of Calamity from the Viewpoint of Human Ecology.* Winchester, Mass.: Allen and Unwin, pp. 33-43.

Watts, M.
1983 On the Poverty of Theory: Natural Hazards Research in Context. In K. Hewitt, ed., *Interpretations of Calamity from the Viewpoint of Human Ecology.* Winchester, Mass.: Allen and Unwin, pp. 231-262.

World Bank
1988 The World Bank's Support for the Alleviation of Poverty. Washington, D.C.: World Bank.

CHAPTER SIX

ECONOMICS AND RESOURCE USE IN THE DEVELOPMENT OF FRAGILE LANDS IN LATIN AMERICA AND THE CARIBBEAN

by

Michael Hanrahan

INTRODUCTION

In this chapter the relationship between the conserving or the degrading use of natural resources and of environmental amenities to economic development is explored. The chapter is concerned with the economic consequences of resource degradation, the economic benefits of preserving resource productivity and quality, and how these affect the goals of income, welfare, and equity. The first section suggests a definition of economic development, measures for it, and how resource and environmental use relate to these measures. The second section discusses how the measures of economic development are influenced by resource and environmental degradation or conservation. The third section is a highly abbreviated and technical discussion of how economics values the consequences and effects of natural resource and environmental degradation or conservation. The fourth section presents evidence from DESFIL and others on the direction, magnitude, and nature of such effects. That evidence shows how economic development in Latin America and the Caribbean has been influenced by resource and environmental conservation or degradation. Finally, the fifth section draws conclusions from the preceding sections.

MEASURES AND STANDARDS: RESOURCE AND ENVIRONMENTAL DEGRADATION AND ECONOMIC DEVELOPMENT

Economic development is often defined in terms of income and its growth, consumer and producer welfare, and equity.[1] These are the goals of many governments and development agencies. Income, growth, welfare, and equity are all influenced by resource degradation or conservation and increases or declines in the quantity, productivity, or quality of resource and environmental amenities. The Development Strategies for Fragile Lands Project has been primarily concerned with the development and use of natural resources and the environment on the steep slopes and in the humid tropical lowlands of Latin America.

The use of resources and environmental amenities is always associated with some degradation:

> A certain level of environmental degradation is an inevitable consequence of human activity. . . . . The question is not how to prevent or eliminate environmental degradation altogether, but how to minimize it or at least to keep it to a level consistent with society's objectives (Panayotou 1989).

This view of resource and environmental use is common among governments and development agencies. The DESFIL project has been concerned with the use, as opposed to the preservation, of the environment and natural resources in development.

Costs, revenues, profits, rents,[2] and the value of economic factors of production are measures or components of income, welfare, and equity, and are directly influenced by conserving or degrading resource use. In other words, degradation and conservation affect the intensity with which land is used, the mix or choice of crops produced, crop yields, the mix and amounts of inputs applied, and the volume and mix of products produced and marketed. These effects in turn have a direct impact on costs, revenues, profits, and rents and on the value of resources in alternative (for example, degrading or nondegrading, sustainable or nonsustainable) uses.

The quantity and quality of consumer goods and services and consumer incomes available to acquire them determine utility and satisfaction. The latter are based on consumer preferences and measure consumer welfare and equity. Preferences, satisfaction, and utility are also affected by degradation and conservation. The idea that people want or prefer goods and services ultimately because of the utility or satisfaction derived from them underlies the economic theory of consumer behavior and demand.[3] For many people, the utility or satisfaction derived from pristine and abundant resources is preferable to that from degraded or scarce ones, and many people are demonstrably willing to pay for these preferences. The maintenance of greater quality in, say, a park, forest, grassland, wetland, or waterway, the preservation of such resources, and even the knowledge that quality and quantity are preserved and continue to exist have measurable value[4] that can be assigned to the resources.

The previous two paragraphs discuss effects on income, welfare, and equity at local and individual levels. There are also numerous off-site and aggregate or macro-level effects. For example, silt and sediment may fill dams and waterways, reduce the capacity of hydro-generation and irrigation systems, fill harbors and navigable waterways, facilitate flooding, diminish the productivity of fisheries, increase the costs of water purification, and have other deleterious effects. Pesticide residues and toxic chemicals may be transported into waterways and result in adverse effects on human and animal health. When mitigating and abating the degradation-induced impacts require resources from other economic activities, alter trade, or influence output, aggregate activity in entire economic sectors and income, growth, and equity in the macroeconomy may be affected.

A final dimension of income, growth, welfare, and equity associated with resource use is time, specifically the passage of long time periods. Resource depletion or destruction can occur over relatively short periods of time but the effects can persist indefinitely into the future. Degradation influences the intertemporal distribution of benefits — who enjoys them, and costs — who pays them. So, the rights of future generations — patrimony — to the benefits provided by resources and the responsibility of the present generation to bear some costs of preserving patrimony are dimensions of equity and welfare. Economic criteria to establish intergenerational patrimony are an essential part of resource economics.

These ideas about economic development — its definition, its components and measures, and producers, consumers, aggregate effects, and time — form the basis for this chapter's discussion of economics and resource use. The next section discusses the consequences and economic effects of selected kinds of degradation or conservation.

CONSEQUENCES AND ECONOMIC EFFECTS OF RESOURCE AND ENVIRONMENTAL DEGRADATION OR CONSERVATION: HOW THE MEASURES OF ECONOMIC DEVELOPMENT ARE INFLUENCED

The concrete, measurable economic effects associated with the consequences of selected degradation and misuse of resources and environmental amenities are the subject of this section. The phenomena selected for discussion are illustrative, and not an exhaustive list. The intent is to show an immediate link between economic development — income, its growth, welfare, and equity — and the consequences of misuse and degradation: diminished revenues, increased costs, lost rents, altered values, the loss of quality and quantity, diminished levels of producer and consumer surpluses, and the skewed distribution through time of the benefits deriving from resource and environmental amenities. The section is conceptual: concrete measures taken from development experience are the subject of Section Four.

Table 6.1 provides a summary of the discussion, which proceeds in four parts. First, producers are discussed in terms of the their supply of products and demand for production inputs. Then consumers are discussed, in terms of their demands for environmental and natural resources amenities. Then, both kinds of effects are discussed at the aggregate or macro level. Finally, the consequences and economic effects of degradation through time are discussed.

Production: The Supply of Products, the Demand for Production Inputs, and Dynamic Changes in Technology

First, consider induced or accelerated soil movement and runoff, resulting from, say, land used more intensively than its inherent capability.[5] Soil movement and runoff are associated with economic effects at both the site of the movement (on-site) and away from the immediate site of the movement (off-site).

TABLE 6.1. SELECTED PHENOMENA, THEIR CONSEQUENCES, AND ECONOMIC EFFECTS ASSOCIATED WITH DEPLETION AND DEGRADATION OF NATURAL RESOURCES AND ENVIRONMENTAL AMENITIES

PHENOMENA	ENVIRONMENTAL CONSEQUENCE	ECONOMIC EFFECTS
Induced or accelerated soil movement, loss, runoff	Loss of productivity (on-site): nutrient, water, organic material lost	Induced changes in product yields, land use intensity, input application and productivity, substitution between inputs or products; inducing altered profits, rents, producer surpluses; macro-economic, intergenerational effects.
	Sediment and pollutant movement and deposition; water turbidity (off-site)	Decreased irrigation, power generation; increased channel, harbor sedimentation; loss of fisheries; loss of site quality; toxic human, animal, plant effects; inducing same development, macro, and intergenerational effects.
Deforestation, forest conversion	Productivity, sedimentation, pollution, nutrient, water organic material consequences similar to soil movement; additional loss of species diversity	Yield, productivity, sedimentation effects similar to soil movement; loss of option to use or benefit from existence of species; attendant uncertainty; public, private values diverge.
Quantity, quality loss in environmental, recreational, ambient resources, amenities	Parks, reserves degrade, disappear; sport fishing, hunting deplete; noise; air pollution	Utility, satisfaction based on preferences diminish; causing movements and shifts in consumer demands for goods and services, inducing changes in consumer surplus, welfare, macro and intergenerational effects.
Aggregate disturbances	Volume, composition of trade changes; domestic output declines; public sector enlarges; public satisfaction diminishes; productive capacity diverted to abatement, repair, maintenance. Negative effects on balance of payments, public expenditures, deficit; employment, GDP decline; resource stock, environmental quality deplete; tax revenues decline; loss in aggregate welfare.	
Passage of time	Productivity, off-site, diversity, quantity, quality, aggregate consequences compound. Lost options; intergenerational inequity	Producer, consumer, aggregate effects pass forward in time; future generations lose options to use or benefit from resources, amenities; highly uncertain outcomes; divergence of public, private interests.

Nutrients, water, organic material, and other inputs — whether applied or naturally occurring — are lost with the moving soil and runoff, leading to changes in productivity as manifested by reduced crop yields, lowered livestock grazing capacities, and lowered growth of trees (Fernandez 1988, Dowding et al. 1985). This may lead to changes in the intensity of land use and of inputs applied. For example, either fewer crops may be produced per time period, or other crops that differ in their ability to generate profits, rents, and income may be produced. More inputs and a different mix of inputs — more purchased inputs, for example-- may be required to maintain yields. The relation is well established between the depth or thickness of topsoil and crop yields (Soil Task Force 1986, Crosson and Stout 1983, Page 1977). Often, losses in soil, soil quality, and water reduce yields, lead to a decreased frequency of plantings and harvests, or induce changes in the selection of crops produced — usually from more to less profitable crops. Either larger quantities of inputs must be applied to maintain yields, or yields decline with the same or lowered input use. These phenomena directly affect total and marginal production costs as the mix, amount, and productivity of inputs applied change. The values of applied inputs in their alternative uses also change. Total and marginal revenues change with the volume and mix of crops produced and sold. As costs and revenues vary, so do profits and rents. Changing profits and rents and changes in the values of inputs in their alternative applications induce movements and shifts in the supply of products and the demand for inputs, causing changes in producer and consumer surplus.

Deforestation, forest conversion, and loss of wetlands have very different physical manifestations, but their consequences and economic effects are similar to soil loss. Added consequences may derive from loss of species or loss of regulatory functions performed, such as filtration, stream flow regulation, and air quality maintenance (Randall 1988, Costanza et al. 1989, Folke 1990, Dixon and Sherman 1990)

Off-site, soil movement and runoff result in sedimentation, the transportation and deposition of pollutants, and increased turbidity. The economic effects can be severe, often many times greater than the on-site effects associated with changes in productivity (Moore 1985). The economic life and production capacities of dams, hydroelectric installations, and irrigation systems have been and continue to be seriously shortened and reduced due to sedimentation. Sedimentation caused by land misuse induces accelerated and costly dredging and cleaning of harbors and navigable waterways. Water turbidity and chemical pollutants in runoff increase water treatment costs and reduce the productivity of fisheries. Health effects occur. Tourism, a major and growing industry in Latin America, is adversely affected by reef destruction and beach pollution.

Consumption: The Demand for the Goods and Services Derived from Resource and Environmental Amenities

Consider a loss of quality inherent in a resource or amenity, or an outright loss of one (loss of quantity). These consequences of environmental and resource degradation are also associated with economic effects. Examples of quality loss might include decline in the appeal of a park resulting from invasion or overuse, decline in a sport fishery due to overfishing, increased ambient noise or unpleasant odor associated with some misuse of a resource, or loss of the ability to appreciate a pristine view due to air pollution. Loss of outright quantity might involve an outright conversion of the park, for example, to agricultural or livestock use; the disappearance of the sport fishery; the conversion of a pristine site to a land fill; and the like. The general effect of this kind of degradation is that the utility or satisfaction derived from consuming the good or amenity decreases or vanishes as the good or service declines in quality or altogether disappears. The consumer prefers the more pristine condition. Although some might think this degradation unfortunate but economically unimportant, an enormous body of evidence shows that large numbers of consumers attach real monetary value to such aesthetic and recreational preferences as evidenced by their willingness to pay for them and their willingness to allocate real income to continue to enjoy them (Smith and Karou 1990; Mitchell and Carson 1989; Dixon and Sherman 1990). Further, these values and preferences are consistent with economic ideas about consumer behavior and are measurable using conventional economic models that assign monetary values to the consumer preferences.

Aggregation to the Macroeconomy

Effects on individual producers and consumers aggregate in the macroeconomy. Changes in land productivity and yields alter total output. Altered output — changes in the mix and volume of products produced — and similar changes in input use may result in shortages of some commodities and surpluses of others. Fewer domestically produced goods and services (for example, crops, fisheries, forest products, energy, or tourism) can lead to domestic shortages or a need to import, for example, heavy machinery, agricultural products, or production inputs. Production and volume of export crops may decline, causing foreign exchange earnings to decline. Labor's share of agricultural output may decline as more purchased inputs are used. The productivity of coastal resources and fisheries may diminish. Their aesthetic or recreational appeal may diminish, causing tourism to decline. Deleterious public health effects may reduce the productivity of the work force, or require a larger health service sector to accommodate disabled workers. As degradation shortens the lives of major public works, their accelerated maintenance or replacement is induced, their operating and maintenance costs increase, and public sector expenditures for mitigation and abatement increase (such as dredging, and machinery and equipment replacement and repair). The state may need to replace the environmental services provided by forests and wetlands as their stock depletes, leading to increased participation of the public sector in the economy, affecting budget deficits and economic stability. As mitigation and abatement measures draw resources from elsewhere in the economy, alternative applications of these resources are foregone and the generation and use of

foreign exchange are affected. Diminished environmental quality may contribute to social unrest, diminished satisfaction among the consuming public, and a loss in aggregate welfare (Moore 1985, Waddell 1986, Dixon and Sherman 1990).

The government, foreign trade, tourism, fishery, agribusiness, and agricultural sectors may experience large, measurable effects when resources are conserved or excessively degrade.

Welfare and Equity Through Time

Productivity losses associated with resource degradation, such as soil movement, runoff, or loss of forests, worsen through time. Resource conservation, in this sense using the soil, forest, or other resource while maintaining or enhancing its productivity, will generally have the opposite effect. The maintenance of quantity and quality in species, natural areas, recreational opportunities, pure air, and the like preserves options for future generations at a certain cost to present ones. Fundamental questions of intertemporal equity are involved because the effects of environmental and resource degradation accumulate with time, so that individuals and whole societies who degrade enjoy benefits during current periods as the degradation occurs (often referred to as "resource mining"), and individuals not yet born and who have no present voice live with the cumulative consequences of the degradation. The disappearance or decline in quantity, quality, productivity, or diversity leads to a lost option to use the amenity, or to otherwise benefit from its existence at some future moment not presently foreseen.

Hanemann (1988) discusses several reasons why the preservation of future options may be important. Public or collective values on preservation may diverge from private ones; public preservation has the character of a collective good.[6] There is a considerable degree of uncertainty concerning the future consequences (risks) of present depletion (or conservation) actions. Individuals, societies, and generations may each value these risks differently.[7]

When resource degradation induces changes in production technology, this effects profits, rents, and consumer and producer surpluses, hence income and welfare, our measures of economic development. When degradation induces substitution between products produced or inputs applied, or leads to altered yields, the same effects occur. When consumers attach positive values to losses in the quantity or quality of resource amenities and when they are willing to pay to prevent these losses — both are common — changes in consumer surplus and welfare occur, again changing the measures of economic development. These effects aggregate to the macroeconomy. They persist through time, and have complex effects on future as well as present generations. The next section shows how economists attach value to these manifestations of resource use or misuse.

MEASURES AND VALUES: HOW ECONOMICS ATTACHES VALUE TO THE CONSEQUENCES AND EFFECTS OF RESOURCE AND ENVIRONMENTAL DEGRADATION

The economic value of natural resources and environmental amenities derives from their use or potential use, from their existence whether used or not, and from the option to use or benefit from their existence at future times or in ways not presently foreseen (Mitchell and Carson 1989, Costanza et al. 1989, Randall 1988). Substantial uncertainty and highly variable values and preferences surround use, existence, and option values. In Latin America, a respectable and growing body of work deals with production-side use value. Very little work appears to have been started or completed concerning consumer-side use value. No references were encountered on existence or option values.

Applied valuation is accomplished by defining the ideas of income, growth, and welfare in measurable ways that relate to producers (the supply side) and consumers (the demand side).

Producers

First, consider the value to producers such as farmers of conserving or degrading resources and environmental amenities. Producers seek to maximize profits over the short to medium term, and rents over the medium to long term (Box One).

Rent is the difference between the revenues from producing goods and services and the variable costs of producing the goods and services. Profit is rent less any fixed costs.[8]

Revenue is the product of market prices for goods and services times the quantities produced. Quantity itself is the result of combining production inputs according to recipes or formulas, under alternative production technologies. Revenue may therefore be expressed as a function of the prices of goods and services, the variable quantities of production inputs, and the technology employed in production.

Production costs are the summation of the quantities of production inputs used to produce the goods and services of interest times the prices of the production inputs. Because either profit or rent may be expressed as functions of inputs used, choice of technology, and product and input prices, the producer seeks to maximize a profit or rent objective by choosing an optimal mix of production inputs and production technologies.[9] For a choice of technology, optimization of either rent or profit leads to the expression of the demand by producers for production inputs as a function of input and output prices.

Under procedures and conditions outlined by Dillon, Ferguson, Young et al., Just et al., and others, optimal choices of inputs may be substituted into the original rent or profit objectives. The tools of differential calculus are then used to derive (1) producer demands for

Box One. Producer Valuation

1. Quantity produced q is a function f of inputs applied x_i. The function f represents a choice of technology, and relates the inputs applied to the quantity produced:

$$q = f(x_i).$$

2. Rent QR equals revenue R minus the variable costs of production C. Revenue is the product of product prices P and product quantities: $R = Pq$. Cost is the sum of input prices, w_i, times input quantities applied, $w_i x_i$. So:

$$QR = Pq - \sum_{i=1}^{n} \{w_i x_i\} = \textit{revenue less the variable costs of production.}$$

3. Profit Π equals rent less any fixed costs of production F.

$$\Pi = Pq - \sum_{i=1}^{n} \{w_i x_i\} - F = \textit{revenue less the variable costs less the fixed costs}$$

$$= QR - F$$

Profit and rent are commonly taken as producer objectives.

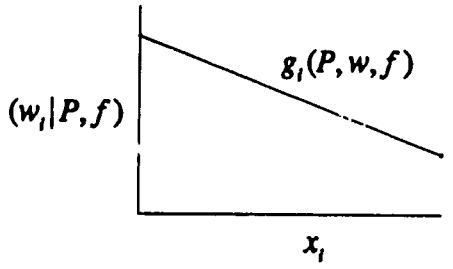
4. Because quantity produced is a function of the x inputs applied, both rent and profit may be expressed as functions of product and input prices, inputs applied, and production technology:

$$QR = Pf(x_i) - \sum_{i=1}^{n} \{w_i x_i\};$$

$$\Pi = Pf(x_i) - \sum_{i=1}^{n} \{w_i x_i\} - F.$$

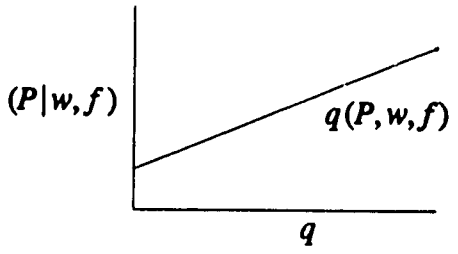
5. Optimization of the profit or rent objectives generates a series of producer demands for production inputs g_i. These are functions of product and input prices and production technology.

$$x_i = g_i(P,w,f);$$



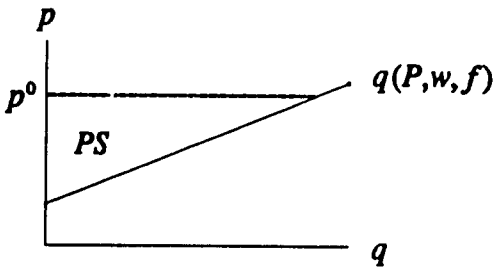
6. Under conditions discussed by Young et al., Varian, Silberberg, and others, and subject to conditions made explicit by Taylor, all of these relations may be manipulated to express the supply of products by producers q as functions of prices and technologies.

$$q = q(P,w,f);$$

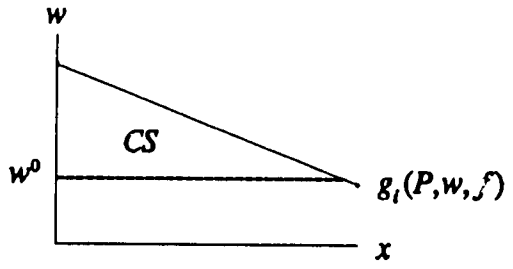


7. Finally, producer surplus PS and consumer surplus for producers CS are defined for given levels of product and input prices as the price-quantity triangular areas depicted graphically.

Producer Surplus ps



Consumer Surplus cs



Both ps and cs measure producer welfare and are equivalent to rent (refer to text).

REFERENCES: Ferguson, 1979; Dillon, 1979; Silberberg, 1978; Antle, 1988; Just et al., 1982; Young et al., 1986; Varian, 1984; Taylor, 1989.

production inputs — functions of input and product prices, given the choice of technology; and (2), producer supplies of goods and services — also functions of input and output prices, given technology. Both input demands and product supplies are graphed in price-quantity space. For specific levels of product and input prices, a standard price-quantity diagram may be used to show the demand by producers for production inputs and the supply by producers of products. The triangular area under the demand for production inputs and above the price line is consumer's surplus for producers, and the triangular area above the supply of products and below the price line is producer's surplus. Both surpluses measure the welfare of the producer. Optimal levels of rent may be recovered from the demand and supply expressions, and are equivalent to the two surpluses. Rent is equivalent to producer surplus.

So, referring to Box One and the foregoing discussion, producer income is measured by profits or rents (line 4). Growth is the change through time of income — the time path of profit or rent. Producer welfare is measured by the two surpluses and is equivalent to rent (line 7). Surplus is recovered from the demands by producers for inputs and their supplies of goods and services, and is equivalent to rent.

Consumers

Analogous reasoning applies to the demand for resources and environmental amenities by consumers, who seek to maximize their utility or satisfaction under individual preferences relating to the resources and amenities, as well as to all other goods and services available for consumption. However, the satisfaction of preferences is subject to limits on expenditures imposed by consumer incomes (Box Two). Resource and environmental valuation may be complicated by the absence of market prices or by public goods aspects of the natural resources or environmental amenities.[10]

Utility or satisfaction is derived from the consumption of goods and services — in this case, items like clean air, pristine views, parks, wildlife, or the preservation of future generations' rights. As the quantity or quality of resource and environmental amenities consumed (enjoyed) increases, so do utility and satisfaction (at least they do not decrease). Environmental goods are preferred to varying degrees by consumers, who are willing to pay to avoid degradation or depletion in the quantity or quality of them, or who must be compensated once degradation or depletion have occurred if their utility and satisfaction are to remain at prior levels.

The consumption of resource, environmental, and all other goods is limited by the ability to acquire them. Total income or total wealth sets this limit. Under procedures and conditions outlined by Deaton and Muellbauer (1983), Varian (1982), Just et al. (1982), Boadway and Bruce (1984), and others, a set of consumer demands may be derived for the goods and services available to the consumer, including resources and environmental amenities. As Box Two indicates, these demands are functions of prices (values), income or expenditure levels, and levels of satisfaction or utility. The demands may be graphed in price-quantity space.

Box Two. Consumer Valuation

8. Utility or satisfaction U, a variable, is a function f of i goods and services consumed, q_i. Total consumer income M constrains satisfaction. Income must remain greater than or equal to the sum of the prices of the i goods consumed, P_i, times the quantities consumed, q_i. These relationships may be expressed as:

$$U(q) = f(q_i) + \mathcal{L}[M - \sum_{i=1}^{n} P_i q_i \geq 0].$$

Consumers seek to maximize utility, where $\mathcal{L}$ is a Lagrangian multiplier interpreted as the marginal change in utility from a marginal change in income.

9. An alternate way of expressing these same relationships is to consider total income M as variable and utility as constraining. The consumer may then seek to minimize the income expended on goods and services ($M = \sum_{i=1}^{n} P_i q_i$), while maintaining some minimum level of utility or satisfaction U^0:

$$M = \sum_{i=1}^{n} P_i q_i + \mathcal{L}[U(q) \geq U^0(q_i)].$$

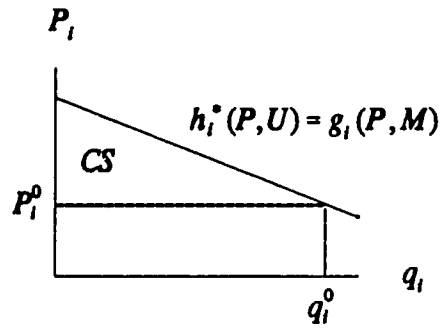
10. Optimization of the maximum utility or minimum income expended objectives generates a set or system of consumer demands for goods and services, including environmental and resource amenities:

$$q_i = g_i(P,M) = h_i^*(P, U[P,M]).$$

The g_i demand expressions derive from maximizing utility subject to the budget (income) constraint and the h_i^* demand expressions derive from minimizing the expenditure needed to attain at least the minimum levels of satisfaction. Under conditions discussed by Deaton and Muellbauer, Varian, Boadway and Bruce, Taylor, and others, these g_i and h_i^* expressions are equivalent and allow expenditures e to be expressed as a function of prices and levels of satisfaction:

$$e(P,U) = M = \sum_{i=1}^{n} P_i h_i^*(P,U).$$

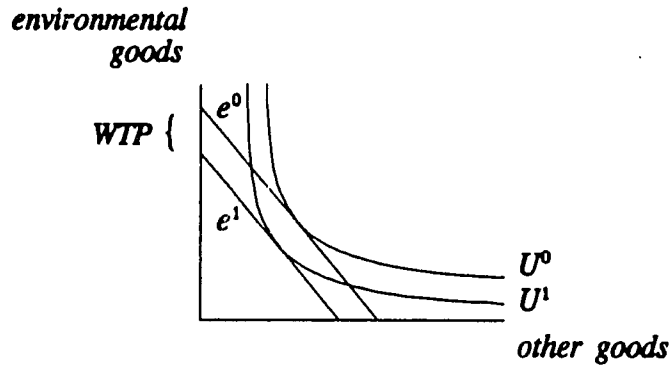
11. The demands may be represented on standard price-quantity graphs.



Consumer surplus, the measure of economic welfare associated with consuming goods or services, such as environmental amenities or natural resources of varying qualities or quantities, is defined as the triangular area *CS*.

12. Finally, the consumer's compensating variation, *CV*, is willingness to pay, *WTP*, to avoid a loss in quantity or quality of environmental and resource amenities. *WTP* is the value placed on the utility or satisfaction associated with the condition before degradation, for example U^0, minus the value that would be placed on the utility or satisfaction associated with the condition after degradation, say U^1 (U is defined as in Step 8).

$$CV = WTP = U^0 - U^1 = e^0 - e^1;$$



REFERENCES: Deaton and Muellbauer, 1983; Varian, 1982; Ward and Loomis, 1986; Taylor, 1989; Boadway and Bruce, 1984.

Given the demands, specific quantities or qualities of resource and environmental amenities may be associated with specific values (prices) of them. The triangular area under the demand and above the price line is the consumers' surplus. It measures the welfare of consumers associated with various quantities and qualities of goods and services. When these are environmental or resource related, the consumers' surplus measures the welfare of consumers deriving therefrom. The expenditure function (Box Two, line 10) can be recovered from the demand expression, as can consumer's surplus.

A consumer's willingness-to-pay is the value of the expenditure needed to attain the utility or satisfaction associated with one level (state or condition) of quantity or quality of goods and services consumed and the expenditure needed to attain a different level. Alternatively, it is the amount of income or wealth that would leave the consumer at least as well-off (satisfied) after a change in condition (of the goods or amenities in question) as before the change.

So, referring to Box Two and the foregoing discussion, consumers seek the greatest possible level of utility or satisfaction. This is associated with the consumption of goods and services including resource and environmental amenities but the consumption is limited by constraints on income or expenditure. Utility is derived from both quantity and quality of goods. Welfare is measured by surplus, recovered from the demands derived from the satisfaction of preferences. Consumers are willing to pay to compensate for variations in the satisfaction of their preferences. This willingness to pay may be expressed (valued) in terms of expenditures.

VALUATION AND EVIDENCE: MEASURES OF RESOURCE AND ENVIRONMENTAL CONSERVATION OR DEGRADATION ON THE ECONOMIC DEVELOPMENT OF LATIN AMERICA AND THE CARIBBEAN

Abundant evidence from Latin America measures the effects of conserving or degrading resource use on the use of inputs by producers and their supply of products. Producers have been influenced largely through changes in the technical parameters of production consequent on conserving or degrading resource use and the impact of these changes on costs, revenues, rents, profits, and surpluses (Fernandez, DESFIL 1988; Nonone, DESFIL 1988; Yahya et al. 1985; Comerma et al. 1973; Walter and Williams 1988; Machicado, DESFIL 1988; Espinoza, DESFIL 1988; Espinosa and Maldonado, DESFIL 1988; Uquillas and Ramirez 1990; Staver 1989; Macias and McDowell 1990). Little quantitative evidence specific to Latin America is available to measure consumer demand for the quantity and quality of resource and environmental amenities and related impacts on consumer surplus, our measure of welfare (Baldares and Laarman 1990, Healy and Newman 1989, Tobias and Mendelsohn 1990). A limited amount of evidence concerning macroeconomic and dynamic effects is available (Veloz et al. 1985; Southgate and Macke 1989; El Hoy 1989; Figueroa, DESFIL 1988; Yahya et al. 1985; Echeverria 1990).

Physical Effects on Productivity and Yields

Steep Slopes

In Venezuela, Fernandez (DESFIL 1988) measured sediment loss and run-off under a control plot and three mechanical and vegetative conservation practices.[11] Terraces alone reduced soil loss from 91.48 mt/ha[12] per year on the check to 33.3 mt/ha on the 21 percent slope and 14.8 mt/ha on the 16 percent slope. Terraces combined with crop residues and vegetative practices reduced soil loss even more, to near zero under the most effective combination treatment. Fernandez also measured surface run off under the several systems. During the two-year experiment, 405 mm of 620 mm total precipitation ran off the control plot. The range of run-off under the treatments was 187 mm to just 14 mm under the most effective. Under less rigorous procedures, rates of soil movement are available from two sites in Ecuador. Figueroa estimated an average loss of 33.3 mt/ha per year over the whole Paute watershed, and Harden (DESFIL 1988) experimentally simulated Rio Ambato watershed erosion rates varying between 20 and 80 mt/ha per year, from bare plots, depending on soil type.

No quantitative evidence measuring the loss of applied production inputs moving with the soil and run-off is available from Latin America, but at San Jose de los Rubios, Ecuador, Espinosa and Maldonado (DESFIL 1988) removed whole fertilizer granules and wheat seeds from a sediment trap placed below a steeply sloped, clean-tilled wheat field planted the night before a severe storm. Similar evidence is believed to be available from the Plan Meris Project in Peru (Nonone, DESFIL 1988). At Moscow, Idaho Dowding et al. (1985) conducted an experimental procedure similar to those of Fernandez and Nonone, using analogous treatments under similar slope, soil, and precipitation conditions. They were able to measure total loss of applied nitrogen and phosphorous in the run-off water and adhering to the sediment. Three to five times as much nitrogen, and four to six times as much phosphorous were lost from a smooth-tilled field as from rough or untilled fields.

This evidence suggests the magnitude of induced soil movement and run-off, and the inputs and yield potential lost with them. Evidence is also available on altered costs, revenues, rents, and surpluses associated with such degradation. Yahya et al. (1985) analyzed the National Program for Soil and Water Conservation in Peru. Between 1981 and 1986, the program applied, developed, and evaluated soil and water conservation techniques on 1,883 on-farm test plots on 1,164 fields in 10 departments along the length of the Peruvian Andes. Principal practices were absorption terraces, contour ditches, and infiltration ditches, applied as on-farm test plots next to untreated check plots, by highland Peruvian smallholders who used their own tools and labor.

Ninety-five percent of the plots had 60 centimeters or less of topsoil, 88 percent had slopes that exceeded 20 percent. Annual precipitation on 89 percent of plots ranged from 300 to 800 mm. Elevation of 82 percent of the plots ranged from 2,500 to 4,000 meters. Sediment

and run-off were not measured, but the authors stated that "absorption terraces totally controlled erosion and run-off."[13]

Terraces represent a fixed cost once constructed. They required 336 to 1,181 person-days of labor per ha, averaging 772 days. Terrace maintenance is a variable cost requiring periodic labor. Altogether, 26 crops and four tree species were produced on the plots. Potatoes, barley, maize, and wheat predominated. All three conservation practices greatly increased test plot yields over those on adjacent check plots. For example, the authors present measurements on 26 crops from 577 absorption terrace test plots. The yields of four crops — potatoes, corn, wheat, and barley (318 plots) — increased in range from 34-142 percent. Terracing (retention of soil and runoff water) increased the yields of all crops whether fertilized or not. The **unfertilized** plots showed the most dramatic increases. Total product per unit of land area increased, even though area under cultivation fell by one-third (terracing removes some field area from cultivation). Together, the practices stimulated the use of more irrigation water. Total production costs rose, but costs per unit of output fell, because output rose more quickly than costs.

Comerma et al. (1973) and Walter and Williams (1988) analyzed the Conservation Subsidy, a Venezuelan soil conservation program that paid land users to apply a schedule of conservation practices including the removal of stones, the construction of contour rock walls, terraces, ditches, drainage structures, vegetative barriers of several types, and other practices. They measured the effects of the practices on areas cropped, crop yields, labor uses, crop mixes, intensities of inputs applied, rents, and value of the practices subsidized. The overall objective was to demonstrate and quantify the changes in crop production technology and land productivity associated with the practices.

Three communities in western Venezuela were studied. They ranged in elevation from 1,500 to 2,400 meters, in annual rainfall from 700 to 900 mm, and in slope from 16-25 percent. The land area studied totaled 158 ha before the practices and 106 hectares afterward, divided into many small fields used by dozens of farmers.

The conservation improvements permitted and stimulated the more intensive use of other production inputs and a switch from crops of lower value to crops of higher value. Areas irrigated, fertilizer used, and the application of insecticides, fungicides, and herbicides all increased. The use of agricultural labor increased. Areas planted in crops of lower value, such as wheat, corn, and certain vegetables, decreased. Areas planted in crops of greater value, mostly vegetables, increased. Total area cultivated decreased; the removal of stones had the effect of increasing arable area and the switch to more labor-intensive crops and production practices required more labor, which was scarce. So the conservation improvements actually resulted in lowering the area cultivated.

With large variations among crops and communities, there were general increases of 200-500 percent in yields per ha, attributable to the increased use of irrigation and the intensification

of production (greater use of purchased inputs, labor, and more crops per hectare per time period). Averaged across some 18 crops, physical output rose from 1.96 mt/ha to 7.53 mt/ha, at the same time that the total area cultivated decreased from 158 ha to 106 ha.[14]

Machicado (DESFIL 1988) and Espinoza (DESFIL 1988) present analogous findings on livestock yields under conservation production of native forages and pastures in steeply sloped highland areas in Bolivia and Peru. Traditional pasture production was the check. Conservation treatments included infiltration ditches, the diversion of surface aquifers onto previously unirrigated pastures, and rotational grazing allowing natural regeneration through rest.

According to Machicado, overgrazing seriously affects the growth and regeneration of both native and exotic species. Because different species recover at different rates, overgrazing alters the mix of species present in the pasture or forage. He cites studies showing that 50 or more native species may be present in a high-altitude native pasture. After lengthy overgrazing, this number falls and the species mix often changes toward less palatable, less nutritious forage plants. Overgrazing and other intensive uses of Andean areas are associated with the rapid deterioration of soil structure and mechanical properties, lost water-retention capacity and nutrients, and accelerated runoff and sediment transport. These effects combine to reduce per hectare yields of dry matter, thus reducing potential livestock yields. At Patacamaya and Comanche, Bolivia, overgrazing, low soil fertility, lack of water, and severe topsoil erosion combined to greatly reduce dry matter yields of native pastures. The division of a 1,000-hectare range into six areas for rotational grazing, periodic rest, and the diversion onto pasture areas of surface runoff increased native pasture yields by 50 percent (Machicado, DESFIL 1988).

At San Jose de Quero, Junin, in highland Peru, Espinoza cites experiences with community pastures and infiltration ditches, rest and rotational grazing, contour ditches, and gully control. After 30 months, the carrying capacities of two test plots rose from 0.25 to 1.0 sheep per hectare per year. Green forage yields rose 12 times over adjacent checks. Growth in two native tree species greatly accelerated.[15]

Lowland Humid Tropics

Productivity improvements resulting from conserving resource use are not confined to highland areas. Staver (1989) reports the results of introducing two species designed to accelerate fallow recovery of bush-fallow cropping systems in lowland eastern Peru.[16] The introduction of these species suppressed herbaceous weeds and accumulated more woody biomass than natural fallows. The introduced species appeared to hold potential for the enhancement of productivity on the basis of early analytical results, in that the yields of food crops grown as a part of the systems were unaffected or slightly increased as fallow periods shortened. However, labor requirements increased and the natural regeneration of trees and shrubs was suppressed.

Traditional lowland colonization around Coca in Eastern Ecuador is characterized by the felling of forest and the cultivation of pasture, coffee, and mixed subsistence crops under

degrading land use practices of extremely low productivity. Elevations average 300 to 500 meters, average farm size is 50 hectares, and annual rainfall reaches 4,000 mm in this area. Beginning in 1984, a series of trials have been conducted on 200 or more Coca farms. These introduce improved pasture species, high-value hardwood trees, and improved coffee cultivation techniques (pruning) into traditional land uses. The desired effect is to raise the productivity of the traditional coffee and livestock activities and to introduce a new resource-conserving high value crop — the hardwoods — while maintaining vegetative cover and soil productivity. In effect, land use will intensify and product per hectare and farmer incomes will increase. At the same time, such use conserves or even enhances the resource base (Peck 1988, Estrada et al. 1988, Gutierrez and Costales 1990, Gutierrez and Shiguango 1990).

Results available to date (Ramirez and Uquillas 1990) indicate that under the agroforestry system (improved coffee management with the introduction of high value hardwoods and a leguminous cover crop), and over a 10-year period, coffee output will more than double compared to the traditional system, total labor use will remain about the same but be more evenly distributed through time, the use of herbicides and fungicides will decline to near zero, and the use of insecticides will stay the same. Under the forestry-pasture system (improved pasture with the introduction of high-value hardwoods and leguminous covers), and over a 10-year period, livestock weight gains will improve by 50 percent (the same number of animal units will gain 50 percent more weight on the same area) compared to the traditional system. Labor use will decline about 30 percent and the use of herbicides will fall about 20 percent.

Several writers on Eastern Ecuador have noted seasonal or permanent shortages of agricultural labor (Peck et al. 1990). Many farms are abandoned or have reverted to extreme poor pasture of very low carrying capacity. The importance to the sustained use of this humid lowland of the same or larger yields and livestock offtake persisting through longer time periods with a more even distribution of agricultural labor cannot be overstated.

Valuing the Effects of Degradation or Conservation on Economic Development

Producers

Analyzing seven of the Venezuelan crops, Comerma et al. computed increases in total production costs that ranged from 100 to 650 percent (Table 5, page 106). In these seven crops, total revenue from greater yields and more frequent harvests increased enough so that average income (rent, or revenues minus the variable costs of production) per unit of land increased in a range of 66-1,820 percent, depending on the crop. The authors note that land prices in the area rose, and there was "an increase in the occupational index of the farmers." The effects occurred over a 10-year period, and were large enough to repay the entire social costs of the Conservation Subsidy program and return a positive net present value over a 50-year period of analysis.

On the Peruvian conservation test plots, substantial amounts of labor were required to construct absorption terraces, averaging 742 person-days of labor per hectare treated (page 13). Since arable area decreased, per-hectare annual production costs also fell, but yields rose an average of 32 percent. Per hectare output rose, such that Yahya states that the average profitability (rent) per hectare of crop production rose 179 percent. Comparing the income from crop production before terrace construction with the income from crop production after constructing the terraces, and even including the value of the 742 days required to construct the terraces, Yahya et. al. conclude that, "the balance is beneficial," from the conservation practices.

On the Coca demonstration farms, the traditional coffee-pasture system was compared with combinations of high-value hardwoods, improved coffee management, and leguminous cover crops. Ramirez et. al. (1990:201) found that per-hectare net producer rents changed from a loss of $850 for the traditional system to a profit of $990 for the full combination of conservation practices.[17] Internal rates of return (IRR) were computed at -6 percent under the traditional system and up to +28 percent under the most favorable conservation system. IRRs were positive for all conservation systems. Using the same analytical procedures, traditional pasture was compared with two combinations of hardwoods and leguminous pastures. Although no tree-pasture system generated a positive 20-year rent stream, losses under the conservation systems were only 40 percent as large as under the traditional system. The same authors also estimated the monetary value of daily labor over the production cycles of the traditional and improved cropping systems (Ramirez et al. 1990:109, Table 44).[18] The improved or conservation practices generally had the effect of increasing the value of a day's labor by two to four times, as compared to the traditional systems.

Consumers

It is unfortunate that so little evidence is available on the demand by Latin American consumers for quantity and quality in environmental and resource amenities. From the limited evidence available, we may suppose that preferences and the satisfaction derived from consuming the amenities do not differ in direction from those in areas where evidence is available.[19] The uncertainty surrounding the consequences of lost diversity and the dynamic consequences of lost quantity and quality should impel policy choices favoring the generation of evidence on the consumer and demand side, similar to the evidence that continues to accumulate on the production side.

Macro Effects

Moving to macro effects, Yahya et al. calculate that the use of absorption terraces on 100 percent of the Peruvian andean areas in Potatoes, wheat, and maize would cause their total annual outputs to rise by 283,000 mt/year in potatoes, 27,100 mt/year in wheat, and 50,600 mt/year in maize.

Under the heading, "There Is No Risk In Paute," the Ecuadorian daily newspaper *El Hoy* (11 November, 1989) quoted data from the national electricity institute that a contract to begin dredging of the Rio Paute impoundment had been let to a Japanese engineering firm. Sediment was accumulating at a rate of 2.5 million cu/m per year, about 22 million cu/m had accumulated in less than 10 years, and the dredging cost was estimated at $10 million over one year. No conservation practices had been implemented on the Paute watershed in the area of this impoundment, but Southgate and Mackie (1989) estimated the downstream benefits of erosion control on the Paute watershed. Benefits were estimated under three hypothetical watershed management scenarios and compared with a no management (current) scenario. Over a 55-year analytical period, the present value of downstream benefits from watershed management above the dam varied from $15 to $38 million, depending on the scenario. Because the Paute dam was situated in an area of steep, highly erodible slopes, the post-hoc costs of arresting the erosion are also high. Over the first five years of the Paute project, the implementing agency, INECEL, projected expenditures of $11 million for reforestation and soil conservation and more than $20 million altogether for abatement.

Veloz et al. (1985) and Lyon et al. (DESFIL 1988) studied the macro impact of protecting several high-erosion subwatersheds on the Rio Nizao, Dominican Republic. The Nizao is a tributary of the Rio Ocoa, where the Valdesia dam is located. Pasture renovation and the installation of contour ditches and living barriers would reduce sediment loading in the Valdesia impoundment, leading to lower dredging costs and a longer productive life for the dam's hydroelectric installations. The costs of installing the conservation practices were calculated at RD$1 million. Over a 25-year period, the discounted costs associated with dredging unabated sediment flow would cost the State RD$25 million — without considering other effects of unmitigated degradation, such as premature replacement of generators or lost hydroelectric generating potential. In a later study, the costs of mounting the extension program necessary to motivate renovation, ditches, and barriers were computed at less than half the dredging costs.

CONCLUSIONS

The discussion presented in this chapter shows a direct link between growth and development and the conserving use of natural resources and the environment. Considering the conceptual framework and the evidence presented, conservation practices in Latin America have tended to change crop production techniques or alter the parameters of production response or both. When output and input prices are taken as parameters, rising yields and greater responses from applied inputs have increased revenues and lowered costs per unit of output (costs per unit of land area may increase). When detailed monitoring evidence is available, experience with conservation practices in Latin America has tended to increase the value of production inputs, such as land and agricultural labor, when conservation practices have been applied. Increasing revenues and lower per-unit production costs determine increased profits, rents, and production-side surpluses, which, in turn, are our measures of producer income and welfare.

The initial and very limited demand side consumer surplus estimates available point in the same direction and appear to be of the same order of magnitude as estimates from other parts of the world where such evidence is available. The accumulation of evidence on consumer valuation should be a priority research area in resource economics in the region.

The evidence presented here suggests that macroeconomic costs consequent on long-term resource degradation are large, and considerably larger than the costs of mitigative or preventive measures that would substantially reduce those costs. These costs include major increases in public expenditures dedicated to mitigation and abatement, negative trade impacts, lost tourism revenues, and foregone agricultural and forestry output.

The effects of resource and environmental depletion and degradation persist through long time periods. Diminished productivity and foregone opportunities for future generations to enjoy the benefits from public goods such as pristine environmental quality or the potentially valuable future uses derived from species diversity represent a transfer of costs forward in time. With varying degrees of certainty, resource conservation benefits future generations.

Environmental amenities and natural resources such as topsoil, tropical forests, reserves, or clean water and air are viewed by economists as goods and services. They can be managed to be used up over relatively short time periods, or they can be managed to provide a steady flow of benefit streams through time. This chapter shows the considerable contribution to economic development from the management of natural resources and environmental amenities such that their use entails the maintenance of their inherent productivity or quality.

Both economic rationale and economic evidence urge the sustainable and rational management of fragile lands and natural resources in Latin America and the Caribbean. Natural resources and environmental amenities in production and consumption have value. This value contributes to economic development, which is inhibited or undermined by resource destruction. Often, this value is higher in sustaining or pristine use than in degrading use. The interests of economic development, uncertainty over the future course of events, and the divergence of public from private interests provide society with a compelling interest in nondegrading resource and environmental use. At both micro and macro levels, mitigative measures pay off. Nondegrading use is cost-effective. Society is demonstrably willing to pay for the quality as well as the quantity of natural resources and environmental amenities.

A non-Frontier Economics view of resource and environmental amenities as finite, even with rapid technological advance, compels these conclusions. A dynamic view of ecosystems, where resources are used and never return to a static equilibrium, requires resource use that maintains or enhances productivity, even as the concept of productivity and how it is measured change through time. Economic development can occur, and growth within limits can take place, without resource destruction. Indeed, the evidence presented here suggests that the nondegrading use of resources generates development, growth, and change in a dynamic ecosystem, viable over the long term. Resource destruction does not.

ENDNOTES

1. Equity in an economic sense is often defined as the broadly based participation in and the even distribution of growth and income. In resource use, the distribution through time of income and welfare is also a dimension of equity. In a larger sense, equity includes other ethical dimensions: the idea of democratic, pluralistic social structures that "empower" many segments of a society (see for example USDS Cable, 1990).

2. A strict definition of economic rent as revenue less variable costs is found in Box One. A broader definition of "rent seeking" is provided by Ascher and Healy (1990), as "the process through which people try to obtain various economic benefits through the political system."

3. Randall (1988) and Hanemann (1988) discuss the basis for attaching value to natural resources and environmental amenities.

4. For example, monetary values assigned to the amount, condition, or state of the resources or environmental amenities such that these values are consistent with both economic theory and human behavior.

5. Inherent capability refers to the long-term productivity of the land. This is a function of slope, soil type, humidity, and other natural factors such as soil thickness or inherent erodability. It may be increased through conservation measures such as terracing, construction of diversion ditches, planting of buffer strips, soil and crop management practices, and so on; or it may be lost as soil moves or compacts, water retention capacity or organic material diminish, and so on.

6. This type of divergence is an example of market failure.

7. The choice of one set of values over another involves moral and ethical judgements extending well beyond the boundaries of economics.

8. There is always a time dimension implied in production. Over a very short time period, most costs are likely to be fixed. Over a long enough time period, all costs are likely to be variable. The longer the period of analysis, the smaller fixed costs are likely to be. As long time periods are often involved before the effects of resource misuse are manifest, rent tends to be the measure of interest in resource economics.

9. The mix and amounts of production inputs and the technology employed are choices for the producer to make; prices are taken as parameters.

10. Goods and services regularly traded in markets have established prices. Many environmental amenities do not trade in markets. In these cases, values must be imputed by means that simulate trade. Ward and Loomis (1986), Walsh et al. (forthcoming), Mitchell and Carson (1989), Randall (1988), Boadway and Bruce (1984), and Just et al (1982) discuss these methods. Public goods generally satisfy two conditions: first, the consumption or use of the good by one

individual does not diminish or preclude its consumption or use by others; and, second, it is impractical or impossible to exclude some consumers in favor of others. Public parks, clean air, and the uncertain future value of species diversity are examples of public goods that embody an economic externality, namely, that the optimal amount chosen by individuals and aggregated to societal level may not be the same as the optimal amount chosen by the aggregate society.

11. Bench terraces, bench terraces with living vegetative barriers, and bench terraces with crop residues. The check was bare fallow. Two length-slope combinations were measured: 10 meter plots had 21.5 percent slope; 20-meter plots 16.5 percent.

12. Very approximately six-tenths of an inch or 15mm per year. At that constant rate, one meter of topsoil would move or be lost in 65 years.

13. An absorption terrace is one constructed to retain maximum moisture.

14. Comerma et al. and Yahya et al. each present quantitative measures on yields, input use, and cropping intensities under the check and several conservation treatments. Not less than three dozen crops were measured at more than 1,000 sites in Peru and Venezuela.

15. Greater detail and additional experience are found in Hanrahan (DESFIL, 1988). Highland experiences in Bolivia similar to those in Venezuela, Ecuador, and Peru are discussed in Macias and McDowell (1990). Productivity effects of introducing fast-growing, nitrogen-fixing alder trees into traditional highland farming systems are described in Dunn et al. (1990). Additional evidence may be available from Guatemala-Highland Soil and Water Conservation Project (see Smith, 1989) and Honduras-Choluteca Land Use Management Project (see Rivas, DESFIL, 1987). Quantitative measurements from the two Central America projects were not available.

16. The shortening of fallow periods in traditional swidden agricultural systems is a chief contributor to the progressive degradation of the humid tropical lowlands.

17. Expressed in constant dollars discounted at 8 percent over 20 years; based on six years of actual test-plot data from 190 farms and extrapolated over 20 years.

18. The value of the marginal product of agricultural labor, that is, the incremental physical product produced using the conservation practices times its price. This is averaged over the production cycle and computed separately for the alternative systems and practices.

19. Smith and Karou (1990) review the results from more than 200 North American studies where quantitative willingness to pay (compensating variation) estimates were derived. Walsh et al. (1991) review the results of 20 years of valuation research on recreation benefits. Dixon and Sherman (1990) present case studies from Thailand, the U.S. Virgin Islands, Australia, and Cameroon. Carson and Mitchell (1989) present pedagogic case studies from the United States.

REFERENCES CITED

Alt, K., C. T. Osborn, and D. Colacicco
1989 "Soil Erosion: What Effect on Agricultural Productivity?" United States Department of Agriculture, Economic Research Service; *Agricultural Information Bulletin* (January, No. 556).

Antle, J. M.
1988 *Pesticide Policy, Production Risk, and Producer Welfare: An Econometric Approach to Applied Welfare Economics*. Washington, D.C.: Resources for the Future.

Baldares, M. J., and J. G. Laarman
1990 "Derechos de Entrada a las Areas Protegidas de Costa Rica." *Ciencias Económicas* X:63-76. San José, Costa Rica.

Boadway, R., and N. Bruce
1984 *Welfare Economics*. New York: Basil Blackwell.

Comerma, J., A. Rivas L., and J. Soriano
1973 "Aumento de la Productividad Agrícola a través de los Trabajos de Conservación de Suelos." *Agronomía Tropical* XXIII(1):95-113.

Costanza, R., S. C. Farber, and J. Maxwell
1989 "Valuation and Management of Wetland Ecosystems." *Ecological Economics* (1):335-361.

Crosson, F R., and A. T. Stout
1983 *Productivity Effects of Cropland Erosion in the United States*. Washington, D.C.: Resources for the Future, Inc.

Deaton, A., and J. Muellbauer
1983 *Economics and Consumer Behavior*. New York: Cambridge University Press.

Dillon, J. L.
1979 *The Analysis of Response in Crop and Livestock Production*. Oxford, England: Pergamon Press Ltd.

Dixon, J. A., and P. B. Sherman
1990 *Economics of Protected Areas: A New Look at Benefits and Costs*. Washington, D.C.: Island Press.

Dowding, E.A., K.N. Hawley, and C.L. Peterson
1984 *Characterization of Runoff as Related to Tillage Management.* St. Joseph, Michigan: American Society of Agricultural Engineers (Paper No. 84-2543).

Dunn, W.W., A.M. Lynch, and P. Morgan
1990 "Benefit-Cost Analysis of Fuelwood Management Using Native Alder in Ecuador." *Agroforestry Systems* (11):125-139.

Echeverría, J.
1990 *Economic Impact of the New Infrastructure Project of the Monteverde Cloud Forest Preserve.* San José, Costa Rica: Tropical Science Center (August).

El Hoy
1989 "No Hay Riesgo en Paute." Quito, Ecuador (November 11).

Espinosa, J., and F. Maldonado
1988 "Logros y Problemas de la Conservación de Suelos en el Ecuador." DESFIL Technical Report. Washington, D.C.: Development Alternatives, Inc. *Memoria de la Conferencia Usos Sostenidos de Tierras en Laderas* (SUSS) Tomo I.

Espinoza, F.
1988 "Avances de la Conservación de Suelos y Aguas en el Perú." *Memoria de la Conferencia Usos Sostenidos de Tierras en Laderas* (SUSS), Tomo I. DESFIL Technical Report. Washington, D.C.: Development Alternatives, Inc.

Estrada, R.D., C. Sere, and H. Luzuriaga
1988 *Sistemas de Producción Agrosilvopastoriles en la Selva Baja de la Provincia del Napo, Ecuador.* Cali, Colombia: CIAT.

Ferguson, C.E.
1979 *The Neoclassical Theory of Production and Distribution.* Cambridge, England: Cambridge University Press.

Fernandez, N.
1988 "La Conservación de Suelos en Areas Hortícolas de un Cuenca Alta de la Region Central de Venezuela." *Memoria de la Conferencia Usos Sostenidos de Tierras en Laderas* (SUSS), Tomo I. DESFIL Technical Report. Washington, D.C.: Development Alternatives, Inc.

Figueroa, E.
1988 "Manejo de la Cuenca Una Opción de Desarrollo." *Memoria de la Conferencia Usos Sostenidos de Tierras en Laderas (SUSS),* Tomo I. DESFIL Technical Report. Washington, D.C.: Development Alternatives, Inc.

Folke, C.
1990 "The Societal Value of Wetland Life-Support." In C. Folke and T. Kaberger, eds., *Linking the Natural Environment and the Economy: Essays from the Eco-Eco Group*. Stockholm: Kluwer Academic Publishers.

Gutierrez, F., and J. Costales
1990 *Pastos con Arboles en la Selva Baja de la Amazonia Ecuatoriana: Manejo Silvo-Pastoril*. Quito, Ecuador: Dirección Nacional Forestal, MAG (Nota Técnica No. 1).

Gutierrez, F., and D. Shiguango
1990 *Café Robusta con Arboles en la Leva Baja de la Amazonia Ecuatoriana: Manejo Agro-Silvícola*. Quito, Ecuador: Dirección Nacional Forestal, MAG (Nota Técnica No. 2).

Hanemann, W. M.
1988 "Economics and the Preservation of Biodiversity." In E.O. Wilson, ed., *BioDiversity*. Washington, D.C.: National Academy Press.

Hanrahan, M.
1986 *Economic Aspects Of Pacific Northwest Soil Erosion Research*. Corvallis, Oregon: Agricultural Experiment Station, Oregon State University (Special Report 782).

Hanrahan, M.
1988 *Sustainable Uses for Steep Slopes: Workshop Proceedings*. Volume II: Synthesis Report. DESFIL Technical Report.Washington, D.C.: Development Alternatives, Inc.

Harden, C.
1988 "Estimación de la Erosión Anual del Suelo en la Cuenca del Río Ambato, Ecuador." *Memoria de la Conferencia Usos Sostenidos de Tierras en Laderas* (SUSS),Tomo I. DESFIL Technical Report. Washington, D.C.: Development Alternatives, Inc.

Healy, R. G., and D. H. Newman
1989 *Opportunity Costs in Establishing the Proposed Bladen Branch Nature Reserve, Belize*. Washington, D.C.: World Wildlife Fund (Consultant report).

Just, R. E., D. L. Hueth, and A. Schmitz
1982 *Applied Welfare Economics and Public Policy*. Englewood Cliffs, N.J.: Prentice-Hall.

Leonard, J. H.
1987 *Natural Resources and Economic Development in Central America.* Washington, D.C.: International Institute for Environment and Development–World Resources Institute.

Lyon, J., D. Southgate, A. Veloz, and R. Veloz
1988 "Los Beneficios fuera de la Finca de la Conservación de Suelos en la Cuenca del Río Nizao, Republica Dominica." *Memoria de la Conferencia Usos Sostenidos de Tierras en Laderas* (SUSS), Tomo I. DESFIL Technical Report. Washington, D.C.: Development Alternatives, Inc.

Machicado, J.
1988 "Manejo de Pastizales Nativos en el Altiplano e Influencia en la Erosión." *Memoria de la Conferencia Usos Sostenidos de Tierras en Laderas* (SUSS), Tomo I. DESFIL Technical Report. Washington, D.C.: Development Alternatives, Inc.

Macias, M., and W. McDowell
1990 *Informe sobre Resultados de la Aplicación de las Prácticas de Conservación de Suelos y Aguas en el Area de Aiquile: Campana Agrícola 1989-90.* Cochabamba, Bolivia: Programa Desarrollo Alternativo Regional (La Paz, Bolivia: USAID.

Mitchell, R. C., and R. T. Carson
1989 *Using Surveys to Value Public Goods: The Contingent Valuation Method.* Washington, D.C.: Resources for the Future.

Monke, E., and S. R. Pearson
1989 *The Policy Analysis Matrix For Agricultural Development.* Ithaca, N.Y.: Cornell University Press.

Moore, W.
1985 *Offsite Costs of Erosion on the Willamette Valley of Oregon.* Corvallis, Oregon: Department of Agricultural and Resource Economics, Oregon State University (Master of Science Thesis).

Nonone, C.
1988 "Manejo de Aguas de Riego y Producción Agrícola en las Tierras Altas Peruanas." *Memoria de la Conferencia Usos Sostenidos de Tierras en Laderas* (SUSS), Tomo I. DESFIL Technical Report. Washington, D.C.: Development Alternatives, Inc.

Page, T.
1977 *Conservation and Economic Efficiency: An Approach to Materials Policy.* Baltimore: The Johns Hopkins University Press.

Panayotou, T.
1989 *The Economics of Environmental Degradation: Problems, Causes, and Responses.* Cambridge, Massachusetts: Harvard Institute for International Development. (ms)

Peck, R.
1988 "Promoting Agroforestry Practices among Small Producers: The Case of the Coca Agroforestry Project in Amazonian Ecuador." Belem, Brazil; *Alternatives to Deforestation*, A. Anderson, ed.

Peters, C. M., A. H. Gentry, and R. O. Mendelsohn
1989 "Valuation of an Amazonian Rainforest." *Nature* (339):655-66.

Ramirez, A., C. Sere, and J. Uquillas
1990 *Impacto Socioeconómico de Sistemas Agroforestales en la Selva Baja del Ecuador.* Quito, Ecuador: United States Agency for International Development.

Randall, A.
1988 "What Mainstream Economists have to Say about Biodiversity," In E. O. Wilson, ed., *Biodiversity.* Washington, D.C.: National Academy Press.

Rivas, C.
1988 "Ejecución del Proyecto Manejo de Recursos Naturales en Honduras." *Memoria de la Conferencia Usos Sostenidos de Tierras en Laderas* (SUSS), Tomo I. DESFIL Technical Report. Washington, D.C.: Development Alternatives, Inc.

Silberberg, E.
1978 *The Structure of Economics: A Mathematical Analysis.* New York: McGraw-Hill.

Smith, G.
1989 *Forty Years in the Altiplano — A Cross-Cutting Evaluation of A.I.D.-Financed Assistance in Guatemala's Altiplano.* Guatemala City, Guatemala: USAID.

Smith, V.K., and Karou
1990 "Signals or Noise? Explaining the Variation in Recreation Benefit Estimates." *American Journal of Agricultural Economics* 72:419-434.

Soil Conservation Policy Task Force

1986 *Soil Erosion and Soil Conservation Policy in the United States*. Soil Conservation Policy Task Force, American Agricultural Economics Association (January, Occasional Paper No. 2).

Southgate, D., and R. Macke
1989 "The Downstream Benefits of Soil Conservation in Third World Hydroelectric Watersheds. *Land Economics* 65:38-49.

Staver, C.
1989 "Shortened Bush Fallow Rotations with Relay-Cropped Inga Edulis and Desmodium Ovalifolium in West Central Amazonian Peru." The Netherlands: Kluwer Academic Publishers; *Agroforestry Systems* 8:173-196.

Taylor, C.R.
1989 "Duality, Optimization, and Microeconomic Theory: Pitfalls for the Applied Researcher." *Western Journal of Agricultural Economics* 14:200-213.

Tobias, D., and R. Mendelsohn
1991 "Valuing Ecotourism in a Tropical Rain-Forest Reserve." *Ambio* 20(2):91-93.

U.S.D.S.
1990 Cable p-050622Z (May).

United States Agency for International Development, Bureau for Latin America and the Caribbean
1989 *Environmental and Natural Resource Management in Central America: A Strategy for A.I.D. Assistance*. Guatemala City: Regional Office for Central American Programs.

Uquillas, J., and A. Ramirez
1990 *Impacto Socioeconómico de Sistemas Agroforestales en la Selva Baja del Ecuador*. Quito, Ecuador: Fundación para el Desarrollo Agropecuario (August, Draft Working Document No. 65).

Varian, H. R.
1984 *Microeconomic Analysis*. New York: Norton Publishers (2nd ed.).

Veloz, A., D. Southgate, F. Hitshusen, and R. MacGregor
1985 "The Economics of Erosion Control in a Subtropical Watershed: A Dominican Case." *Land Economics* 61:145-155.

Waddell, T., ed.
1986 *The Off-Site Costs of Soil Erosion.* Washington, D.C.: The Conservation Foundation.

Walter, B. J., and L. S. Williams
"Controlled Erosion Terraces in Venezuela." In W. C. Moldenhauer and N. W. Hudson, eds., *Conservation Farming on Steep Lands.* Ankeny, Iowa: Soil and Water Conservation Society.

Ward, F. A., and J. B. Loomis
1986 "The Travel Cost Demand Model as an Environmental Policy Assessment Tool: A Review of Literature." *Western Journal of Agricultural Economics* 11:164-78.

Yahya Vargas, M., A. Vasquez V., J. A. Moreno, and G. Gonzales Oviedo, eds.
1985 *Impacto de la Conservación de Suelos y Aguas en la Sierra Peruana.* Lima, Peru: Ministerio de Agricultura, Programa Nacional de Conservación de Suelos y Aguas en Cuencas Hidrográficas (November).

Young, D. L., R. C. Mittelhammer, A. Rostamizadeh, and D. W. Holland
1986 *Duality Theory and Applied Production Economics Research: A Pedagogical Treatise.* Washington State University, College of Agriculture Research Center (Technical Bulletin).

CHAPTER SEVEN

THE USE OF INCENTIVES TO PROTECT FRAGILE LANDS AND RESOURCES

by

John K. Gamman

INTRODUCTION

The use of incentives to promote environmental protection in developing countries is designed to foster the adoption of alternate technologies, sustainable agricultural practices, and improved management of environmentally fragile lands. Although these objectives are commonly held, the use of incentives is distinguished from other development efforts by an appeal to the needs and interests of groups and individuals that are typically bypassed (see Chapter Five). Increasingly, incentives are introduced by international donor agencies and nongovernmental organizations, which understand that lasting environmental reform is dependent upon local decision making. The successes and failures of these attempts reflect the complex constellation of political, cultural, and economic issues that challenges policy makers.

How do policy makers and development planners concerned with environmental protection design and implement incentives that fully account for these issues? What can we learn from our past experience with incentives intended to protect fragile natural resources that can improve future performance? These are the key questions that will be addressed in the following discussion.

DEFINING INCENTIVES

Incentives are used to motivate people to take action they likely would not undertake on their own initiative. Conversely, disincentives are used to discourage people from taking action they would otherwise take. If an incentive or disincentive is properly designed and implemented, it will successfully alter or reinforce behavior. We are concerned with incentives and disincentives that alter human behavior to promote the sustainable use of fragile lands and natural resources.

Several types of incentives can be used. Direct incentives promote desired behavior by offering a fixed reward. The reward can be money or an in-kind service or good (or a nonmaterial reward such as prestige), but is always conditioned on a demonstrable change in behavior that benefits a natural resource. Direct incentives can take the form of daily wages, loans, royalties, income support, or a variety of subsidies.[1] Direct cash incentives have been commonly used to promote environmental protection. For example, farmers are paid to plant a certain number and type of trees to halt soil erosion or reclaim degraded agricultural land.

Direct economic incentives can successfully foster short-term direct action designed to promote environmental protection, but may also engender dependence on external assistance.[2] McNeeley (1988) argues that direct cash incentives, if applied, should be used to create self-sufficiency and encourage local communities to accept responsibility for their environmental resources. To achieve these objectives, direct cash incentives can be augmented or replaced by indirect incentives. Indirect incentives may result in cash, but usually consist of noneconomic measures such as moral or nonmaterial incentives. An example of an indirect incentive is a national policy that gives preferential treatment to tourist development in areas that do not possess outstanding environmental values, in order to protect nearby fragile natural resources from development. Or, a government may change land tenure policies to encourage farmers to rehabilitate degraded agricultural lands.

Moral incentives, which reward people for a change in behavior or attitude, include public recognition, appeals to nationalism, elevated social status, or the loss of any of these.[3] They can be targeted to individuals or entire communities, and are based on an understanding of local cultural norms and values.

The primary difference between direct and indirect incentives is their timeliness. Both types can be formulated as disincentives. For example, communities may receive a tax levy for restricting wood-gathering to a certain area. Or, maintenance of a variegated cropping pattern, instead of a community switch to a cash crop, will enhance a village's ability to hold feasts and festivals.

INCENTIVES AND THEIR CONSEQUENCES

Many individual policies or projects fail to consider the multiple systems and actors that are affected, or the catalytic pattern of interventions. De Boer (1989) notes how environmental improvement projects in hillside areas have focused on a series of symptomatic solutions rather than addressing the real causes of environmental degradation. DeBoer defined five underlying causes which, if addressed, would curb the degradation of hill areas:

- The effect of expanding population pressures on a fragile environment;
- The rules that control the use of communal property resources;
- Access to resources by different groups;
- The climate for investment, trade, and employment generation; and
- Incentives to work in remote areas where environmental problems are often the worst.

Because environmental, political, cultural, and economic conditions must all be considered, unintended consequences often result from incentive-based interventions that do not accommodate the multiplicity of factors present.

Incentives may not have their desired effect for several reasons. An example of unintended consequences arising from complex economic factors is provided by the coca substitution program sponsored by the U.S. government in Peru.

In the last several years, the United States has spent millions of dollars trying to eradicate coca leaf plantations and processing laboratories in Peru's Upper Huallaga Valley, where one half of the world's cocaine originates. Crop expansion continues to increase, if at a slower pace, because peasants depend heavily on coca for income and can sell their coca for more than other agricultural commodities. Widespread eradication of the coca crop would destroy the regional economic base, "increasing the chances that 200,000 peasants would join subversive groups" (Brooke 1990). Coca is an important export commodity for Peru, worth $1-2 billion a year.

To reduce dependence on the coca crop, peasants need to diversify their crop production. To effectively substitute new crops, better roads, utilities, and agricultural extension services are required. The eradication effort has not provided these incentives. Rather, it has focused on reduction of the supply of coca leaf, which drives prices up, thus strengthening the industry and consequently undermining the goals of the eradication effort by providing greater incentives for coca production. An incomplete understanding of the economic and cultural conditions in Peru inhibited an effective eradication program design.[4]

To better develop and implement incentives, one must examine the role of interest groups in the public policy process. But in countries that do not have open political processes, including participatory public meetings and an independent media, the relationships among major interest groups, unorganized stakeholders, and the political leadership are hidden and discreet. Without knowing what these relationships are and why they exist, it is not possible to predict how the actors involved in an incentive program will react. For example, large cash incentives,

in the form of foreign aid or general development assistance, may be diverted by powerful interest groups or individuals before they reach their target.[5] In addition, incentives, especially nonmaterial ones, that represent a change in the political status quo may be perceived as posing a threat to established leaders and thus inhibit their implementation.

Cultural conditions that can hinder the intended results of policies include the use of oral traditions, the importance of informal authorities in the political process (such as village elders, women, and church leaders), different concepts of time and space, and a general distrust of outsiders seeking rapid change. Peasants in rural areas may live in one valley all of their lives. Their concept of geographical space is tied to their lifestyle and education; it is related to their permanent place within the landscape and the interdependency between those who dwell there. Embedded in this human environment is a set of cultural norms difficult for outsiders to understand.

DESIGNING INCENTIVES

A successful incentive program consists of many separate strategic interventions, each of which represents an opportunity for failure or success of the proposed reform. Separate interventions needed on different levels must be closely coordinated to culminate in the cumulative effort required if reforms are to have lasting results.

An initial intervention in an incentive program may seek the permission of the central government to allow civil servants, NGOs, and local community groups to participate. This activity typically involves obtaining the permission of a minister who oversees the portfolio that most closely relates to the type of reform that is proposed. For example, if the reform involves replanting eroded hillsides or rebuilding abandoned terraces, permission would typically be sought from the Ministry of Agriculture.

Incentives may have to be offered to the minister to obtain his or her permission. Organizing a peasant community to take part in an environmental improvement program may be seen as a potential political threat to the government. Project planners need to examine the overall needs of the ministry to know what kind of incentive will help convince the government to participate. For example, the government may need equipment to modernize its sugar cane industry.

A nonmaterial incentive may also be effective. Project planners can work with international organizations that can publicly praise the government for its the cooperation and initiative in participating in the reform effort, complimenting political leaders for their far-sighted approach to development and conservation. For an incentive program to reach political

leaders and senior civil servants who carry out policies for them, other kinds of strategic interventions may be required.

One important type of intervention relates to the temporal aspects of the intervention itself. It commonly takes several years for a public institution, especially one limited by a dearth of human, financial, and technical resources, to incorporate policy reforms into its institutional memory. If a desired reform requires a long-term intervention, either as a repeated action each year or a series of actions over many years, adequate time must be allocated to train civil servants, change general policies into specific regulations, and otherwise educate national policy makers about the issues represented in the reform. A series of interventions may be needed, consistent with the dominant underlying political and cultural conditions, over a period of several years.

Interventions needed to promote long-term institutional learning may include developing relationships with NGOs, academics, and resource users who are poor (like farmers, fishermen, charcoal producers, or herders). These parties are often viewed with suspicion or public hostility by political leaders, yet often are an essential part of a reform program, for they possess the local knowledge needed to make it work.

Strategic interventions may also be needed to encourage local parties, such as resource users and NGOs, to participate in a project. Economic and noneconomic incentives can be offered, but personal relationships and trust must first be established with leaders of these groups. Guarantees may be needed from the government that no political reprisals will result if stakeholders traditionally excluded from the political process agree to participate in a reform program. Similarly, interventions may be needed on behalf of civil servants to provide them with protection from political leaders.

These possible interventions assume that the sponsors of the incentive package first conduct the research and field work needed to understand the complexities of the host community and country, and design an incentive program tailored to the specific political, cultural, and economic conditions.

Specific Types of Incentives

Direct and indirect incentives or disincentives can further be grouped into three categories: policy, economic, or cultural. Depending on the conditions of the area of intervention, especially the type of actors involved, one or a combination may be appropriate. A brief review of how each applies to environmental reform will help increase awareness of potential uses of an overall package of incentives.

Policy Incentives

Policy-based incentives exist in a variety of forms and can be generated from indigenous groups or introduced by exogenous actors. They often take the form of new laws, regulations, and programs intended to build local or national institutional capacity. A donor agency may require a country to adopt new national environmental laws as a prerequisite for funding a development project. Incentives for environmental protection can also appear in other parts of the national policy-making process. For example, if a country agrees to set aside land for a new national park, a donor agency may relax its credit policies as a way to provide foreign exchange to offset national debt. This kind of project/policy linkage can be problematic. For example, if a proposed policy associated with a coastal tourism project calls for preserving portions of a coastline that possess attractive scenic values, an existing national policy to attract foreign exchange by promoting development may conflict with the proposed application. These so-called "perverse incentives" are common, and compound other difficulties often encountered with the policy-making process.

A large gap exists between theorizing how a policy should be created or changed and somehow ensuring that it happens.[6] This gap is especially apparent when policy changes are attempted in societies in which the interests of village elders, religious leaders, and women play a crucial part not understood by outsiders.[7]

The content of policy-based incentives also depends on the way in which the government is organized. If government institutions responsible for undertaking the incentive actions are centralized, incentives need to be designed one way. If the government is decentralized, the incentives need to reflect this condition. The success of policy-based incentives also depends on whether they require outside assistance or can be implemented independently.

Economic Incentives

Economic incentives are commonly used to make the marketplace more amenable to desired behavior. An example is using taxes or fines (disincentives) to penalize industry for polluting beyond established standards, also referred to as effluent charges. The purpose of economic incentives is to augment public policies that mandate certain types of behavior, as a way to reinforce desired actions to preserve sensitive natural resources. Economic incentives are based on the recognition that the marketplace cannot protect natural resources without interventions that influence its behavior.

Aspects of the local or national economy that should be considered in the design and implementation of an incentive program include:

- Whether the economy is centralized or decentralized;
- Whether the official exchange rate accurately reflects the value of the national currency;
- Whether a strong informal sector exists that may not be recognized by national policies related to pricing, subsidies, quotas, and taxes; and
- The role of local subsistence economies that rely on trade and barter.

At the national level, many types of economic incentives can be provided to promote the design and implementation of environmental policies and projects. First, related and competing national policies must be adjusted and coordinated with the incentive package so they will not cancel each other out. Second, a set of fiscal incentives (a subset of economic incentives) can be used to reinforce policy incentives designed to affect behavior at the local level.

Fiscal incentives can include the use of tax exemptions and credits that provide tangible benefits in exchange for actions that provide environmental enhancements, such as setting aside fragile lands in official conservation areas or developing them in a sustainable fashion (McNeeley 1988).[8] Then, incentives can be designed to encourage action on the local level to manage and, if necessary, restore the area that has been set aside. Fiscal incentives can also include waiving import duties and quotas for equipment and materials needed for natural resource protection and management, and providing capital by trading foreign debt at a discounted rate in exchange for undeveloped conservation land, or using the new foreign exchange to hire professional managers or purchase necessary materials.

Social and Moral Incentives

Understanding the values of a culture can enable development professionals to design effective incentives that incorporate local motivations. Such incentives include social and moral incentives that traditionally have been the domain of social planners trying to improve the quality of life in rural areas. Project planners are increasingly exploring ways to use these incentives to implement environmentally sound projects. Social and moral incentives are generally more effective if combined with economic and policy incentives. This approach requires project planners to carefully research local cultural values and behavior, and to design interventions compatible with them, thereby increasing the likelihood that the interventions will be more acceptable, stable, and self-sustaining than those based on foreign perceptions and values. The use of social and moral incentives is based on the belief that values rooted in the local community and family can be constructively used to reinforce desired behavior (Weitz 1986).

Like other incentives, social and moral interventions can be used to effect change on several levels. The most direct changes are at the individual level. Individual rewards can take the form of community recognition, such as prizes or honors awarded a large social gatherings, or membership in an exclusive club that elevates a person's standing in the community, or simply being recognized as one who has worked hard for the good of the community.

Social and moral incentives can also be used at the organization or community level. Many environmental improvement programs, such as reforestation, resettlement, and fisheries protection, require widespread voluntary participation of resource users (such as farmers, herders, or fisherman); yet their low social status provides little incentive for participation.[9] Incentives designed to elevate the social status of farmers and peasants could encourage behavior that benefits the larger society. For example, the status of farmers and peasants could be raised by allocating more national resources to agriculture to modernize production and improve marketing, or by creating government-sponsored associations and clubs as forums for participation in the public policy process. If resource users are organized as part of an environmental improvement project, the improved social infrastructure that results can be used to design and implement specific incentives.

Incentives That Have Worked

Recent experience indicates that incentives vary in effectiveness in protecting fragile natural resources. It is somewhat difficult to explain successes and failures with incentives, given the limits of existing data. However, based on field experience and conjecture, some conclusions can be drawn about successful incentives. They appear to be most effective when used for projects on the local level. When incentives are used on the national level, outcomes vary widely, reflecting greater complexity and the unintended consequences that often result.

Development professionals who have experienced success with local-level incentives have reported several reasons for it.[10] The success of incentives is tied to ownership. If peasants are required to make some material contribution or payment to an effort, this increases the likelihood that it will succeed. Experience shows that when individuals are trained as part of a development project to take a certain action to protect natural resources, such as planting trees, they are more likely to stay with the project if they "own" the fruits of their labor in some way.

The effectiveness of monetary incentives varies with their use. One kind of monetary incentive is improved access to capital. Farmers may need soft loans to buy trees to reforest denuded slopes and stabilize eroding soils. The farmers then own the trees and may take part in reforestation because it provides credit that is otherwise nearly impossible to obtain. When farmers plant trees that they own, they assume ownership in a larger sense of the overall environmental improvement project. Some programs have even allowed banks to raise interest

rates or restrict access to future credit if certain prescribed techniques are not used for planting and maintenance (Tschinkel 1987). This further increases the farmers' stake in the project.

Incentive programs that have worked seem to share several characteristics that can be summarized as follows:

- Incentives are coordinated with related national or local policies to reduce or eliminate conflicts between them;
- Incentives are designed to address root problems. For example, long-term land tenure may be needed to implement a self-sustaining hillside protection project;
- Material incentives, such as high-quality agricultural inputs for farmers, are targeted to meet the special needs of the participants;
- Projects are designed to contain a mix of economic and noneconomic incentives;
- When economic incentives are used, they work best in a well-functioning market;
- Activities promoted by incentives are compatible with everyday activities of the participants; and
- A long-term effort over many years is usually needed to establish desired patterns of behavior.

Incentives That Have Not Worked

There are three basic reasons why many incentive programs have not worked. First, they depend too heavily on economic measures, failing to use noneconomic components at the same time. Second, they are based too heavily on the perceptions of project planners, undervaluing or ignoring local values, conditions, and objectives. Third, they are designed without adequate consideration for the constraints posed by local or national policies, which are often expressed informally and difficult for outsiders to understand.

Economic interventions can be necessary and useful when the participants require access to capital to buy materials or high-quality inputs. But if not used properly, economic incentives can create dependency or attract participation by people who quickly lose interest after the initial infusion of capital is complete.

Incentive programs are often designed with a strong emphasis on results rather than process. Interventions designed by planners from developed countries who lack field experience often display little understanding of the local context. Even local civil servants who assist with project administration may not be aware of the needs and attitudes of villagers. This is part of the urban-rural bias that causes technical and financial resources to be targeted towards projects in urban areas, where political leaders derive the greatest benefit from promoting projects. Barriers to obtaining local information can be overcome, but it requires developing long-term relationships with parties that are also involved in promoting policy reforms, such as local NGOs. Often no effort is made to conduct comprehensive interviews and reconnaissance missions to accurately identify conditions in host countries, because it requires time and money.

Uncertainty is not limited to rural areas. Public policy decisions are often made in private, without participation of key stakeholders. Hence, the nuances of the political system are extremely difficult for outsiders to understand. When the dynamics of a closed policy-making process are combined with a shortage of trained civil servants, resistance to innovation, and immature public institutions fraught with administrative fragmentation and questionable political will, it is nearly impossible to implement plans and policies (Gamman 1990). The prognosis is not rosy. Attempts to protect fragile and limited natural resources, and to promote environmental reform, are beset by a mixture of difficult problems. Yet, we have seen that some successes have occurred. Based on these successes, it is possible to offer suggestions for improving the way that incentives programs are used.

RECOMMENDATIONS FOR THE DESIGN AND USE OF INCENTIVES

Organizations involved in protecting, restoring, and promoting sustainable use of natural resources in developing countries can increase the effectiveness of interventions through the use of incentives. This advice is directed primarily at international foreign assistance agencies, but also applies to environmental NGOs and similar organizations concerned with improving environmental quality. This set of recommendations is not meant to be exhaustive.

Create Packages of Economic and Noneconomic Incentives

Economic and noneconomic incentives can be used together to induce changes in human behavior that promote the sound use of environmental resources. Historically, economic incentives, such as direct cash payments or subsidies, have been relied on too heavily. Once economic incentives are used as an initial step to create support for a project or policy, they should be supplemented by noneconomic measures. Noneconomic measures, such as moral and social incentives, are crucial ingredients in any program to change entrenched human behavior. In addition to improving the social sustainability of environmental programs and projects, non-economic incentives have another direct benefit. They require the intervenor, often a

development professional from a Western country, to take the necessary time to carefully examine the social hierarchy, and to spend time in the community to understand the complexity that underlies any attempt to change the way people act and think. In turn, this commitment will help development professionals increase their ability to create a series of strategic steps to formally organize an intervention process.

Design an Incentive Strategy with a Series of Sequential Steps

To improve the consistency of incentive use, a uniform approach should be adopted for incorporating them into projects and programs. A uniform approach can include a series of similar steps that are completed each time an incentive package is designed. There is no single solution to designing a fool-proof package of incentives but, by using the same steps to develop a program, a set of questions will be raised that will stimulate a more thorough and internally consistent effort. A series of sequential questions could include the following.

What preconditions need to be met to create a project that will be sustained? Preconditions typically involve the issues of participation, representation, and accountability.

What specific steps have to be taken after the preconditions are met? Development professionals can follow a basic series of steps to increase the likelihood that an incentive program will be successful. These steps are:

- Evaluate the institutional capacity of the host country to carry out the desired reform.

- Conduct a culturally based stakeholder analysis to identify all the parties who will be affected by or benefit from the incentive program. Once a stakeholder analysis is complete, it should be filed with the regional and home offices of the donor agency and placed in a larger **Stakeholder Inventory** to start establishing an institutional memory of how decisions are made in the host country. One person in office should be given responsibility for cataloging and maintaining the inventory. It may also be helpful to conduct a stakeholder analysis within the donor agency to understand how competing interests within the agency have to be accommodated to increase the chance that a project will succeed.

- Design interviews that focus on eliciting information rather than prescribing solutions. Professionals conducting field work should take the time to elicit stories from participants to find out their history and the needs that a project is to address.[11]

- Create performance standards and link them with postproject evaluation and monitoring. Incentive programs should be structured using specific standards that can be evaluated in the future to help determine if they succeeded or failed. Performance standards, also called objective criteria, will also stimulate discussion of important issues when incentives are being designed; they force participants to speak in the same technical language. **Postproject monitoring** is crucial. When projects are budgeted, funds should be included to hire local organizations or people, such as NGOs or retired civil servants, to conduct observations and interviews with people who have participated in the incentive program. The results of these interviews should be given to selected in-country NGOs as well as the regional and home offices of the sponsoring donor agency as part of an **incentive inventory** that will help design better programs in the future.

Train Project Planners in Politics and Culture

Successful results with incentive programs are most often obtained by professionals with extensive field experience. However, because of the rotation policies within donor agencies, it is difficult for them to maintain continuity within a host country. The result is that valuable information about the local or national culture and political system is lost, and new personnel must start all over again. This is frustrating for donor agency professionals, and sends the wrong signal to host country policy makers.

To make up for this lack of continuity, and to design incentive programs that respond to actual conditions and needs, donor agency personnel should receive regular training in two areas. The first area focuses on the policy-making environment in the host country; who sets national policy, how do they do it, and what is the result? Exactly what is the nature of political decision making in the host country? This in turn will orient professionals so they are better able to carry out a stakeholder analysis in the countries where they work.

The second area relates to local and national culture, and recognizes the important role that it has in the success of any outside intervention or policy reform. Cultural norms, such as language, religious belief systems, family relationships, the importance of informal authorities (for example, women, elders, spiritual leaders), concepts of time and space, oral traditions, and the way people perceive the natural environment, are important areas of difference. To counteract the tendency of outsiders to view a country through their own cultural lens, donor agency personnel should be trained to understand and respect the cultural norms in countries where they work.

The goal of providing advanced training in politics and culture is to allow development professionals to grasp the nuances and complexities inherent in the "culture of decision making" in the developing world.

These recommendations represent one approach to improving the use of incentives to protect fragile and limited natural resources. They focus on the need to encourage the participation of parties that are commonly left out of the policy-making process, to improve the accountability of natural resource management, to target interventions at groups and individuals who can make projects work, and to provide training to donor agency professionals that recognizes the importance of the culture of decision making. The challenge now is to convince donor agencies that this approach merits attention, so that the requisite resources are provided to carry it out.

ENDNOTES

1. There are several examples of how incentives intended to protect fragile or limited natural resources are linked with development projects. A local fishing fleet can be outfitted with larger vessels and long-line rigging, subsidized by a donor agency, and trained how to use them, to lessen fishing pressure on traditional species that are caught with smaller boats and nets closer to shore. If effective, this will help to preserve the traditional fishery, while opening up new fishing opportunities for the fleet. The measures taken in this example are direct, material incentives, consisting of the new boats, equipment, and training in how to use them.

2. For a discussion of different types of economic incentives, and how they are used to conserve biological resources, particularly at the community level, see McNeeley, 1988.

3. Goulet (1989) discusses at length the use of nonmaterial incentives and how to use them. He describes participation in the political process, especially in emerging democracies, as a kind of moral incentive.

4. On a related topic, Papanek (1967) describes how "inefficient decisions are taken for several reasons." He discusses how the actions of decision makers in a market system affect other decision makers, and how hard it is to anticipate the affects of their decisions on external economies and diseconomies. Papanek also mentions how economies are affected by tradition and other factors that are hard to foresee.

5. Shifting political allegiances that result from pending elections or the need to create economic opportunities and conserve foreign exchange may cause policies to change overnight. These political complexities, a result of immature political institutions coupled with cultural norms that prize the strength of the individual, make it extremely hard to implement new policies intended to protect fragile natural resources.

6. Preston (1985) discusses the complexities in the social change process, and talks of the "ethico-political notion of development," which creates uncertainty and hampers interventions from outside parties.

7. Cleaves (1980) describes how diverse actors have competing ideas about what government should do to address public problems, and how groups can form alliances to favor or undermine policies that change the intentions of the original policies and influence policy makers.

8. McNeeley discusses at length different kinds of economic incentives that can be used in combination with national policy reform to promote conservation of biological diversity.

9. Weitz describes how the social status of agricultural workers has greatly decreased in countries as they develop economically, with farmers and peasants often seen as menial laborers. During field work in the Caribbean country of St. Kitts in 1988, a long-time Peace Corps official told the author that local fishermen had the lowest social status of anyone in the community, and were commonly characterized as "Anyone with a wet ass and an empty gut."

10. Information in the discussion about the success of local incentives is derived mainly from Hanrahan 1988.

11. The concept of an approach to participatory planning that uses an explicit model is based on the work by John Paul Lederach of the Mennonite Conciliation Service, Akron, Pennsylvania. Lederach shows how an explicit model of communication, based on the natural experiences and common sense of the participants, is consistent with cultural norms in developing countries, as compared to the implicit approach, when local knowledge is distrusted and outside experts assume that they know the needs of local communities.

REFERENCES CITED

Brooke, J.
1990 Peru Suggests U.S. Rethink Eradication in Land Where Coca is Still King. New York Times, November 18, 1990. page 3.

Cleaves, P. S.
1980 Implementation Amidst Scarcity and Apathy: Political Power and Policy Design. In M. S. Grindle, ed., *Politics and Policy Implementation in the Third World*. Princeton, N.J.: Princeton University Press.

DeBoer, A. J.
1989 Sustainable Approaches to Hillside Agricultural Development. In H. J. Leonard, ed., *Environment and the Poor*. Washington, DC: Oversees Development Council.

Gamman, J. K.
1990 Environmental Policy Implementation in Developing Countries. Ph.D. Dissertation, Dept. of Urban Studies and Planning, Massachusetts Institute of Technology, Cambridge, Massachusetts.

Goulet, D.
1989 *Incentives for Development: The Key to Equity*. New York: New Horizons Press.

Hanrahan, M.
1988 "Sustainable Uses for Steep Slopes" Workshop Proceedings, Vol II: Synthesis Report. DESFIL Technical Report. Washington, D.C.: Development Alternatives, Inc.

McNeeley, J. A.
1988 *Economics and Biological Diversity: Developing and Using Economic Incentives to Conserve Biological Resources*. Gland, Switzerland: International Union for Conservation of Nature and Natural Resources.

Pakanek, G. F.
1967 *Pakistan's Development: Social Goals and Private Incentives*. Cambridge, Mass.: Harvard University Press.

Preston, P. W.
1985 *New Trends in Development Theory: Essays in Development and Social Theory*. London: Routledge and Kegan Paul.

Tschinkel, H.
1987 Tree Planting by Small Farmers in Upland Watersheds: Experience in Central America. *International Tree Crops Journal* 4.

Weitz, R.
1986 *New Roads to Development*. New York: Greenwood Press.

CHAPTER EIGHT

PLANNING AND POLICY IN FRAGILE LANDS MANAGEMENT

by

Michael Hanrahan[1]

INTRODUCTION

Policies are general statements of philosophy or underlying intent, designed to provide rationale for eventual actions and programs. Policies should provide direct, forward linkage to implementation or intervention programs. Written strategic plans link the general policies with the action programs. So, policies set forth a general desired outcome, a strategic plan maps the broad actions needed to attain or realize the policy, and a program contains specific measures (tactics) to implement the strategy and policy. Strategic environmental and natural resources planning for fragile lands is perhaps the most fundamental purpose of the DESFIL project.

We define an environmental and natural resources or ENR plan as a written statement that sets out a course of action and an allocation of resources to implement a policy (McCaffrey and Webb Ms). For example, it is the policy of A.I.D. to, "support the achievement of broadly-based, sustainable economic growth (through) encouraging the preservation and sustainable use of the natural resource base" (USDS 1990).[2] A general plan for the achievement of this policy at the Central America,[3] regional level is provided by the document, "Environmental and Natural Resource Management in Central America: A Strategy for A.I.D. Assistance" (USAID/LAC 1989). And, specific actions to implement both, again at regional level, are provided by the RENARM program.[4]

Although the DESFIL project is not concerned with policy making, our planning experience has included the preparation of environmental and natural resources (ENR) concept papers, strategic long-range plans (in St.Kitts, the Central America Region, El Salvador, Costa Rica, Peru, and Ecuador), Environmental Profiles (Honduras), Tropical Forestry Action Plans (Belize and Guatemala), Environmental Impact Assessments (Haiti, Costa Rica, and Bolivia), and the entire range of A.I.D. project planning documents (project identification documents, project papers, project appraisals, and so forth in Bolivia, Costa Rica, El Salvador, Guatemala, the Central America Region, Haiti, and Jamaica). DESFIL has also sponsored the preparation of a series of research reports on planning, including Gamman 1990a, Meyer 1990, Valencia et al. 1990, and Hanrahan 1987.

ISSUES IN PLANNING AND POLICY

The efforts of the DESFIL project have been focused mainly on steep slopes and humid tropical lowlands. However, we believe that the issues and problems that characterize ENR planning and policy for these fragile lands are more generally those of the ENR planning and policy process and that the lessons learned from the fragile lands experience are broadly applicable as well.

The DESFIL experience suggests that the following are among the more significant issues affecting ENR planning and policy:

1. Institutions proliferate, personnel rotate frequently, human and financial resources are scarce, and non-ENR policy interests[5] are abundant and pressing (see Chapter Four). In the hemisphere's developing countries, these factors produce short-range vision in resource allocation and use; engender conflictive policies and programs; dilute focus, attention, and authority; and foreclose sustained political will (Hanrahan 1988, Gamman 1990a, 1990b; Honadle and VanSant 1985).

2. There is a general lack of awareness that income growth, equity, and the nondegrading use of natural resources are compatible, and an incorrect perception that they are conflictive (see Chapter Six for an extended discussion of this issue).

3. Policy and planning are divorced from implementation programs, that is, policies and plans are little used to guide subsequent development. So planning has little impact (Valencia, Russo, and Hanrahan 1990; Bromley 1990).

4. Beneficiary professionals, institutions, and governments seem unable to develop or to implement effective, or high impact, policies and plans (Gamman 1990a).

5. A broad and balanced range of interests may not be represented in policies, plans, or implementation programs. The interests of significant stakeholders may not be represented (Gamman 1990a).

6. Environmental impact analysis remains isolated from policy making and planning, and mitigation remains separate from implementation (Hanrahan and Pereira 1990; Daugherty, ed. 1990; Chapter Ten, this volume).

The remainder of this chapter deals with the use of planning and policy making to overcome these issues.

HIGH IMPACT PLANNING

Whereas those involved in ENR tend to focus on implementation and action, DESFIL experience suggests the need for a greater emphasis on the planning process.[6] Our hypothesis is that the **process** by which strategic ENR plans and programs are formulated is a major determinant of their impact. DESFIL experience shows that iterative, participatory planning can have a significant impact on the efficacy of ENR programs.

We agree with Bromley (1990) that a **process** where interests become transformed into entitlements is the essence of collective action and institutional change. Having a stake in the situation at hand — for whatever reason — increases the impact of the proposed policy for the stakeholders. Reliance on cost-benefit analysis and economic efficiency arguments alone ignores the political realities of most policy-making situations.

Clearly, the force of public attention and policy sets the stage. But if a plan is to translate policies into program actions, it must be used to achieve desired outcomes: to shape public debate, set priorities, coordinate the actions of diverse agencies and funding institutions, define common agendas, and provide for coordinated and concerted action. (Pedagogy is perhaps the most fundamental outcome of development, and may be a purpose and an outcome of planning.) When a plan or strategy achieves these outcomes, it has impact. The synthesis of the DESFIL experience in strategy preparation is that these outcomes of planning are determined by how the plan is prepared and the process used in planning. The actual contents of the plan, or what it may say, are by contrast less important than the process of preparation.

The previous paragraph equates impact with use, and use with concerted action, coordinated agendas, agreement on priorities, and the setting of boundaries on debate. In turn, we propose that these are determined by all of the following:

- An **awareness** that the subject being addressed — in this case, ENR in the context of development — is important, and the **recognition** that the subject is legitimate and significant.

- A **consensus** on priority problems, constraints, and actions; **acceptance** of the actions and assistance advocated; and the **co-opting** of related issues, opinions, and positions under the common strategic plan.

- The **completeness** of the strategic plan. Are many points of view subsumed in it; hence, is it complete enough to be of **broad appeal**? Are its contents and advocated actions **understood** by its constituency?

- The extent that it succeeds in setting a **common agenda** and in coordinating resources and actions to implement the policy.

Valencia et al. (1990) and Gamman (1990a) examine these ideas. They use three case studies from Latin American and the Caribbean to illustrate different planning processes, their impact on pedagogy, and the translation of policies to action programs.

Saint Kitts: Planning the Uses of the Southeast Peninsula

Overview

In 1986, the Government of St. Kitts and Nevis (GOSKN) and USAID signed an agreement designed to open up the South East Peninsula (SEP) to planned physical and economic development. An inaccessible, undeveloped, and unoccupied area possessing beautiful beaches, diverse landscapes, and spectacular Caribbean vistas, the Peninsula was a prime development site, but required a penetration road. The project included supervision and construction of the road, technical assistance to improve tax administration, and development and implementation of a land use and environmental management planning program intended to ensure that land development for tourism and high-quality residential development occurred in a timely and environmentally sound manner, preserving the physical and environmental amenities that made the Peninsula so attractive.

The South East Peninsula Conservation and Planning Program intended to:

- Provide support to the SEP Board in carrying out its functions for land use management;
- Implement the essential mitigation measures identified in the SEP Environmental Assessment and establish the institutional framework for the subsequent implementation of its secondary recommendations;
- Train personnel in land use management and environmental protection;
- Analyze, describe, and inform on government policies regarding investment; and
- Streamline systems for approvals of Peninsula-related investments (development and use of its resources).

These purposes were advanced by preparing a series of plans, handbooks, and drawings. Locally adapted procedures for environmental analysis were developed. The capabilities of the SEP Board and Technical Analysis Unit (TAU) II in planning and zoning were developed during the preparation of the planning documents (learning by doing). An island-wide environmental education program conducted in schools, media, and workshops sought to raise the awareness of the whole Kittian population about the importance of preserving the natural amenities of the Peninsula.

In general, preparation of the development plans, and the parallel empowerment of the Board, may be characterized as follows: the consultants would arrive to prepare either a technical analysis or one of the principal planning documents. They would meet with the cognizant GOSKN officials, and prepare a draft document while still on the island. The consultants would then leave while this document would receive initial scrutiny and comment from the Board and the GOSKN. The consultant(s) would then return to incorporate the initial round of comments and reactions into a second draft. The Board and the TAU would then continue a lengthy and quiet process of circulating the draft document to solicit further comment and review, build support, and seek consensus.

The Board and the GOSKN were, and continue to be, forced to familiarize themselves with the plans, to know their policy and implementation nuances and significance, and to adapt them locally because of worldwide interest in the development of the Peninsula, and the enormous economic, social, and political stakes involved.

Although these plans were not written initially by their ultimate constituents, the process required Board, government, and developers to familiarize themselves with them, and to provide analysis, comment, and input on all of the plans and proposed rules. The process provided opportunities for modification and coopting of diverse interests and points of view. Though still in draft, these documents are being used daily as the SEP Board and GOSKN receive development proposals from interested developers. Meanwhile, a parallel environmental education program has been carried out all over the island to raise public awareness about the natural resources of St. Kitts in general and the proposed activities on the SEP in particular.

Impact: Institutionalization of Environmental and Land Use Management

At the present writing, the plans are in daily use, and the Board is the clearinghouse for interested developers, at times turning down projects that do not follow the guidelines as set out by the SEP development program.

The quiet, patient, and behind-the-scenes building of a constituency for the plans allows their modification, and serves to coopt interests and build consensus and authority for them. This, in turn, mitigates the fear of both the Board and the government that the plans, if formally codified, would become set in stone.

Visibility and awareness are high because of the stakes and pressure involved. Virtually everyone on the island and all of the interested developers are aware that the development of the SEP has begun, and that the GOSKN is controlling its planning. As the developers flood the Board with proposals, and the government is pushed to decisions, the planning documents are increasingly used, and so have ceased to be external consultant documents and have become actual internal Kittian working documents. It has been both inevitable and desirable that the plans have been modified and adapted with the press of events.

The highly participatory mode adopted was a major source of delay. For the Board to approve and start to use the plans required two years. But any idea that planning documents of this magnitude of political and social importance might be produced and turned forthwith into functioning land use and environmental management tools ignores political reality. The stakes are too high to entrust the development process to any but GOSKN at the highest levels. At those levels, time must elapse and involvement and understanding must occur for consensus to form.

Given the Kittian context, the project and program may not have been able to achieve their intended purposes by some other process. In fact, given the uncertain status of the Board, and the powerful interests acting on the SEP, the planning process may have had more impact by being developed and slowly institutionalized. This reflects Kittian political reality and ultimately compromises between the need to preserve the original environmental amenities that impel development, the interests of the developers, and the ultimate paramount interests of Kittian society.

Honduras: Developing an Institutional Capability for Natural Resources Analysis

Overview

Approximately 80,000 hectares of forests are destroyed annually in Honduras by disease, forest fires, and conversion to agriculture and pastures. This represents a great loss in potential revenues for a country whose main economic activity traditionally has been based on the forest industry. The loss of forests is a causal factor of rural out-migration and the increase of marginal urban populations, poverty, and social unrest. Forest loss and other aspects of natural resource management, such as protection of flora and fauna, water quality, and coastal resources, have been seen as marginal to, or casualties of, development, and so neglected by Honduran institutions and policy makers.

Meanwhile, there is much data to indicate that accelerating problems of environmental degradation in Honduras are having serious economic effects. The enormous costs to distribute clean water to Tegucigalpa, the problems stemming from the reduced life span of the El Cajón Dam, and the diminishing agricultural productivity of the Southern Zone are examples.

Since 1978, the Government of Honduras (GOH) has been making efforts to include environmental and resource considerations in national development plans. The 1979-1983 Plan, developed in cooperation with the United Nations Environmental Programme, was the first to include guidelines related to environmental protection. Subsequent five-year plans have also included these guidelines. Their general nature, a lack of adequate infrastructure, and weak GOH institutions have largely precluded the implementation of these plans.

The foregoing factors indicated the need for ENR planning and institutional development, in part pedagogic. In 1988, the GOH through the Ministry of Planning and Budget (SECPLAN)

decided to develop a national institutional capability for environmental management and a national environmental and natural resource management (ENRM) program. We will refer to this program as the Honduran Environmental Program (HEP). Its purposes were to:

- Enhance the institutional capacity of SECPLAN for environmental management, including coordination with other GOH institutions;
- Strengthen SECPLAN's Department of Environment;
- Contribute social, institutional, and technical documentation needed for policy making;
- Prepare general institutional guidelines regarding the sustainable use of natural resources, guidelines that cut across the whole Honduran institutional structure; and
- Train a cadre of Honduran professionals capable of environmental analysis, aware of the implications of resource use in generating economic growth, and able to propose mitigation and abatement measures (pedagogy).

An institutionalized capability to design, implement, and evaluate development programs for sustainable resource use was perhaps the fundamental desired outcome. This capability was to be dispersed throughout the institutions controlling the use of Honduran natural resources, extending well outside the Ministries of Planning and Natural Resources. From the outset, the pedagogic purpose was explicit.

The purposes of the HEP were to be achieved through a series of activities requiring cooperation between SECPLAN's Territorial Planning Division and other GOH resource management institutions, and through the creation and support of an interinstitutional, multidisciplinary team of national professionals who would undertake all project activities with assistance from professional expatriate personnel.

To work toward the achievement of all the purposes simultaneously, it was decided to recruit and use a large, interinstitutional, multidisciplinary team of Honduran professionals. Their secondment was requested from institutions throughout the GOH. Three major written reports were to be prepared as a means to achieve the HEP's purposes. Pedagogy would be furthered through learning by doing, as the Honduran team actually researched and wrote the reports.

The first of these reports was an update of the 1982 *Honduras Environmental Profile*. It documented the status of Honduran natural resources and now serves as a source of information for decision making. Problems and constraints are diagnosed, and its resource use

recommendations can be translated into a strategy for action at the policy level and can serve as a set of guidelines to SECPLAN and the rest of the GOH.

A field exercise in problem analysis in the Southern Zone of Honduras, the Rio Sampile Pedagogic Case Study, was conducted for the preparation of the second report. The geographic diversity of this area and its high population density concentrated in a small area examples of most environmental problems that affect the whole of Honduras.

From the beginning of the project, efforts were directed towards the formation of a national interinstitutional team, which would include professionals from all concerned GOH institutions and from collaborating NGOs. The intention was that the experience gained in updating the Environmental Profile, studying the Rio Sampile, and the other activities would lead to the preparation of a National Environmental Management Plan. The Plan would be the ultimate written product of the HEP. Once these hands-on exercises were completed, the team, or at least its individual members, would remain dispersed throughout the GOH. The HEP's institutionalization and the pedagogic purposes would be achieved.

To support the process, a series of seminars and workshops were conducted by DESFIL for a wide Honduran audience. Workshops were held on geographic information systems (GIS), environmental impact assessments, and Land Use Classification systems. Visiting expatriate technicians presented informal seminars to SECPLAN. A four-day meeting of Honduran environmental educators was organized to prepare a national strategy for environmental education and to promote the creation of a national environmental education network.

Altogether, the DESFIL-guided activities of the HEP spanned two years. Literally dozens of planning and reporting sessions were held. Hundreds of letters, workplans, and interim progress reports were prepared. Scores of interinstitutional requests for cooperation and the secondment of personnel were made, verbal and written. Workshops were held, outlines prepared, data gathered, and drafts, revisions, and rewrites done. At crucial junctures, information was released to the public and radio and television publicity courted.

Approximately 150 Honduran professionals participated in the compilation of the *Profile*. Over 100 professionals from 23 GOH institutions took part in the *Profile* workshops. Fifty are listed as *Profile* authors, 115 as collaborators. Sixty Hondurans are involved in the Environmental Education network. Fifteen Hondurans participated with six expatriates in the Southern Zone case study. The whole program has had involvement at ministerial level; several vice-ministers participated in workshops, the National Plan was debated in Congress, and the President of Honduras was presented with it at a public ceremony reported by the media.

Impact: Human and Institutional Development

SECPLAN could not function as an island in the Honduran government. To implement a program of this nature, which involves many other institutions, SECPLAN first had to enjoy the

credibility and then the cooperation of at least some of these other institutions. Without them, plans would not be used. Therefore, the first task at hand was to involve, on an equal footing, as many as possible of these other agencies, so that the HEP would be perceived as belonging to all of them.

The original estimated program time frame greatly underestimated the time actually required. The highly participatory mode was largely responsible for the delays. Institution building required time for training and experiential demonstrations, and additional time for these to result in awareness and action from the institutions and professionals involved.

At first, *Profile* working groups did not interact among themselves as much as was desired. Chapter coordinators had infrequent meetings. Groups worked in relative isolation. This improved when synthesis and the assignment of priorities underscored a larger awareness of the complex interdependencies in sustainable resource use. The large number of professionals (around 250) participating in the meetings, field exercises, and workshops resulted in high visibility. Conflict served to publicize the project and created expectations about it.

Understanding of the problems, causes, and consequences of resource degradation gradually increased as the HEP evolved. Working in isolation at first limited understanding, particularly in relation to the creation of an empowered national environmental analysis capability — the interinstitutional group of government professionals. As time went on, the meetings, drafts, discussions, reviews, workshops, and other interaction increased awareness of the degradation problem, the understanding of its causes and consequences, the ability to analyze and assign priorities, and the ability to set a consensus action agenda defined and coordinated by Hondurans. Assurance of joint authorship and careful attention to visibly recognizing the cooperating institutions and professionals helped considerably to reduce initial tensions and create a team spirit.

The finished documents will undoubtedly be widely used, an outcome assured by the process used in preparing them (2,000 Spanish language copies of the *Profile* have been distributed in Honduras thus far). The program is forcing a pragmatic definition of goals, and a prioritization of objectives. As limited resources force choices, the team is acquiring more understanding of the complexity of ENR problems and a realistic view of possible corrective actions. They realize the multifaceted, poly-professional nature of the problem and of the actions required to deal with it.

Original mistrust and isolation evolved toward a much improved working relationship among the participating institutions, who became partners in a process that included more reasonable expectations and acceptance of limitations. SECPLAN now does not attempt to impose its will on the other institutions, jeopardizing their cooperation. SECPLAN now relies more on the expertise of its partners. In turn, this secures cooperation and co-opts points of view.

By design, those planning the National Environmental Management Program and its ultimate constituents have not been separate groups. The scientists and professionals who participated in the HEP also function as one of its audiences, using the results as information becomes available. Their understanding of the complex and extensive interrelationships among environmental problems grows. They also form part of the larger audience, that of the Honduran decision makers and the general public. Those carrying out the HEP are an interinstitutional, multidisciplinary team of Hondurans, newly empowered to undertake environmental analysis.

Central America: Coordinating Agendas and Programs for Natural Resources Use in Development

Overview

Accelerating environmental destruction associated with economic growth in the nations of Central America has been well documented (Leonard 1987; Daugherty, ed. 1990; EMTECSA de C.V. 1985; Universidad Rafael Landivar 1984; Dickinson, ed. 1982; Hilty 1981; ISTI 1980; Tschinkel and Zadroga 1987; USAID/PPC 1988). Agricultural and rural development programs designed to generate income for poor rural communities, stimulate national income growth, and encourage export-based industry have all been undermined by this environmental destruction. To an increasing extent, development assistance agencies have come to understand that long-term economic development requires nondegrading natural resource use.

Biophysical, economic, and social similarities among the Central American nations suggested that, as opposed to national or bilateral solutions, it would be more effective to undertake region-wide programs. However, intrainstitutional coordination can be as problematic as interinstitutional. In the case of A.I.D., one regional and seven bi-lateral missions and the interests of several Washington Bureaus revealed institutional weaknesses similar to those observed in developing country bureaucracies.[7]

To address the institutional weaknesses within A.I.D. that affected the use of natural resources in the economic and social development of the Central America region, A.I.D. elected to prepare a long-term strategic ENR plan. Its general purposes were to:

- Establish boundaries and rationale for A.I.D.'s Central American ENR efforts (those of the one regional and seven bilateral missions); and
- Set forth a 10-year regional agenda for environmental and natural resources management in the design, justification, and implementation of related programs.

A regional program was subsequently planned, to implement the regional, as opposed to bilateral, dimensions of this strategy. This Regional Environmental and Natural Resource Management Program (RENARM) was intended to:

- Develop and strengthen environmental and natural resources nongovernmental organizations (both international and Central American);

- Develop and strengthen regional research, training, and outreach institutions in the ENR programs of these organizations;

- Provide regional technical services in pest and pesticide management, forestry, environmental analysis, and policy analysis;

- Increase interaction, cooperation, and reciprocal support with the region's bilateral missions and otherwise within A.I.D.; and

- Increase interaction and cooperation with the regional ENR actions of other donors, and with the region's seven national governments.

Completion of the Central America Strategy and RENARM planning documents required 15 months. Iteration, consultation, review, drafting, publicizing, and related completion of the plans involved all of the following:

- Four formal workshops involving all parties expected to participate in eventual program implementation: personnel from Agency headquarters, the eight missions, other donors, host government agencies, NGOs, and others. Numerous internal round tables, workshops, and review sessions by those drafting the documents (altogether, about 60 persons);

- Cables, memoranda, and progress and workshop reports circulated to the expected eventual participants, and comments back from them;

- Preparation of written position papers and think pieces, and review and written comments on these by projected participants in implementation. Review and written comment on written drafts of the Central America Strategy and RENARM planning documents;

- Preparation of written appendices to the documents by the A.I.D. field missions, detailing how proposed implementation actions fit within ongoing or planned implementation programs, or how new programs might be designed to mesh with the Strategy; and

- Final review and approval by the Assistant Administrator for Latin America, who held final formal review of both sets of documents — and their appendices — and approved them on behalf of A.I.D.

Impact: Regional Programs and Concerted Action

Some 250 persons either delivered oral argument or commented in writing on written drafts, and about 60 persons wrote parts of the Strategy or RENARM program documents.

The process fully incorporated the constituents and anticipated implementers of the Strategy and the RENARM program. It encouraged people and institutions to exchange viewpoints and mesh criteria. This gave a vested interest to the crafters of the plans since the group participating in writing the documents would also be setting and implementing the regional agenda that they defined.

The lengthy, iterative, participatory discussions and writing sessions forced participants and their respective institutions to recognize ENR problems throughout the region. Participants had to come to terms of consensus on environmental and natural resource management problems and set a common agenda toward resolving these problems. Ongoing and proposed development assistance programs, funding levels, and the incorporation of the strategy agenda into the programs of A.I.D. bureaus and missions and the programs of other national and international agencies all evidence success in bringing ENR to the forefront in Central American development assistance.

Ample precedent exists for long-range strategic planning by very different processes. For example, strategies and programs can be prepared internally by small groups, and not approved at Bureau or regional level. Programs such as RENARM are frequently prepared by a team of external technical consultants, with limited consultation of intended users or constituents, and little writing by persons outside the consultant group. The advantages to this approach are faster speed, lower initial cost, and less revising and rewriting. These advantages are important to the normal operations of development assistance agencies.

By contrast, the Central America Strategy and the RENARM program seek to make a difference in resource use and to mitigate, if not overcome, the institutional constraints discussed throughout this chapter (and also in discussion in Chapter Four). For these outcomes, the Strategy and the RENARM program needed to define an accepted common agenda that would be implemented with enthusiasm and have a significant impact in attacking the ENR constraints to regional income growth.

The completeness of the Strategy, and the consensus that has developed around it, makes its use likely: its agenda already appears to have become common among the more than 10 internal USAID actors in Central American ENR. The Strategy advocates the programming of large amounts of development assistance, promising to buttress significant and coordinated resource management programs in the region. Most institutions that participated — A.I.D., other bi- and multi-lateral donors, international NGOs, and public and private Central American institutions — have since committed $200 million against the problems and constraints defined as the common agenda, confirming the sought-for impact.

On the negative side, the process cost several times more than normal program development, and took a great deal more time. Since the use of long-range strategic plans to lead programs is outside the usual A.I.D. program development process, it may be questioned on these grounds.

In this instance, the planning process, although more expensive and lengthier than normal, resulted in a Strategy and a program based on consensus and cooperation. It defined a standard ENR agenda for the region. True, the process involved greater costs, significant delays, extensive reviews, and cumbersome numbers of people and institutions. However, it was successful in raising awareness of ENR issues in income growth and their relevance to development assistance. It engendered inter- and intra-institutional cooperation. In short, it had impact as defined at the beginning of this chapter.

POLICY FAILURE: RESOURCE ALLOCATION DECISIONS IN THE EASTERN CARIBBEAN

Noting that ENR policies and laws frequently exist but are subverted in development decisions, Gamman (1990a) analyzed resource allocation decisions on the Eastern Caribbean islands of Saint Kitts, Saint Lucia, and Barbados. On those islands, benign resource uses supported by environmental policies or legislation competed with more destructive uses of the same resources. In each case, the more destructive resource use was adopted. Gamman sought to determine why.

Gamman differentiates organized interest groups from stakeholders. The latter are unorganized groups who nonetheless stand to gain or lose in common ways from how resources are allocated. On the three islands, those parties who are included or who are left out of development decisions are described, as is the working of interest group politics — how decisions are made, who is represented, or who is not.

Gamman found that the relationship between interest groups within a country and a policy-making process that excludes key stakeholders caused decisions to be made that overrode environmental policies. Policy failure could be ascribed to interest group politics, the culture of decision making, and other reasons. The failure of environmental policies could be explained by examining how interest groups use their relationships with political leaders to exert control over development.

National political leaders want to maintain their power, and do this by supporting large development projects that are environmentally destructive but highly visible to voters. Bureaucrats seek to enforce policies that protect fragile natural resources, but depend on politicians for their jobs. This prevents them from enforcing the environmental policies. Major stakeholding groups, including resource users (such as farmers, herders, or fisherman) and local

NGOs are generally excluded from the decision-making process. Environmental policy implementation is hindered.

New public policies that might be required by donor agencies as conditions of development assistance fail because they do not account for local political, cultural, and economic conditions. Environmental concerns are treated as tangents to the development process. Policies, laws, and regulations intended to preserve natural resources are treated as "add-ons" to development. Environmental policies that are required by donor agencies are seriously constrained by the extreme short-term temporal limits of donor project cycles, and the lack of political will within countries and donor agencies to embrace reforms that threaten normal operating procedures.

Imported public policies ignore local culture and exclude key stakeholders, so they rarely succeed. Donor experience in these cases shows that a new, more open approach to policy making needs to be developed. This open system needs to include all affected stakeholders, including donors, national political leaders, international and local NGOs, and resource users.

Culture and political decision making are inseparable. Politics in many developing countries are intensely personal, and affected by a history of dependency, insularity, and distrust of outsiders. Innovation in policy making requires that politicians and civil servants take risks, which is difficult to do without upsetting political leaders. New open systems of policy making must account for the relationship among local cultural norms, politics, and what Gamman calls the "culture of decision making."

In addition to the obstacles created by national politics and the culture of decision making, other reasons were found for the failure of public policy initiatives, such as environmental policies. Linkages between environmental and economic policies have to be developed that reflect the near total reliance of countries on short-term economic development strategies. Conflicting behavior and lack of long-term political will within donor agencies confound the translation of policies to sustained actions. Gamman concludes that efforts to improve environmental policy implementation have to account for four key factors: politics within host countries, politics within donor agencies, the culture of decision making, and the reliance on short-term development strategies.

RESULTS

The Saint Kitts-Nevis South East Peninsula Conservation and Development Program has resulted in the internalization of the planning process by the GOSKN and those who will develop the Peninsula. The Honduras National Environmental Management Program continues as a pedagogic planning process. Through learning by doing, it develops individual and institutional Honduran recognition of the causes and consequences of resource degradation and a national capability for environmental analysis. Planning the Central America ENR Strategy and

RENARM Program achieved substantial consensus on regional ENR constraints to sustainable development. The use of A.I.D. development resources in their elimination was coordinated. If lengthy and iterative, these highly participatory processes have had continuing impact in all three cases. By contrast, closed processes that excluded important groups affected by resource use produced the destruction of resources and internecine contention in the Eastern Caribbean.

In Central America, broad regional and more specific national agendas are now set. To a large degree, they mesh, providing for coordinated actions. The plans have resulted in large amounts of foreign assistance — currently exceeding $120 million — programmed toward the coordinated agendas.

In Honduras, more than 200 professionals from 30 institutions were trained in environmental analysis by preparing three planning documents. The Honduras Environmental Profile 1989 (Daugherty, ed. 1990), defines ENR problems, constraints, and priorities through the eyes of the Honduran professionals and planners, at least some of whom program the use of the country's resources. The process, the documents, and their contents are known at ministerial and staff levels and among the foreign assistance community.

In Saint Kitts-Nevis, an initially nascent planning board and an embryonic body of land use legislation were transformed. An empowered board now uses a comprehensive set of development guidelines to gage and regulate multimillion dollar resource use proposals. The developers know what types of rules they will be judged by before formulating their development plans, and specifically what criteria their plans, once developed, may be judged deficient.

The legal and policy frameworks for the three programs were explicit and well articulated in Central America, implicit and only generally articulated in Honduras, and nascent in St. Kitts - Nevis. In all three cases, an intentionally deliberate pace fully incorporated the constituencies for planning, the anticipated users of the plans. Painstaking process encouraged the exchange of views. A meshing of criteria co-opted agendas and viewpoints. The crafters of the plans, also their users, acquired vested interest in the plans.

CONCLUSIONS

Lengthy, iterative, participatory planning contributes greatly to the awareness of problems associated with degrading ENR use. It helps planners to recognize the relevance of those problems to equity and growth and to accept the idea that care must be taken to assure sustainable ENR use. This kind of planning results in more complete plans whose rationale and content are better understood and therefore actively implemented by their users. Interests become entitlements, as the participant-users find themselves with a stake in implementing the results of their own planning efforts, where their own ideas are represented.

Participatory planning has continuing impact on program design and effectiveness as well as policy formulation and implementation. It is lengthier and more costly than some planning procedures, but more likely to result in consensus and cooperation. An intentionally deliberate pace fully incorporates constituents (the anticipated users of plans) in the planning process and encourages participants to exchange the views and criteria of their respective institutions, creating vested interest among the crafters of the plans, who become their users.

Pedagogy, often a fundamental development objective, is well served by participatory planning. In human resource development, participants learn to compromise and cooperate through repetitive interaction at meetings, workshops, consultations, plenary discussions, and review sessions. Quiet, patient, behind-the-scenes constituency building occurs. By working together with representatives from various organizations with different agendas, participants learn to negotiate and reach consensus on ENR plans. Thus, plans do not remain external consultant documents, but become internal working documents.

Participation of this type results in high impact, extensively used plans that set boundaries on debate, set priorities, coordinate agendas, and result in concerted action, especially including the programming of financial resources. It also results in a greater sensitivity to local issues and circumstances and greater potential to respond to changing conditions than can be expected from an externally developed program.

On the negative side, constituent participation in program development costs several times more than external program development and takes much more time.

Since it is outside the usual development planning process, participatory strategic planning may be resisted. However, the notion that externally prepared program planning documents will be quickly accepted and effectively used ignores political and behavioral reality. Nor can an external process have pedagogic impact. Our cases suggest that planning constituencies understand, accept, and use plans precisely when the plans are prepared by the constituents themselves.

ENDNOTES

1. The bulk of this chapter, including text, is drawn from two DESFIL blue cover reports, one by Isabel Valencia, Sandra Russo, and Michael Hanrahan (1990); and the second by John Gamman (1990a). Full authorship of all four persons is acknowledged.

2. This definition of policy would appear to be somewhat more general than Monke and Pearson (1989): "Policies for agriculture consist of government decisions that influence the level and stability of output and input prices, public investments affecting agricultural revenues and costs, and the allocation of research funds to improve farming and processing technologies." More broadly, as here defined, policies may also include private actions, and comprehend the

usual, more general statements of foreign assistance agencies, as in Webster, "A definite course or method of action and in light of given conditions to guide and determine present and future actions; a high level overall plan embracing the general goals and acceptable procedures . . . ."

3. Central America is defined as the seven countries from Panama to Belize, inclusive.

4. Regional Environmental and Natural Resources Management Program, RENARM, a project of the Regional Office for Central American Programs, ROCAP, A.I.D.

5. Such as needs for immediate sources of income, foreign exchange, or employment creation.

6. Ascher and Healy (1990) take a similar approach, pointing out that an emphasis on process rather than on outcomes alone is the essence of the policy sciences approach.

7. These weaknesses included problems associated with institutional proliferation, the consequent dilution of authority among the many involved, acting at cross-purposes, the lack of long-term program continuity, and the absence of political and institutional will. These difficulties are often viewed as interinstitutional in nature, yet they may also occur internally in large, complex institutions.

REFERENCES CITED

Ascher, W. and R. Healy
1990 *Natural Resource Policymaking in Developing Countries: Environment, Economic Growth, and Income Distribution.* Durham and London: Duke University Press.

Bromley, D. W.
1990 "The Ideology of Efficiency: Searching for a Theory of Policy Analysis," *Journal of Environmental Economics and Management* 19: 86-107.

Daughtery, H. E., ed.
1990 *Perfil Ambiental de Honduras 1989.* DESFIL Technical Report. Bethesda, Md.: Development Alternatives, Inc.

Dickinson, J. C. III, ed.
1982 *Honduras: Perfil Ambiental del País, Estudio de Campo.* McLean, Va.: JRB Associates.

EMTECSA de C.V.
1985 *El Salvador: Perfil Ambiental Estudio de Campo.* San Salvador: EMTECSA.

Gamman, J.
1990a A Comparative Analysis of Public Policies Affecting Natural Resources and the Environment: Interest Group Politics in the Eastern Caribbean. DESFIL Technical Report. Bethesda, Md.: Development Alternatives, Inc.

Gamman, J.
1990b Environmental Policy Implementation in Developing Countries (Ph.D. dissertation). Department of Urban Studies and Planning, Massachusetts Institute of Technology, Cambridge, Mass.

Hanrahan, M.
1988 "Sustainable Uses for Steep Slopes," Workshop Proceedings. Vol. II: Synthesis Report. DESFIL Technical Report. Washington, D.C.: Development Alternatives, Inc.

Hilty, S.
1981 Environmental Profile of Nicaragua. Office of Arid Lands Studies, University of Arizona, Tucson, Ariz.

Honadle, G. and J. VanSant
1985 *Implementation for Sustainability: Lessons from Integrated Rural Development.* West Hartford, Conn.: Kumarian Press.

ISTI
1980 Panama: State of the Environment and Natural Resources. Washington, D.C.: ISTI.

Leonard, J. H.
1987 *Natural Resources And Economic Development In Central America: A Regional Environmental Profile*. International Institute for Environment and Development. New Brunswick (U.S.) and Oxford (U.K.): Transaction Books.

McCaffrey, D. and M. Webb
ms Enhanced Coordination for Fragile Lands Development, An Agenda for Development Assistance Agencies. DESFIL. Bethesda, Md.: Development Alternatives, Inc.

Meyer, C.
1991 The Irony of Donor Efforts to Build Institutions: A Case Study from the Dominican Republic. DESFIL Technical Report. Bethesda, Md.: Development Alternatives, Inc.

Monke, E. and S. R. Pearson
1989 *The Policy Analysis Matrix For Agricultural Development*. Ithaca, N.Y.: Cornell University Press.

Tschinkel, H. and F. Zadroga
1987 Natural Resource Management in Costa Rica, A Strategy for USAID. Guatemala City: USAID Regional Office for Central American Programs.

USAID/PPC
1988 United States Agency for International Development, Bureau for Program and Policy Coordination. A.I.D. Policy Paper - Environment and Natural Resources (Document no. PN-AAV-464). U.S. Department of State.

USAID/LAC
1989 United States Agency for International Development, Bureau for Latin America and the Caribbean. Environmental and Natural Resource Management in Central America, A Strategy for AID Assistance. Regional Office for Central American Programs, Guatemala City.

Universidad Rafael Landivar
1984 Perfil Ambiental de la Republica de Guatemala. Guatemala City: Universidad Rafael Landivar.

USDS
1990 Cable p-050622Z, May, 1990.

Valencia, I., S. Russo, and M. Hanrahan
1990 Strategic Environmental and Natural Resources Planning: Hypotheses, Case Studies, and Policy Conclusions for Latin America and the Caribbean. DESFIL Technical Report. Bethesda, Md.: Development Alternatives, Inc.

CHAPTER NINE

THE TROPICAL FOREST: COMPETING DEMANDS FOR PRESERVATION, EXPLOITATION, AND CONVERSION

by

Joshua C. Dickinson III
and
Francis E. Putz

INTRODUCTION

A Political Mandate

DESFIL, as an A.I.D.-funded project, reflects the Agency's broader concerns for the sustainability of development and the Congressionally mandated concern for tropical forests, biological diversity, endangered species and indigenous peoples. It is the sense of Congress that development incorporating the above concerns is "environmentally sound development."

> The Congress is particularly concerned about the continuing and accelerating alteration, destruction, and loss of tropical forest in developing countries. Tropical forests constitute a major world resource. Their destruction and loss pose a serious threat to development and the environment to developing countries. Tropical forest destruction and loss result in shortages of wood, especially wood for fuel; siltation of lakes, reservoirs and irrigation systems; floods; destruction of indigenous peoples; extinction of plant and animal species; reduced capacity for food production; and loss of genetic resources; and can result in decertification and in destabilization of the earth's climate. Properly managed tropical forests provide a sustained source of fiber and the other commodities essential to the economic growth of developing countries. (Section 118 of the Foreign Assistance Act of 1961, as amended in 1986)

The Congressional statement above is a direct result of the efforts of conservation lobbyists.

It is our purpose in this chapter to address the principal issues underlying this mandate as they relate to the management of humid tropical forests.

This concern for sustainable development generally, and specifically when applied to tropical forests, is also a central theme of the Bruntland report (WCED 1987) and is an integral element of the agenda of the 1992 United Nations Conference on Conservation and Development (Strong 1991).

Competing Demands

At issue are the competing demands for preservation, exploitation, and conversion of the tropical forest. Each of these demands is represented by a disparate set of interest groups. Interest in preservation of the tropical forest tends to increase with distance from the forest, with a small peak in the national capital and major peaks centered around Washington D.C.; Gland, Switzerland; and London. Preservation is supported overwhelmingly by academic biologists, nature conservation groups and their contributors, and by ecotourism firms and their clients. To these groups the forest represents at once a diverse array of ecosystems and species, a potential source of medicines, the resource base for indigenous peoples, and a majestically beautiful environment.

Those who exploit the forest include indigenous peoples, lumbermen, and gatherers of such products as rubber and chicle. Indigenous groups have recognized moral, if not legal, rights to the forest lands they inhabit. When cultural traditions are strong and population density low, shifting agriculture, hunting, and gathering tend to be sustainable uses of the forest. Given that only a fraction of 1 percent of the timber operations are considered to be practicing sustainable use of the forest (Poore 1989), this industry is considered to be one of the villains in the forest destruction process. Lumbermen may leave a thoroughly degraded forest after logging, but it is still a forest and will recover a measure of its structure and diversity over time, if left undisturbed. Conversion, on the other hand, is carried out through the combined action of small-scale agriculturists, large and small livestock raisers and a few plantation operators (such as oil palm, and forest plantations). Forest areas converted to other uses may return to forest if abandoned, but the process may be particularly slow when soils have been degraded and reservoirs of plant and animal colonizers distant.

TROPICAL FORESTS

Definition

A good definition must encompass all the forests that are tropical while allowing for important differences. All forests found between the Tropics of Cancer and Capricorn are tropical with allowances for minor divergences on either side of these arbitrary latitudes. A humidity regime sufficient to support a closed canopy of trees further narrows the parameters. The Holdridge life zone system provides a precise set of climatic parameters for defining the ecologically distinct forest life zones found in the tropics and subtropics. The Tropical Moist Forest life zone occupies the greatest area of the Latin American tropics simply because most of the region lies

below 1,000 meters of altitude with a majority of the lowlands on the moist eastern side of the continents in both hemispheres. Most of the forests referred to as "rain" forest are within the Tropical Moist Forest or neighboring Wet Forest life zones. When the landscape is stood on edge, as along the eastern side of the Andes or on isolated peaks in Central America, the area encompassed by one life zone may be exceedingly small. These strips or altitudinal bands harbor a rich variety of species, but are highly vulnerable to disruption because of their small area. The ramifications of this situation for maintaining the diversity of tropical forest ecosystems are discussed below.

Conversion of the tropical forest has not proceeded at an equal rate in all life zones. This is due in part to rather straightforward differences in agricultural potential. Soils of life zones flanking the unity line marking where potential evapotranspiration (PET) equals precipitation (PET/P = 1) will have and maintain a higher fertility than soils derived from the same parent material in the wetter life zones where the PET/P ratio is low. Agricultural settlement has been concentrated in the Dry and Moist life zones since pre-Colombian times. The cooler Pre and Lower Montane and Montane Dry and Moist Forest life zones have been particularly attractive to European settlement because of the adaptability of midlatitude crops and lifestyle (Dickinson 1986). Deforestation has tended to occur on the alluvial soils of valleys before progressing up the steep slopes of the surrounding mountains. As population pressure has increased, conversion has expanded to life zones and slopes previously bypassed.

Diversity of Ecosystems and Species

The Holdridge life zone system is particularly useful in developing strategies for the conservation of biological diversity. Concern for species conservation manifests itself in several ways. Conservation fund raising tends to focus very successfully on the charismatic megafauna — cats, primates, and pandas — but not on mosquitos or mycorrhiza. Equally popular, at least until Daniel Janzen's spectacular campaign for the Tropical Dry Forest in Costa Rica, has been the "tropical rainforest" where the highest concentration of species can be found. We recognize that biological diversity conservation has three distinct but complementary goals. The highest priority is the conservation of a diverse array of ecosystems. An intact, functioning ecosystem provides the highest probability that the second goal will be achieved; the conservation of the maximum number of species, maintaining germplasm with agricultural or medical potential, as well as meeting the popular concern for saving fellow vertebrates. A third goal is the maintenance of the diversity of intersystem interactions. An example is the intimate relation between mangrove and surrounding estuarine systems. The life zone system of classifying plant formations provides a quantitative framework for identifying terrestrial ecosystems on a global scale. For the purpose of conservation of both species and systems, the hierarchy of life zones, associations, and successional stages assures coverage. For example, ecotones may be defined as occurring at the transition between two life zones, at the boundary between edaphic or other associations, or at successional transitions such as between an old field and adjacent forest.

The threat to species and ecosystems is not spread evenly across the face of the earth. As pointed out above, the six life zones flanking the unity line have historically been the most attractive to settlement. Level to moderately sloping land within those life zones has been subjected to wholesale conversion to agriculture. Now the threat has shifted. Why?

People driven by population pressure and inequitable access to land and productive resources are spreading up-slope and into wetter, drier, and higher life zones. Ecosystem degradation and species loss accelerates because conventional land use practices are less productive and more destructive than in the six core life zones of the valleys. This settlement process fosters the spread of poverty and the loss of diversity. In addition, indigenous peoples earlier eliminated from life zones more attractive to dominant cultures, are now being threatened by these ill-adapted migrants.

Species assemblages unique to life zones of small areal extent are particularly vulnerable to loss. This risk increases markedly with:

- Increasing slope — because temperature decreases with altitude, transitions between life zones occur more quickly with steeper slopes with resulting smaller area per life zone along a transect across a mountain range; and

- Increasing altitude above sea level — because the total area within any altitudinal belt decreases with altitude. The land area between 3,000 and 4,000 meters altitude is a small fraction of that between 0 and 1,000 meters.

Fragility

As an ecosystem, the humid, lowland tropical forest is complex and biologically diverse — the seeming essence of resilience and stability. Tropical forests have evolved over millennia the ability to retain or rapidly reestablish biological structure in the face of pest and disease outbreaks, tree falls, indigenous shifting cultivators, and even hurricanes, volcanic eruptions, and earthquake-generated landslides. For example, many thousands of hectares of tropical forest were destroyed in Ecuador as a result of mass movements of soil during an earthquake in 1987. Yet the forest system will recover from that catastrophic event. Even on the exceedingly poor soils of the Guiana Shield where clearing and burning results in loss of the great majority of the nutrients in both the soil and plant biomass, the forest recovers. Jordan (1985) calculated that the nutrients needed to support a fully developed forest would be restored through minerals contained in rainfall over a period of approximately 150 years. A clearing observed by Humboldt at the beginning of the nineteenth century could be considered to be "climax" forest by the mid-twentieth century. In these two examples, the resilience is contributed to in the first by the patchiness of the thousands of mass movements facilitating revegetation and in the second by time. Given the ubiquitousness of disturbance, both of natural and human origin, precision is elusive in identifying a particular patch of forest as climax or primary. A definition of when climax conditions have been reached is provided by Horn (1971): "This stage is called the

climax and is defined as that stage when no significant change occurs during the lifetimes of several research grants."

Why then does DESFIL include lowland tropical forests, together with erosion-prone steep lands, in its definition of fragile lands? In what sense is the tropical forest fragile? In many of the humid tropical forests of the hemisphere the patchiness created by shifting cultivators and tree falls has been supplanted by a landscape in which the forests are patches in a matrix of cleared land (Hartshorn et al. 1982). Clearings of thousands of hectares have become "permanent," at least in the context of the human time scale. In many areas the rate of deforestation outstrips natural succession (Myers 1980; Fearnside, In Press), although the magnitude of the overall forest loss in the Amazon basin has perhaps been exaggerated (da Cunha 1989, Robinson 1990). The vulnerability of forest ecosystems derives from the sheer magnitude of forest clearing. Seed sources become too remote and the habitat of particular species is lost. Even when areas of forest are left untouched, ecological degradation may occur if fragments of forest are too small (Lovejoy and Oren 1981). Species are lost, either directly through habitat loss or indirectly through broken system linkages (Harris 1984). It is true that over geologic time ecosystems would recover and species would likely evolve to fill every niche. However, even a tick of the geologic clock is an eternity to the conservationist and planner. This situation is particularly apparent in several areas such as Mexico, Central America (Leonard 1987), and southeastern Brazil, where a massive shrinkage of the original forested area has occurred.

Forested lands in the humid tropics also exhibit a fragility linked to the nature of the soil substrate itself affecting the capacity of the land to sustain conventional annual cropping and grazing. This is because of the following characteristics common to forested areas of the tropics. Erosion is widespread because steep slopes are found both in mountainous areas and across extensive areas of lowlands outside of flood plains (these short but steep slopes are obvious on radar images). Also the soils formed *in situ* under humid conditions are deeply weathered and therefore nutrient poor. Finally, in humid tropical forests the majority of the nutrients are found in the living biomass; therefore, when the forest is removed, the small quantity of remaining nutrients are subject to leaching.

Sustainability

Pezzey (1989) provides 50 published definitions of, and statements about, sustainability, including one that says that the sustainability metaphor is likely to become "so abused as to become meaningless." Such was the fate of the concept and word "environment." Sustainable use of renewable natural resources simply means that a given stock of forests, soils, water and so on should be managed so that their quality and quantity do not diminish over time (Markandya and Pearce 1988). Allen (1980) points out that for a subsistence society sustainable use of its entire resource base is essential. The more developed and flexible the economy, "the less need to utilize certain resources sustainably, but by the same token **the less the excuse not to**" (emphasis added).

The tropical forest conservation mandate established by Congress (see quote above) is a high order, fraught with a variety of use conflicts. It calls for North Americans to be concerned about biological diversity, indigenous peoples, sustained production of economically valuable commodities, watershed protection, and global climate stability. This mandate embodies simultaneously ethical, aesthetic, social, scientific, and economic issues that will be resolved in the political arena to no one interest group's complete satisfaction. To be sustained, each of the mandated uses above must be evaluated in terms of:

- A definition of the ecological structure and processes to be sustained to achieve biodiversity conservation, commodity production, watershed protection, or other uses of interest to society;
- The levels of protection or intervention needed to maintain a desired function;
- The complementarity between and among functional uses of the forest; and
- Where and how much land of which life zones will be required to satisfy which interests; and
- The priorities set for use of land and capital to satisfy the different interests, both national and international.

Although conflicts among different users is inevitable, a common basis remains for agreement among all who use the forest resource sustainably for a given purpose. Any sustained use is superior to conversion to other uses. The collective term "forest resource" is used purposefully to emphasize the multiple functions of forest ecosystems, whether the use is aesthetic appreciation, scientific study, extraction of products, or the process of maintaining soil stability and water flows at the watershed scale.

There is a note of urgency in defining sustainability specifically in regard to forest management for timber. For example, World Wildlife Fund and other institutions are promoting a worldwide prohibition in trade of timber products not produced under sustainable management, without clearly defining sustainability in ecological and social terms (WWF 1989, IHPA 1990). Lack of a widely accepted definition can lead to loss of credibility and fraud. However, certification can become a valuable tool in promoting sustainable forest use if verification is technically credible and enforcement is uniform globally.

A serious threat to tropical timber value is the pressure to discourage its use. This ranges from local prohibitions on the use of tropical woods in public construction and attachment of warning labels, to legislation prohibiting the financing of primary tropical forest exploitation. The hypothesis that deforestation contributes to global warming has precipitated legislation in the U.S. Congress to foster limiting the contribution of greenhouse gasses to the atmosphere by certain key countries (U.S. Congress 1989). One of the provisions of the law states that A.I.D.

will not expend funds on any activities that result in any significant loss of tropical forests, or involve industrial timber extraction in primary tropical forest areas.

This provision of the law may very well have an effect opposite to that desired, precisely because it seeks to negate the value of the forest to the very industry that currently derives the greatest economic value from it. Assuming such measures are effective in either drying up the international market for tropical timber or discouraging its exploitation, the result may be to encourage greater forest destruction. If the encouragement of sustainable management of primary forests for high value timber is not an option, then pressures will increase to convert the devalued forests to crop and pasture land or use them as a source of industrial fuel (Brazil, for example), cellulose, or timber for local use. Whereas nontimber forest products and ecotourism can give value to a tropical forest, we doubt that such uses without subsidies can compete with other pressures unless combined with sustainable timber management (Dickinson et al. 1991).

The pressure to adopt this type of restriction reflects the belief of many conservationists and some foresters (Spears 1979) and ecologists that tropical forests cannot (or will not) be managed sustainably. It is the position of the authors of this chapter that tropical forests, both primary and secondary, can be managed sustainably for timber and nontimber products given an appropriate policy environment, known technology, and interdisciplinary assistance to those involved directly in forest exploitation.

Valorization

While we fret over the sustainability of competing management goals for the tropical forest, forests are being cleared and converted to other uses. Unquestionably, if forests are to be maintained they must have value to society. Appreciation of value takes many forms: the school child or voter who knows the forest is the home of cuddly kinkajous and the noble jaguar; the lumberman, ecotourism operator, or rubber tapper who appreciates a competitive income from the standing forest; as well the few thousand world citizens whose activism and donations generate awareness and action by governments and multilaterals. This value must be particularly appreciated by colonists on the cutting edge of forest conversion, as well as by policy makers and those capable of translating primarily aesthetic or scientific concerns into effective political action on a local and international scale. In the developed countries, the concern for tropical forests is aesthetic and scientific. Unfortunately, few effective mechanisms exist for forest lovers to pay the forest converters' opportunity cost. How this might be remedied has been discussed (Rubinoff 1983, Katzman and Cale 1990), and purchase of land for park expansion through donations has occasionally been effective (for example, the Monteverde Cloud Forest Reserve and the Santa Rosa National Park in Costa Rica).

Deforestation is a rational action by which many thousands of individual farmers and ranchers generate income. In addition to the need for food and response to market opportunities, national and international policies often actively encourage clearing and discourage management

for timber production from natural forests (Repetto and Gillis 1988, Repetto 1990, Binswanger 1989, Warford 1987). The current rate of loss of tropical forest cover throughout the hemisphere testifies to its lack of perceived value. A logical alternative to conversion is sustained yield timber management. Applied ecologists and the timber industry, however, have limited experience in the design of economically viable as well as sustainable forest management systems (Palmer 1975). Another problem is that in addition to the policy disincentives and lack of technical knowledge, tropical forest products comprise a very small part of the BNP of both the developed and the less developed countries. Furthermore, the bulk of the value added to tropical forest products, from fine hardwoods to rubber, occurs in the developed countries. The value of finished products far exceeds what the lumberman and the rubber tapper receive for their raw materials. Obviously, more value must be added at the forest edge if the pressure for conversion is to be stemmed.

Buffer Zone Management

The preservation of natural areas with their diverse flora and fauna is a driving force in the lives of many people, particularly in the United States and a handful of other developed countries. Powerful organizations have been created to preserve natural areas, with goals ranging from assuring habitat for a single spectacular species to maintaining an array of representative ecosystems. As a result of intensive efforts by nature conservationists, governments in developing countries have established legally and geographically defined protected areas. Where such protected areas are well beyond the settlement frontier, integrity is maintained by isolation. However, "paper" parks do not fare well in the face of settlement pressure, lumbering, and mining. Given effective protection, the best that can be expected is that parks will become islands in a sea of farms and ranches. This is the predicted fate of protected areas in much of Central America, most notably in Costa Rica (Leonard 1987). That the ecological integrity of smaller isolated parks may be difficult to maintain has been well documented (Lovejoy and Oren 1981). Harris (1984) effectively documents the role of corridors between protected areas of sub-critical size in expanding effective wildlife habitat.

Once the ecological factors have been considered, compatibility with human presence in and around protected areas becomes the paramount challenge in natural area management. Buffer zone management is a concept that addresses two related human threats to protected areas. First is the direct threat to the protected area itself. Rarely are developing countries able or willing to provide an adequate level of protection to a park from wildlife and timber poaching, or even wholesale invasions by settlers, ranchers, and timbermen. Second, forest clearing up to the protected areas border has severe effects on the flora and fauna. Both threats have stimulated efforts to manage human activities in buffer zones around protected areas. Common goals and issues associated with buffer zone management include:

- Maintenance of low population density;
- Promotion of activities compatible with protected area integrity and function; and

- Establishment of a hierarchy of decreasingly restrictive uses with increasing distance from the protected area.

Some of the uses of buffer zones being widely discussed and occasionally tested are sustained yield management of natural forests, extractive reserves for non-timber products, and ecotourism (USAID/Costa Rica 1989). Less compatible activities for buffer zone areas immediately adjacent to nature reserves include plantation forestry and agroforestry.

Buffer zone management is a geographically explicit example of the broader awareness among nature conservationists that their goals cannot be achieved in developing countries without actions directly benefitting those who pose a threat to protected areas.

Ecotourism

Ecotourism is an element of the growing global tourism industry oriented specifically towards natural areas (Boo 1990). In general, ecotourists believe in nature conservation, travel in small groups, accept less than luxurious services, and expect an informed and educational interpretation of nature.

At the margins of ecotourism are what might be classed as adventure tourism and sightseeing. Adventurous tourists pit themselves against nature (and themselves) as they raft the raging Urubamba river in Peru, or survive for a week in the Amazonian forest with only a machete. Sightseeing represents the other margin — a passive and often distant appreciation of nature — from the deck of a cruise ship on the Amazon or from an air conditioned bus with multilingual landscape interpretation. With careful planning, both adventure tourism (Russell 1989) and sightseeing can complement ecotourism activities.

Tropical forests constitute a major ecotourism destination. Ecotourists represent a wide range of sophistication and interests with tour operators catering to all types, ranging from dedicated birders to those attracted by a glossy brochure to an off-beat vacation site. Typical of the more casual ecotourist were the participants in a DESFIL conference on natural area conservation in Ecuador. They were treated to a forest walk out from Metropolitan Touring's Flotel on the Napo River. These ecotourists — politicians, bureaucrats, conservationists, and military personnel — on the walk and dugout ride evidenced no concern that the forest had scattered banana trees and only one relic giant ceiba tree.

Ecotourism is seen as a major contribution to local income generation in many buffer zone management schemes. This is predicated on several assumptions:

- The attractiveness to ecotourists of the protected tropical forest area. Tourist activities require access roads and trails, accommodations, competent interpretation, as well as outbound/inbound operator connections;

- The compatibility of tourism with protected area management goals. Trails and people are generally compatible with a park set aside for public use and education. If total protection and scientific research are the goals, ecotourists will have to go elsewhere. The Monteverde Cloud Forest Preserve in Costa Rica is probably not the best site for studying quetzal bird behavior when the trails hold hordes of school children on nature excursions;

- The potential contribution of tourism to the local economy. Local ecotourism impact can vary widely (Mathieson and Wall 1982). A commercial package costing the tourist $2,000 may pay a few dollars in park entry fees and little more in tips. Only with concerted action by local people in concert with an appropriately motivated government and externally financed NGOs can substantial local benefits be assured (Lillywhite and Lillywhite 1990);

- The compatibility of tourism with the local culture. An important factor is the nature of the local populations; are they well-heeled, large property owners, poor peasant migrants, or an indigenous group with little positive outside contact? Large property owners are only a problem to the extent that they may exploit tourism opportunities to the exclusion of other groups. Peasant migrants often have little familiarity with the forest, little in the way of crafts, and no capital. They must be trained in the skills needed to participate in the tourism economy. Indigenous people generally know the flora and fauna intimately and may have a craft tradition. However, they are vulnerable to exploitation and continued destructive cultural contact through tourism. They need to be empowered to participate on their own cultural terms and offered carefully adapted training for dealing with ecotourists. One challenge to ecotourism is to create an economic environment in which a monkey is perceived as more valuable as a tourist attraction than as a meal; and

- The compatibility of tourism with other uses of buffer zones, particularly logging. Driving into a clearcut or encountering a bulldozer on a skid trail will depress most dedicated ecotourists. On the other hand, 10 years after a clearcut or three years after selective logging, a properly maintained skid trail will serve birders admirably. Nontimber extractive reserve exploitation may also be compatible with ecotourism and buffer zone management to the extent that ancillary hunting activities do not decimate the wildlife of interest.

THE CASE FOR PROTECTION

A distinctive form of protection is the establishment of natural areas for the use of indigenous peoples. In Panama the Emberá (Chocó) peoples have a legally established Comarca or homeland in the Chucunaque drainage on the Pacific side of the Darién, just as do the Cuna on

the Caribbean side. When indigenous people form a culturally and politically cohesive unit and have lands not currently under threat from settlers and cattlemen, it is possible to think of such protected areas as sustainable. In addition to the moral right that indigenous people have to the land they have occupied for centuries, their unique knowledge of useful plants and animals provides a dual justification for protecting both the integrity of their culture and the natural areas themselves.

Maintenance of biological diversity is a major scientific and lay conservationist concern that has strong political backing in the United States, but not necessarily yet in the countries where nature is most diverse. Preservation of large tracts of tropical forest is critical to the long-term research agendas of some scientists. Such agendas involve the preservation of adequate samples of the full array of life zones classified as "tropical forest." What constitutes an "adequate" sample represents a research agenda in and of itself (Lovejoy and Oren 1981). Unfortunately, the studies of critical ecosystem size in the Amazon address a relatively small array of life zones. Needed also is an assessment of the importance of preserving the linkages among adjacent dissimilar systems.

Field-oriented science can have immediate as well as long-term economic benefits. Research stations usually also provide local and national influxes of money, training, and employment possibilities. For example, the Organization for Tropical Studies, a largely U.S.-financed training and research organization based in Costa Rica, has made significant contributions to the economy. This has occurred through direct expenditure of several million dollars per year and more importantly through providing scientific information and training in natural area conservation. This support has enhanced the worldwide image of Costa Rica as a nature tourism destination (Laarman and Perdue 1989).

Unfortunately, protection of natural areas is just beginning to be accepted as a politically acceptable course of action in most developing countries. Parks and other classes of protected areas have been established, often existing only on paper, to protect the integrity of natural areas. In fact, inaccessibility remains the most effective protection of tropical forests. Where governments have recognized the value of protecting natural areas, but lack the budget and hence staff to carry out programs, privatization of natural area management is being attempted. Belize has delegated some management functions to groups such as the Belize Audubon Society. The Tropical Science Center, a local, private, nonprofit, institution, runs Monteverde Cloud Forest Reserve in Costa Rica. Another trend worthy of note is the externalization of financial resources for preserve management, exemplified by the debt-for-nature swaps.

THE CASE FOR FOREST MANAGEMENT

Forest Use Decision Making

In our analysis we are employing an "expert systems" approach to integrating knowledge about social, ecological, and economic conditions to identify appropriate forest-use practices. A given in our analysis is a gradient of increasing intensities of forest use, from complete protection at one extreme to conversion to industrial plantations at the other (Table 9.1). A variety of silvicultural options are considered. The goal is to elucidate the decision-making process rather than to generate specific land use prescriptions. In the following sections, forest land use choices (Table 9.1) are outlined and the key determinants (Tables 9.2-9.4, found at the end of this chapter), here called "qualifiers," are described. The decision rules basically consist of a series of IF-THEN statements based on the ecological, social, and economic qualifiers. Several examples are outlined to explain the decision-making process and to demonstrate the heuristic value of the system.

Extractive Reserves

Extractive reserves are being heralded widely as an ecologically and sociologically satisfactory alternative land use to logging, slash and burn agriculture, or agricultural conversion (for example, Fearnside 1989, Daly 1990). Although the designation "extractive reserve" could just as easily be used for selective logging areas as for collection areas for nuts, latex, and other nontimber forest products (NTFP), common usage is restricted to the latter. Furthermore, NTFP extraction and even selective logging are often contrasted in such a way as to suggest that logging precludes other extraction activities (Peters et al. 1989). Rattans provide a good example of a NTFP that actually benefits from selective logging through opening the canopy and stimulating their growth. Compatibility of selective logging and chicle tapping is apparent in the Yucatan (personal observation, JCD).

The success of extractive reserves appears to depend on very low human population densities (1.0 - 1.7/km^2 according to Fearnside 1989), marketable NTFP (like rubber) and some control of the market by the extractors, a commitment to sustainable harvesting practices (Peters 1990), and the continued beneficence of the state (Katzman and Cale 1990) or at least some assurance of continued usufruct rights. Extractive reserves are most appropriate on sites unsuitable for agriculture; on good soils, extractive activities are unlikely to be economically competitive with more intensive agriculture.

TABLE 9.1. FOREST-USE PRESCRIPTIONS ARRANGED IN ORDER OF INCREASING INTENSITY AND COSTS

I.	Protection	
	Level 1	Complete Protection
	Level 2	Allow nondestructive research
	Level 3	Allow minor experimental manipulations, voucher collections
	Level 4	Promote tourism, particularly ecotourism
II.	Extractive reserves for nontimber forest products (NTFP)	
	Level 1	Latex, fruits, and other NTFP that do not require killing of adults
	Level 2	Rattan, palm hearts, limited hunting, and harvesting animals for research
III.	Selective logging with natural regeneration without silvicultural treatment	
	Level 1	Large, minimum dbh, controlled felling, planned extraction, engineering logging roads and skid trails, post-logging road drainage and closure.
	Level 2	Small minimum dbh, controlled felling and etc.
IV.	Selective logging with natural regeneration and silvicultural treatment	
	Level 1	Low intensity treatment: liberation of potential crop trees.
	Level 2	Medium intensity treatment: refinement of entire logging areas
V.	High intensity logging with uniform treatments or shelterwoods management	
VI.	Enrichment planting with native species along cleared lines	
VII.	Strip clear cuts with natural regeneration, refinement of regrowth forest	
VIII.	Coppicing and coppice with standards using native species	
IX.	Conversion to managed village woodlot for fuelwood, fodder, etc.	
X.	Conversion to, or establishment of industrial forest plantation for pulpwood or biomass production.	

Much of the enthusiasm for the extractive reserve concept derives from the diversity and potential market value of NTFP (see, for example, Peters et al. 1989). But although enumeration of harvestable forest products and calculation of potential profits have served as a foundation for arguments for market-driven conservation, the foundation is a bit weak. One problem is with the marketability of nontimber forest products. Although the rattan market is thought to be extremely elastic (Godoy 1990), the same cannot be said for products that are only used locally such as fruit and thatch. The extractive reserve concept also seems implicitly based on the assumption that forest dwelling peoples with long histories of harvesting NTFP naturally do so in a sustainable fashion. There is evidence, however, that rapaciousness in regard to resource use is not solely a characteristic of loggers. In a somewhat inflammatory article entitled "The ecologically noble savage," Redford (1990) discusses this myth. Unfortunately examples abound of uncontrolled exploitation by forest dwellers. Vazquez and Gentry (1989) report that in the Iquitos region populations of many native fruit species with high economic potential (at least locally) are being rapidly depleted by destructive harvesting practices. The history of the use of wildlife is highly variable as well (Robinson and Redford 1991). Finally, the effects of even fairly gentle forest-use practices can result over time in profound changes in forest structure and composition. The role of pre-Colombian Mayan forest manipulations are evident, for example, in the high stocking of breadnut trees (*Brosimum alicastrum*) and other species in the vicinity of long-since vacated settlements (Barrera et al. 1977, Gómez-Pompa 1987).

The effects of extraction activities depend on the nature of the products being extracted and the intensity of harvesting (Table 9.2). Plant and animal population sensitivity to different harvesting schedules have been investigated for preciously few forest products but maintenance of stable populations is more likely for products like latex or even fruits (Peters 1990) than for palm hearts or animal skins.

Selective Logging with Natural Regeneration

Without postfelling silvicultural treatment but with the proper control, selective logging closely mimics natural forest processes. Unfortunately, the controls that would make selective logging sustainable are seldom implemented (Poore 1989). At worst, selective logging is equivalent to "high-grading," that all-too-common practice of logging without regard to future timber productivity or ecosystem function. Under the best conditions, the logging operation itself serves as a silvicultural treatment insofar as selective tree removal stimulates the growth of the remaining trees.

In the absence of controls on felling and extraction, ecological damage in general and damage to potential crop trees in particular can be devastating. The total amount of logging damage varies with the number of trees felled, volume of timber removed, abundance of lianas, stand composition, terrain, soil characteristics, and type of equipment used (for a review see Ewel and Conde 1980). Estimates of logging damage are unfortunately difficult to compare because of the different tree-damage classification systems used by researchers and the lack of

long-term studies of the fate of damaged trees. Most studies of logging damage, however, report that about 50 percent of the canopy is destroyed when only 10 percent of the basal area (10-20 trees/ha) is removed (for example, Burgess 1971, Fox 1968, Redhead 1960, Uhl and Vieira 1989). In the same logging areas, roads and major skid trails cause serious damage to 10-20 percent of the ground, with severity of damage increasing with slope (Hendrison 1990).

Results from carefully managed selective cut experiments are promising (de Graff and Poels 1990). Logging damage can be substantially reduced by following some basic guidelines. Pre-felling cutting of canopy lianas, for example, has been shown to reduce the incidence of crown and bole damage to neighboring trees by 20-40 percent (Fox 1968, Appanah and Putz 1984) and reduces later liana infestation as well (Putz 1985). When the direction of felling and log extraction routes are determined before logging, damage to the residual stand and the area covered by roads and skid trails was reduced by about 50 percent in Suriname (Jonkers 1987), Sarawak, Malaysia (Marn and Jonkers 1981), and Queensland, Australia. Furthermore, tree growth rates in logged stands exceeded those observed in old-growth forest in Suriname by a factor of two (Jonkers 1987). Caution should be exercised in assuming this is a general response since in Sarawak, in contrast, selective logging without subsequent silvicultural treatment resulted in no apparent growth rate increases of residual trees (Primack et al. 1989).

Although logging damage can be substantially reduced, controls are seldom imposed because of the perception of increased costs to the logger. Even if future timber yields and the value of ecosystem preservation are not considered, there is evidence that because of the high costs of timber extraction, controlled logging actually saves money. In Sarawak, planned extraction increased skidding efficiency by 36 percent (Marn and Jonkers 1981). The concessionaire contracted to log the experimental plots for the CELOS project in Suriname saved so much on extraction that he offered to pay the researchers to design a logging system for the remainder of his concession (N.R. de Graaf, personal communication). Silvicultural treatments increase the stocking and growth of economically valuable species at the expense of species with little market potential. Unfortunately, plants with little or no direct market value may be of tremendous ecological importance. Perhaps the best examples of this contrast in value are figs and hollow trees; both play "keystone" ecological roles in tropical forests but neither yields salable products. Controlled selective logging without silvicultural treatment is the least damaging form of forest management and may be appropriate where the ecological effects of forestry must be minimized and where there is little demand for increased forest productivity. These conditions are likely to occur in areas of low human population density, at great distances to markets, and with little potential for alternative land uses (Tables 9.3 and 9.4).

Selective logging with natural regeneration and silvicultural treatment is another approach. Timber yields in logged forests can be increased through judicious use of basic stand improvement techniques. In setting out to manage a forest in an area where there has been little forestry-related research, there is a dangerous tendency to apply a pre-existing silvicultural system from elsewhere (Hutchinson 1987). The appropriate mix of stand improvement treatments depends on a multitude of factors including stocking of advanced regeneration, species

and size-class specific responses to competition reduction, risks of weed infestation, and marketability of thinnings, all of which are site specific.

The goal of refinement treatments is to increase the growth and stocking of well-formed trees of marketable species through competition reduction. The gentlest silvicultural treatments involve removing potential competitors only in the near vicinity of selected potential crop trees. The "liberation thinning" system described by Hutchinson (1987) is an example of this sort of treatment. Generally trees overtopping or crowding potential crop trees from the side are removed by arboricide application; "thinning from below" seldom results in substantial growth rate increases. Modern arboricides are apparently environmentally safe but are quite expensive. Their advantage lies in the fact that poisoned trees die slowly, fall apart piecemeal, and do little damage to their neighbors in the process. Felling competitors, in contrast, would likely create more problems than it solved. By restricting silvicultural treatments to the vicinity of potential crop trees, much of the area treated retains a complete canopy.

Stand improvement treatments applied without regard to the location of potential crop trees can be successful where stocking is dense and weed infestations are unlikely or short-lived. Silviculturally treating areas with low stocking can stimulate seedling growth and establishment if seed sources are available and the environmental conditions resulting from the treatments are suitable. For some species (like *Swietenia macrophylla*) drastic canopy opening apparently is a necessary prerequisite for dense regeneration (Snook 1989).

Enrichment Planting of Native Species

When stocking of commercial species is sparser than is acceptable, forests can be enriched without undue clearing by underplanting with seeds or seedlings. Enrichment planting has a long history and is currently in use in several tropical areas (Weaver 1986). Nursery-grown seedlings of commercially valuable species are planted along lines spaced as widely as the mature crowns are broad. Because the canopy is opened only along lines where seedlings are planted, the forest remains intact to a great extent. Lateral shade cast by the remaining forest contributes to the development of straight, clear boles on the planted trees.

Generally, overtopping vegetation must be cleared and vines cut back at least twice during the first year after planting and then annually until the seedlings overtop the understory vegetation. Fast-growing, self-pruning tree species with high-value timber seem most appropriate for enrichment planting.

Several factors may jeopardize the success of enrichment planting in practice. High seedling mortality may occur in areas where wild or domestic browsing animals are abundant. Leafcutter ants as well as deer and cows fall into this category. However, the most serious impediment is the motivation of the crews responsible for planting and tending of seedlings. All too often seedlings planted at a substantial cost are neglected once set out in the forest because planting crews are evaluated on the basis of the number of trees planted rather than the number

of trees that ultimately survive. This applies equally to crews fielded by government agencies or by logging companies concerned primarily with meeting the letter of concession agreements. Although enrichment planting operations must be ecologically suitable, attention to socioeconomic conditions (Tables 9.3 and 9.4) is particularly important.

Strip Clearcuts With Natural Regeneration

In tropical moist and wet forests many economically valuable tree species require natural openings, such as gaps caused by the fall of large trees, for regeneration. Gaps created by long-cycle shifting agriculture are analogous. At the La Selva Biological Station in Costa Rica, 63 percent of the canopy trees were found to be gap species (Hartshorn 1989, 1990). Forest management using narrow strip cuts to imitate naturally created gaps can be used to favor rapid regeneration of economically important species. Strip cuts have been experimented with extensively in north temperate forest, particularly in Germany, where strip cutting has been carried out for more than a century.

Theory has been put into practice in a high diversity, premontane tropical rain forest life zone in the Palcazu valley of eastern Peru (Tosi 1982). The Palcazu project is basically a strip clearcut with oxen extraction on what is expected to be a 30-40 year rotation. Tree regeneration in the 30-40 m clearcuts is from wind dispersed seeds from the surrounding forest and from stump sprouts.

Documentation of the ecological and silvicultural efficacy of this system is complicated by two unrelated considerations. First, technical staff have not been able to enter the Palcazu area for two years due to restrictions arising from guerrilla conflict. Second, it takes a number of years for the composition and quality of a maturing stand to become evident following clearcut. At the time of the last observations it was evident that a large number of economically significant species were present in the regeneration, either as seedlings or stump sprouts.

Clear cutting of strips is combined in management planning with a commitment to full utilization of virtually all wood products. Nearly all of the wood from the clearcut strips is used either for saw timber, poles, or charcoal. Wood processing is carried out by local villagers with secure land tenure. Once beyond the experimental stage, the percentage of the stand utilized will depend on the profitability of marketing treated poles, lumber from relatively unknown or limited utility species, and charcoal in addition to lumber and other products from valuable species.

As with any management system, sustainability depends not only on the soundness of the management concept itself, but also on markets and on the critically important long-term discipline required to execute a plan (Table 9.4). Large land owners and indigenous groups with an intimate knowledge of their environment, secure tenure, and sufficient political and business acumen have the potential for seeing a forest management plan into a second cutting cycle (Table

9.3). Inappropriate government concession policies or a lack of commitment to long-term enforcement of appropriate policies do not encourage sustainable management.

On silvicultural grounds, one cannot help but be concerned about problems with vines and other weeds; even light selective logging can result in vine tangles that persist for decades. Reliance on stump sprouts may also be problematic if, as in other forests, many of the coppiced shoots suffer heart rot. Likewise, marketability of small-dimension timber and mixed species (and grades) of saw logs may be problematic. Sociologically, the impetus to plant a crop of maize or cassava in the clearcuts must be great; cultivation and particularly fire, however, could spell disaster for the silvicultural plan. Finally, maintenance of saw mills and machines for pressure impregnating poles with preservatives may tax local technological know how. None of these problems seem insurmountable but the system remains very much in an experimental phase.

Although strip clearcuts are well known to foresters, at least in the temperate zone, the consideration given by project designers to social conditions in the Palcazu is unprecedented. The concession is being run by local people, the traditional land owners. It is to these people that profits from the community-run concession accrue (Tables 9.3 and 9.4). Locating many of the forest product processing facilities near the logging area increases the likelihood that these profits will be substantial. If the strip clearcut system proves satisfactory in the Palcazu Valley, the project sets an important precedent by involving local people in structural silviculture, an undertaking generally considered the domain of large corporations.

Coppicing of Native Species

The tremendous capacity of many species of hardwoods to sprout new stems after cutting is the basis for what is perhaps the most ancient form of forest management: coppicing. The stools of cut trees often produce multiple sprouts with exceedingly rapid growth rates, at least initially. Although coppicing is generally used to produce poles, small dimension timber, and wood for charcoal production, coppiced trees can be combined with trees grown from seed in what is known as a coppice with standards system.

The standards are grown for several coppicing cycles for saw timber; the coppice provides some lateral shade during establishment and early growth of the standards. Coppicing at 3-10 year intervals provides short-term economic returns and employment opportunities while retaining some degree of forest cover.

The importance of living roots in preventing soil erosion on steep slopes makes coppicing and coppice with standards an appropriate silvicultural system when erosion is a potential problem.

DISCUSSION

In descending order of relative impact on the structure and functions of a forest ecosystem are the following types of exploitation: sustained yield lumbering; subsistence by indigenous forest dwellers at low population density; nontimber, "extractive" enterprises; and ecotourism field operations and research. Each activity has an enormous range of potential impacts resulting in some overlap in relative impact. Furthermore, forests are often exploited in several ways simultaneously or sequentially. For example, the harvest of nontimber products may often be compatible with selective logging.

Having introduced the various forest land use possibilities listed in Table 9.1, it remains to examine the conditions under which these land uses seem most appropriate (Tables 9.2-9.4). Perhaps the easiest way to explain the sociological, ecological, and economical qualifiers is to examine a few prominent forest management systems in use in Latin America in light of these qualifiers. Extractive reserves for nontimber forest products, for example, only seem feasible where the human population is sparse and growing slowly if at all, where the extractors have secure land titles, and where more intensive land uses are precluded by infertile, erosion-prone soil, the frequency of catastrophic storms, low silvicultural potential, and moderate to high prices and market demand for nontimber forest products. If logging is combined with other extractive activities, these constraints are loosened a bit but by no means entirely.

Silvicultural systems like the CELOS selective cut system developed in Suriname and the strip clearcut system in the Palcazu Valley are suitable under slightly different ecological and economic conditions. Although the Palcazu forest is logged by a community-run organization and forests in Suriname by timber companies, selective logging and silvicultural treatments can be carried out by communities just as well; the Ejido-based forest management operations in the Yucatan of Mexico are a case in point. Regardless of whether the concessionaire is a multinational or a local village, both strip cuts and CELOS-like systems depend on low human population densities, secure land titles or long-term and respected concession agreements, and substantial silvicultural knowledge.

The most prominent difference between the systems is the predominant mode of tree regeneration on which they rely. Regeneration in clearcuts is from wind blown or animal dispersed seeds (and possible from stump sprouts) whereas selective logging is predicated upon the presence of adequate advanced regeneration (seedlings, saplings, poles, and small trees of timber species).

Forest management, by definition, involves changes in forest structure, species composition, growth rates, and potentially ecosystem function. The more substantial the management efforts the more likely that some species will be lost. Even low intensity extraction of non-timber forest products, however, often results in substantial changes in the populations of some species. Some of these changes are unavoidable, while others are causes by necessarily destructive harvesting practices. It is important to recognize, however, that even the most

rapacious loggers or thorough market-hunters may be behaving in an entirely rational manner in regard to their immediate, often pressing needs. Directional felling and careful timber extraction make little economic sense if the logger is unlikely to be fined for poor logging practices and is also unlikely to profit from the next cutting cycle or rotation. Market hunters have often hunted their prey to extinction in an attempt to feed their families.

When the goal is maximization of timber production, well-managed stands of natural forest increasingly resemble plantations; well-stocked forest from a purely silvicultural perspective bears only a slight resemblance to natural forest. Liberation of potential crop trees is done at the expense of noncommercial species. That noncommercial species can be of extreme ecological importance goes without saying. That they participate in complex interactive networks on which the survival of the commercial species depend (such as pollinators or seed dispersal agents), is also a distinct possibility. A fundamental philosophical question that conservationists need to answer is whether treatment designed to enhance the commercial yields from forest are worth the price. Will the pressure to exploit the few remaining tracts of intact forest lessen if yields from managed forest increase?

TABLE 9.2. KEY ECOLOGICAL DETERMINANTS IN MAKING FOREST LAND USE PRESCRIPTIONS

ECOLOGICAL QUALIFIERS	Level		
	1	2	3
Susceptibility to erosion	high	medium	low
Probability of catastrophic storms	high	moderate	low
Elevations	<500m	500-1000m	>1000m
Annual rainfall	<1000m	1000-2500m	>2500mm
Number of dry months per year (<100mm/mo)	<2	2-4	>4
Susceptibility to fire	high	moderate	low
Soil fertility	low	medium	high
Soil drainage	severe	moderate	poor
Soil trafficability	poor	moderate	high
Potential for silvicultural management of natural forests	goods	moderate	poor
Mode of regeneration of major timber species	seedlings	both	seeds
Shade tolerance of major timber species	seedlings	both	seeds
Ecological uniqueness, presence of rare or endemic species	very	moderate	slight

TABLE 9.3. KEY SOCIOLOGICAL DETERMINANTS IN MAKING FOREST LAND USE PRESCRIPTIONS

SOCIOLOGICAL QUALIFIERS	Level		
	1	2	3
Human population density (#/km$_2$)	<2	2-50	>50
Projected population growth rate (including in-migration)	slow	moderate	fast
Land tenure security of local residents	low	medium	high
Intensity of land use	low	medium	high
Religious constraints on forest-use practices	many	some	none
Recognized legitimacy of concession agreement	low	medium	high
Relations between concession holder and local residents	antagonistic	neutral	cooperative
Silvicultural knowledge	high	medium	low

TABLE 9.4. KEY ECONOMICAL DETERMINANTS IN MAKING FOREST LAND USE PRESCRIPTIONS

ECONOMICAL QUALIFIERS	Level		
	1	2	3
Cost of transportation to major port or industrial processing facility	high	moderate	low
Duration of concession agreement	>25	10-25 yr	<10 yr
Prior investment in forest product processing facilities	small	moderate	large
Market value of saw timber and veneer logs (fob)	high	medium	low
Market value of non-timber and forest products	high	medium	low
Market demand in relations to current supply of products	great	moderate	slight
Availability, dependability, and seasonality of local labor force	low	medium	high
Dependence of local residents on forest products	high	medium	low
Potential for local processing of non-timber forest products	great	moderate	slight
Potential for market expansion	great	moderate	slight

REFERENCES CITED

Allen, R.
1980 *How to Save the World.* Barnes and Noble, Totowa, New Jersey.

Appanah, S. and F.E. Putz
1984 Climber abundance in virgin dipterocarp forest and the effect of pre-felling climber cutting on logging damage. *Malaysian Forester* 47:335-342.

Barrera, A., A. Gómez-Pompa, and C. Vasquez-Yanes
1977 El manejo de las selvas por los Mayas: sus implicaciones silvícolas y agrícolas. *Biotropica* 2:47-61.

Binswanger, H. P.
1989 Brazilian Policies that Encourage Deforestation in the Amazon. Environment Department Working Paper 16. World Bank, Washington D.C.

Boo, E.
1990 Ecotourism: The Potentials and Pitfalls. World Wildlife Fund, Washington D.C.

Burgess, P.F.
1971 The effect of logging on hill dipterocarp forest. *Malayan Nature Journal* 24:231-237.

da Cunha, R. P.
1989 Deforestation Estimates Through Remote Sensing: The State of the Art in the Legal Amazonia. National Space Research Institute (INPE). São José dos Campos, Brazil.

Daly, D.
1990 Extractive reserves: a great new hope. *Garden* 14:14-21, 32.

de Graff, N.R. and R.L.H. Poels
1990 The CELOS management system: a polycyclic method for sustained timber production in a South American rainforest. In A.B. Anderson, ed., *Alternatives to Deforestation.* New York: Columbia University Press, pp. 116-127.

Dickinson, J.C.
1986 Settlement in the humid tropical life zones of Latin America. Yearbook, Conference of Latin Americanist Geographers 12:34-42.

Dickinson, J.C., F.E. Putz, S.Castillo M., J.G. Laarman and V. Molinos
1991 Successful Approaches to Natural Forest Management in the American Tropics. DESFIL Technical Report. Washington, D.C.: Development Alternatives, Inc.

Ewel, J.J. and L.F. Conde
1980 Potential ecological impact of increased intensity of tropical forest utilization. Biotrop Special Publication 11.

Fearnside, P.
n.d. Deforestation in Brazilian Amazonia, In G. Woodwell, ed., *The Earth in Transition: Patterns and Process of Impoverishment*. New York: Cambridge University Press, (in press).

Fearnside, P.M.
1989 Extractive reserves in Brazilian Amazonia. *BioScience* 39:387-393.

Fox, J.E.D.
1968 Logging damage and the influence of climber cutting prior on logging in the lowland dipterocarp forest of Sabah. *Malayan Forester* 31:326-347.

Godoy, R.
1990 The economics of traditional rattan cultivation. *Agroforestry Systems* 12:163-172.

Gómez-Pompa, A.
1987 On Mayan silviculture. *Mexican Studies* 3:1-19.

Harris, L.D.
1984 The Fragmented Forest: Island Biogeography Theory and the Preservation of Biotic Diversity. Chicago: University of Chicago Press.

Hartshorn, G.S.
1989 Application of gap theory to tropical forest management: natural regeneration on strip clear-cuts in the Peruvian Amazon. *Ecology* 70:567-569.

Hartshorn, G.S.
1990 Natural forest management by the Yanesha forestry cooperative in Peruvian Amazonia. In A.B. Anderson, ed., *Alternatives to Deforestation*. New York: Columbia University Press, pp. 128-138.

Hartshorn, G.S., L. Hartshorn, A. Atmella, L.D. Gómez, A.Mata, R. Morales, R. Ocampo, D. Pool, C. Quesada, C. Solera, R. Solórzano, G. Stiles, J. Tosi Jr., A. Umaña, C. Villalobos, and R. Wells
1982 Costa Rica: USAID Country Environmental Profile. Tropical Science Center, San José, Costa Rica.

Hendrison, J.
1990 Damage-Controlled Logging in Managed Tropical Rainforest in Suriname. Netherlands: Wageningen Agricultural University.

Horn, H. S.
1971 *The Adaptive Geometry of Trees*. Princeton, N.J.: Princeton University Press.

Hutchinson, I.D.
1987 Improvement thinning in natural tropical forests: aspects and institutionalization. In I. Mergen and J.R. Vincent, eds., *Natural Management of Tropical Forests*. New Haven, Conn.: Yale University Press, pp. 113-134.

IHPA
1990 Consensus Statement on: Commercial Forestry, Sustained Yield Management and Tropical Forests. Alexandria, Va.: International Hardwood Products Association.

Jonkers, W.B.J.
1987 Vegetation Structure, Logging Damage and Silviculture in a Tropical Rain Forest in Suriname. Netherlands: Wageningen Agricultural University.

Jordan, C.F.
1985 Nutrient Cycling in Tropical Forest Ecosystems. Chichester: Wiley Press.

Katzman, M.T. and W.G. Cale, Jr.
1990 Tropical forest preservation using economic incentives. *BioScience* 40:827-832.

Laarman, J.G. and R.R. Perdue
1989 Tropical science and tourism: the case of OTS in Costa Rica. *Tourism Management* March 1989: 29-38.

Leonard, H.J.
1987 Natural Resources and Economic Development in Central America. Washington D.C.: International Institute for Environment and Development.

Lillywhite, M. and L. Lillywhite
1990 Low Impact Tourism. Botswana Tourism Conference. Evergreen, Colo.: D.T.I., Inc,

Lovejoy, T.E. and D.C. Oren
1981 The minimum critical size of ecosystems. In R.I. Burgess and D.M. Sharpe, eds., *Forest Island Dynamics in Man-Dominated Landscapes*. New York: Springer-Verlag, pp. 7-12.

Markandya, A. and D.W. Pearce
1988 Environmental Considerations and the Choice of the Discount Rate in Developing Countries. Environment Department Working Paper 3. Washington, D.C.: World Bank.

Marn, H.M. and W. Jonkers
1981 Logging Damage in Tropical high Forest. Forest Development Project Sarawak Report, UNDP/FAO.

Mathieson, A. and G. Wall
1982 Tourism: Economic, Physical and Social Impacts. London: Longman.

Myers, N.
1980 *Conversion of Tropical Moist Forests*. Washington, D.C.: National Academy of Sciences.

Palmer, J.R.
1975 Towards more reasonable objectives in tropical high forest management for timber production. *Commonwealth Forestry Review* 54(3/4): 273-289.

Peters, C.M.
1990 Population ecology and management of forest fruit trees in Peruvian Amazon. In A.B. Anderson, ed., *Alternatives to Deforestation*. New York: Columbia University press, pp. 86-98.

Peters, C.M., A.H. Gentry, and R.O. Mendelsohn
1989 Valuation of an Amazonian rainforest. *Nature* 339:655-656.

Pezzey, J.
1989 Economic Analysis of Sustainable Growth and Sustainable Development. Environment Department Working Paper 15. Washington D.C.: World Bank.

Poore, D.
1989 *No Forest Without Trees*. London:Earthscan Publications Ltd.

Primack, R.B. E.O.K. Chai, S.S. Tan, and H.S. Lee
1989 Relative performance of dipterocarp trees in natural forest, managed forest, logged forest and plantations throughout Sarawak, East Malaysia. In W.R.W. Mohd, H.T. Chan, and S. Appanah, eds., *Proceedings of the Seminar on Growth and Yield in Tropical Mixed/Moist Forests*. Malaysia: Forest Research Institute, pp. 161-175.

Putz, F.E.
1985 Woody vines and forest management in Malaysia. *Commonwealth Forestry Review* 64:359-365.

Redford, K.H.
1990 The ecologically noble savage. *Orion* 9:24-29.

Redhead, J.F.
1960 An analysis of logging damage in lowland rain forest, Western Nigeria. Nigerian Forest Information Bulletin 10:5-16.

Repetto, R.
1990 Deforestation in the tropics. *Scientific American*, April 1990:36-42.

Repetto, R. and M. Gillis
1988 *Public Policies and the Misuse of Forest Resources*. New York: Cambridge University Press.

Robinson, E.
1990 As suspects go on trial, rain forest is at issue. Washington Post, December 12, 1990.

Robinson, J.G. and K.H. Redford, eds.
1991 *Neotropical Wildlife Use and Conservation*. Chicago: University of Chicago Press.

Rubinoff, I.
1983 A strategy for preserving tropical rainforests. *Ambio* 12:255-258.

Russell, R.V.
1989 Adventure travel: the psychology of tourist behavior. *Women in Natural Resources* 10:10-11.

Snook, L.C.
1989 The search for sustainable tropical silviculture. Tropical Research Institute News, Yale University.

Spears, J.S.
1979 Can wet tropical forest survive? *Commonwealth Forestry Review* 58:165-180.

Strong, M.F.
1991 Statement to Second Session of the Preparatory Committee for the United Nations Conference on Environment and Development. Geneva: UNCED.

Tosi, J.A.
1982 Sustained Yield Management of Natural Forests: Forestry Sub-project, Central Selva Resources Management Project, Palcazu Valley, Peru. Report to USAID/Peru.

Uhl, C. and I.C.G. Vieira
1989 Ecological impacts of selective logging in the Brazilian Amazon: A case study from the Paragominas region of the state of Pará. *Biotropica* 21:98-106.

USAID/Costa Rica
1989 Forest Resources for a Stable Environment (FORESTA). Project Paper for USAID, San José, Costa Rica.

U.S. Congress
1986 Section 118 of the Foreign Assistance Act of 1961, as amended in 1986. Washington, D.C.: U.S. Government Printing Office.

U.S. Congress
1989 International Development and Finance Act of 1989. Public Law 101-240 Dec. 19, 1989. Washington, D.C.: U.S. Government Printing Office.

Vazquez, R. and A.H. Gentry
1989 Use and misuse of forest harvested fruits in the Iquitos area. *Conservation Biology* 3:350-361.

Warford, J. L.
1987 Natural resources and economic policy in developing countries. In P. Nijkamp, ed., *Environmental Management and Economic Development*. Special edition of The Annals of Regional Science. 21(3), pp. 3-17.

Weaver, P.L.
1986 Enrichment plantings in tropical America. In J.C. Figueroa Colón et al., eds., *Management of the Forests of Tropical America: Prospects and Technologies*. Río Piedras, Puerto Rico: USDA Forest Service, Institute of Tropical Forestry, pp. 259-278.

WCED
1987 *Our Common Future*. London: Oxford University Press.

World Wildlife Fund
1989 Tropical Forest Conservation. Position Paper 3. Washington D.C.: WWF.

APPENDIX

THE HOLDRIDGE LIFE ZONE SYSTEM:

A Tool in Sound Fragile Lands Development

by

Joshua C. Dickinson III

The pattern of plant and animal communities (ecosystems) varies across the face of the globe in a generally coherent relation to latitude, elevation, climate, and soil. Modern human settlement and land use patterns are spreading across the landscape in a less than coherent pattern with a predictably high incidence of inappropriate natural resource use. DESFIL seeks to define the biophysical, cultural, and economic factors driving unsustainable land use and to promote actions and policy changes leading to the long-term viability of development efforts. The life zone ecology system is a valuable tool for understanding both natural systems and the best options for human use of the land.

The life zone classification system was devised by the ecologist Leslie R. Holdridge based upon empirical research on climate and vegetation in the American tropics. This system is used to characterize plant formations worldwide in accordance with three major climatic factors: temperature; precipitation; and the relationship between the two, evapotranspiration. Holdridge (1967) describes the life zone system in detail.

The relationship among temperature, precipitation, and potential evapotranspiration (PET) is illustrated in Figure 1. Each life zone is an ecosystem defined by a unique range of climatic variables. The diagram is three dimensional, representing both altitudinal belts and latitudinal regions. Figure 2 illustrates the vertical zonation of life zones in the tropics. Note that the tropical life zones extend up to 1,000 meters above sea level near the equator. One could expect to find permanent snow near the equator at nearly 4,750 meters above sea level.

A strength of the system is that a life zone map can be prepared from either extrapolation of reliable climatic data and altitude, or from characteristics of the vegetation (physiognomy, height, complexity index, and so forth) unique to a particular life zone. In practice, both approaches are used complementarily, given the paucity of reliable climatic data in many areas and the extent of clearing of natural vegetation.

FIGURE 1

DIAGRAM FOR THE CLASSIFICATION OF WORLD LIFE ZONES OR PLANT FORMATIONS

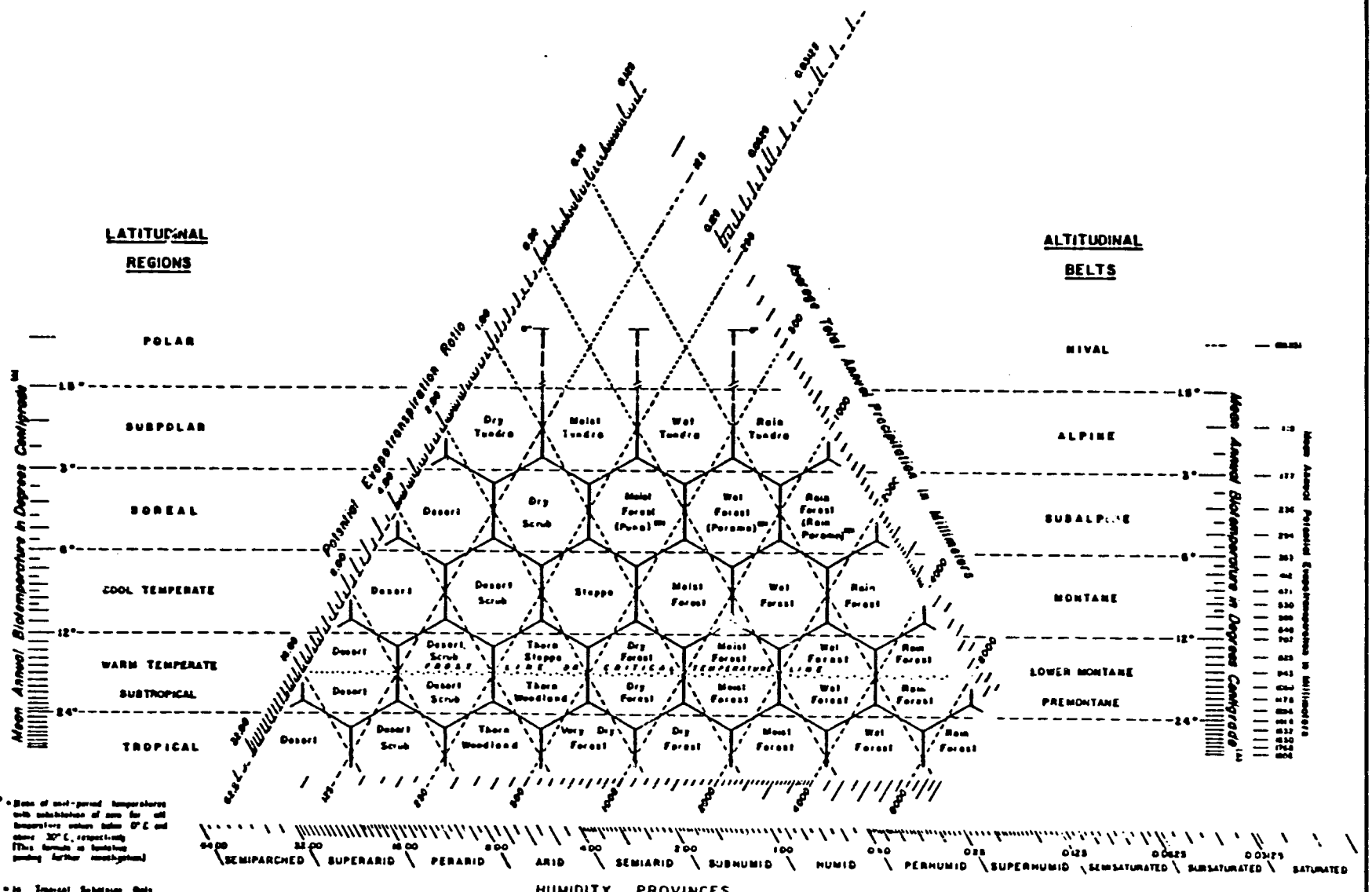
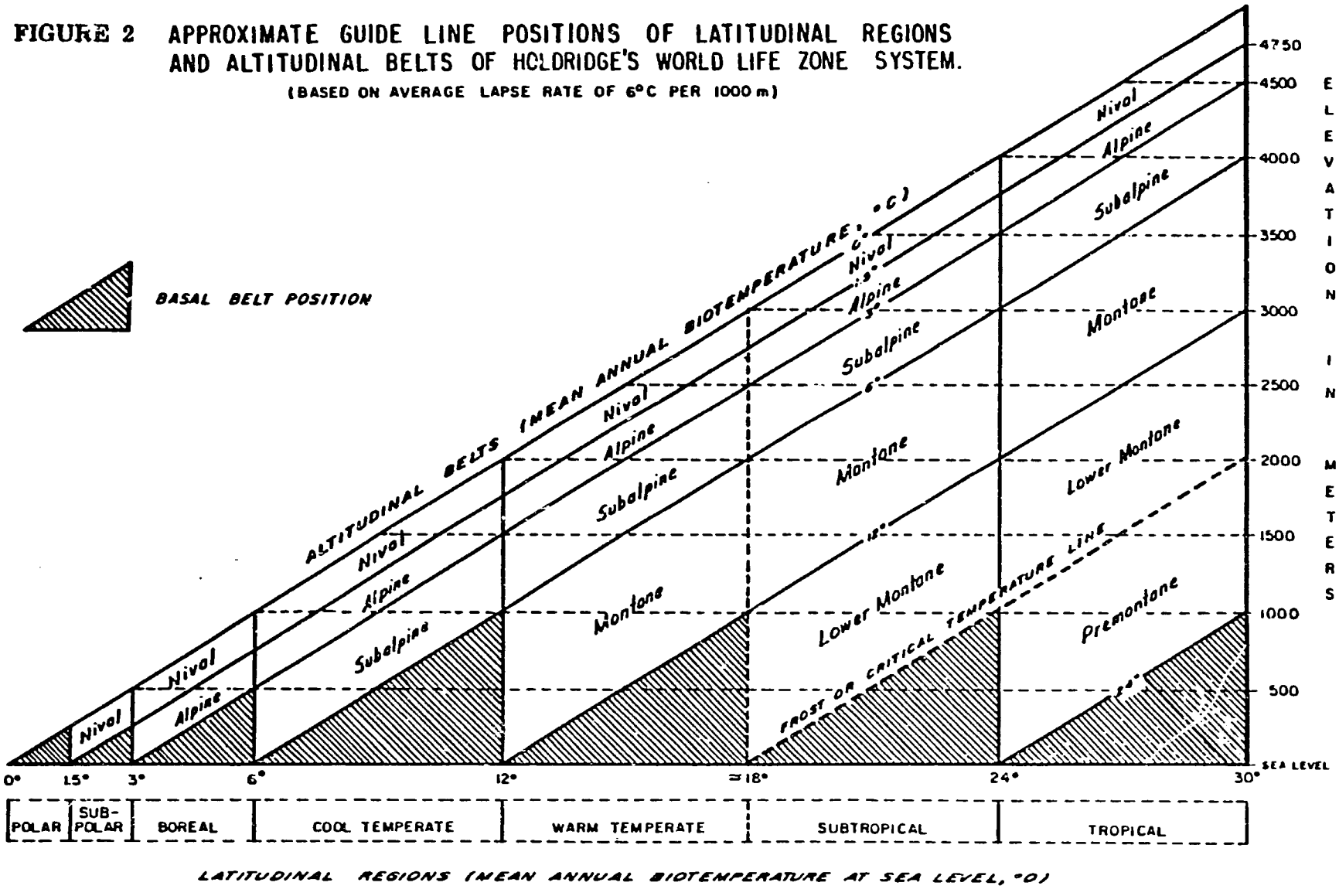


FIGURE 2 APPROXIMATE GUIDE LINE POSITIONS OF LATITUDINAL REGIONS AND ALTITUDINAL BELTS OF HOLDRIDGE'S WORLD LIFE ZONE SYSTEM.

(BASED ON AVERAGE LAPSE RATE OF 6°C PER 1000 m)



Structure of the life zone system

The life zone classification system makes it possible to define terms in a precise and uniform way, by providing a hierarchical framework for defining ecosystems at three levels of detail. These are:

- **The life zone.** This most general level is defined by three climatic factors that can be readily measured or extrapolated from available data: temperature, precipitation, and potential evapotranspiration (PET). The life zone chart in Figure 1 has been constructed based on these three factors, with altitude and latitude controlling temperature. The soil found in a particular life zone is that which would be expected to evolve over geologic time under that climatic regime. The **climatic association** is the vegetation assemblage found in a specific life zone that has uniquely characteristic physiognomy and complexity.

- **The association.** Although most of the earth's vegetation falls within the zonal climatic association, important exceptions occur that will substantially change the vegetation characteristics. These exceptions include edaphic, hydric, and atmospheric associations. Examples of edaphic associations include exceptionally poor soils on steep slopes or in granitic shield areas, or unusually rich soil associated with recent alluvial deposits or volcanic activity. Hydric associations occur due to periodic flooding or high water table conditions. Examples of atmospheric associations include cloud forests where condensation markedly increases available moisture and monsoonal conditions where relatively high rainfall is concentrated during a very few months of the year.

- **The successional stage.** Within any life zone association the vegetation actually found at a site may have been disturbed by a hurricane, fire, or logging. The land may be in crops or pasture. If left undisturbed, the vegetation would tend to return to recognizable conditions defined by the prevailing climatic, edaphic, hydric, or atmospheric conditions. Land capability assessment based on the life zone system addresses appropriate uses of the land within a particular association regardless of the successional stage — bare ground to climax vegetation cover.

Figure 1 incorporates both altitudinal and latitudinal subdivisions of the landscape. Differences between zones determined by altitude and zones determined by latitude are significant. The effect of averaging climatic data in determining life zones is to eliminate differences in range. Thus, Seattle Washington, at 47° 30' N. latitude at sea level, and Puyo, Ecuador, at 1° 35' S. latitude at 950 meters elevation, both have a mean annual temperature of 72° F., but the range of temperature over the year is much greater in Seattle. In those tropical

areas with a distinct dry season, some pests and weeds may be eliminated due to stress. In this case seasonal drought serves the same function as the cold of a midlatitude winter. The longer day length in the midlatitudes also promotes cultivation of high yield varieties and short cycle crops.

Of major significance in land use planning is the unity line on Figure 1 (1:1 ratio between PET and precipitation), which marks the boundary between humid life zones on the right, where precipitation exceeds PET, and the dry life zones on the left. Any dense broadleaf forest to the right of the unity line in Figure 1 is a rainforest. As the ratio of precipitation to evapotranspiration increases to the right of the unity line, so does the potential for leaching of nutrients from the soil under conventional cropping and grazing. From an atlas, one can see that most of the Amazon Basin has an annual rainfall between 2,000 and 4,000 millimeters, and is under 1,000 meters elevation. Applying these parameters to the life zone diagram we find that most of Amazonia falls within the Tropical Moist Forest life zone with an all-important variety of edaphic and hydric associations. For example, there is a striking difference between the floodplain and the uplands where there is neither soil renewal by alluvial deposits nor flooding. Within the life zone framework, probably the only Tropical Rain Forest (rainfall in excess of 8,000 milimeter below 1,000 meters elevation) is found in a limited area of the Colombian Chocó. In areas of more or less continually varying elevation, such as Central America, there are a variety of life zones with no single dominant type.

Most of the world's population has been concentrated in the life zones flanking the unity line — principally the six life zones labeled Moist Forest, Dry Forest, and Steppe on the diagram. This applies to life zones defined by both altitude and latitude. In mainland Latin America, 18 of the 20 national capitals are located within these six life zones. The two exceptions are Lima, a seaport in an irrigated desert (Cuzco, the former Inca capital, is located in the Montane Moist Forest life zone), and Santiago, where the Spaniards could not penetrate into the unity line life zones because of Araucanian (Mapuche) Indian resistance. It was not until after World War II that the migration into wetter life zones began to increase, triggered by accelerating population growth, unrealistic land settlement schemes, and the availability of DDT for the control of malaria-carrying mosquitos. Attempts to increase the exploitation of marginal areas have led to the need for a systematic assessment of the productive potential of fragile tropical lands.

Observations

The Life Zone system is based on empirically observable and quantifiable data, precipitation, temperature, and evapotranspiration, all of which have standardized units for data collection and reporting. This increases the replicability of results, prediction utility, and accuracy. Life zone classifications also allow for comparative research and planning. Development technology that was successful in a given life zone, with a given set of associations, may be successfully transplanted to a similar life zone in another geographic location (Dickinson 1986). Such a transfer is dependent, however, on modification of the strategy for sociocultural differences.

Geographers, anthropologists, and others working in Latin America and the Caribbean have devoted much effort to studying cultures and the ecosystems within which they function. As we review this rich body of literature in search of the illusive keys to sustainability in agriculture and development, it is useful to organize site-specific information within the life zone framework. Using the life zone base, it is possible to compare resource management strategies holding the ecological factor constant. If a crop or resource management practice performs uniquely well in one life zone, then technology transfer may be possible to a similar life zone anywhere. At this level of detail, it is important to go to the life zone **association** scale, which allows soil, drainage, and climatic refinements in site description to be included.

Although it is systematic and comprehensive, such an approach is not a panacea. A biophysical survey results in the presentation of technically viable options, not prescriptions. There is no way to directly consider geoeconomic factors that may drastically affect what land uses are feasible. Relevant considerations include market factors, such as demand for the product, and the time and cost associated with distance to market. Cultural factors and technology levels may require modification of development strategies, or be critical in choosing among them. Thus, it is clear that a sociocultural survey and assessment be carried out concurrently with the biophysical survey.

References

Dickinson, J. C. III
1986 Settlement in the humid tropical life zones of Latin America. In *Conference of Latin Americanist Geographers Year Book.*

Holdridge, L. R.
1967 *Life Zone Ecology*. Revised edition. San José, Costa Rica: Tropical Science Center.

CHAPTER TEN

ENVIRONMENTAL ANALYSIS OF FRAGILE LANDS

by

Dennis McCaffrey

OVERVIEW

This chapter focuses on the use of environmental analysis in developing fragile lands. The formal environmental impact assessment procedures required under A.I.D. regulations and Congressional directives on tropical forests and biodiversity are discussed in this context.

Two case studies, the Central Selva Natural Resources Management Project in the Palcazu river valley of eastern Peru, which began in 1981 (Bolanos and Watson 1981; Dickinson et al. 1981; Hartshorn 1989; R. C. Smith 1981; Tosi 1981, 1982), and the Maya Biosphere Reserve Project in the Peten of Guatemala, which began in 1990 (McCaffrey 1991), are used to illustrate changes in focus of environmental analysis over the past decade and the ways in which differing environmental situations affect development project design.

The case studies are followed by a discussion of sources of useful information on the environment and natural resources in developing countries.

A.I.D. POLICIES AND PROCEDURES FOR ENVIRONMENTAL ANALYSIS

Regulation 216

Policy and Procedures under the Regulation

Important facets of A.I.D. policy on the environment and the procedures A.I.D. uses to advance its environmental policies and to analyze the effects of its actions on the environment are set out in the Code of Federal Regulations at 22 CFR 216. Regulation 216, promulgated in October of 1980, sets forth four points of environmental policy that apply to the entire development assistance program. Of these, the fourth point has particular relevance to fragile lands. It reads:

> [It is A.I.D. policy to:] (4) Define environmental limiting factors that constrain development and identify and carry out activities that assist in restoring the renewable resource base on which sustained development depends.

Fragile lands, by definition, exhibit limiting factors that constrain development (Bremer et al. 1984; Chapter One, this volume). Virtually any development project proposed for fragile lands would fall within the policy statement quoted.

Regulation 216 establishes a three-step process for environmental analysis. As the first step, A.I.D. undertakes an initial environmental examination that provides enough information about a proposed action and the environment(s) the action might affect to take the second step, that of making a threshold decision. The threshold decision determines whether the proposed action will have a significant effect, in other words, will result in alterations to the environment of the country in which it will occur that have the potential to outweigh the benefits expected to accrue as a result of the action. If the proposed action appears to have the potential to affect the environment significantly, the agency must perform a full-scale environmental assessment, defined as:

> A detailed study of the reasonably foreseeable significant effects, both beneficial and adverse, of a proposed action on the environment of a foreign country or countries.

The regulation defines environment in foreign countries as "the natural and physical environment." For a definition of environment inside the United States, the regulation refers to the rules established by the Council on Environmental Quality.

Environmental Assessments

The environmental assessment process begins with a scoping exercise, usually performed by the USAID Mission proposing the action, which identifies the significant environmental issues raised by the proposed action. The scoping exercise results in a written statement of the scope of the environmental assessment needed to address the issues. The scoping statement sets out a calendar for performing the assessment and terms of reference for how to perform it.

An environmental assessment describes the environment(s) a proposed action will affect. Regulation 216 requires particular attention to identifying potential impacts on endangered species and their habitats. The assessment describes the proposed action from an environmental perspective and explores and evaluates reasonable alternatives to the proposed action as well as the alternative of taking no action. The assessment should frame the alternatives to facilitate comparison of their respective environmental impacts. Comparative evaluation of the environmental impacts draws on detailed predictions of the environmental consequences of the proposed action and each of its alternatives. These predictions consider unavoidable adverse affects, the relationship between short-term use of the environment and maintaining its long-term

productivity, and irreversible or irretrievable commitment of resources under the proposal and its alternatives. Specifically, the assessment explores such factors as energy efficiency, requirements for renewable and nonrenewable natural resources, urban quality, and historic and cultural resources.

When a proposed action or its alternatives would result in adverse environmental impacts, an environmental assessment recommends mitigation measures to counteract the impacts or reduce their severity.

Regulation 216 requires involvement of the country whose environment is affected in the environmental assessment process. The foreign government should be aware of the environmental assessment during its preparation, and A.I.D. should consult with the government on the results of the assessment and their significance. A.I.D. also encourages national governments to make environmental assessments of proposed A.I.D. actions available to the public.

Applying the Results of Environmental Assessments

Regulation 216 does not specify precisely how the environmental assessment of a proposed action relates to subsequent decisions on whether and how to proceed on the action. In other words, Regulation 216 does not mandate selection of the best alternative from an environmental point of view. It does not even mandate performing recommended mitigation measures if an action that affects the environment adversely is undertaken.

In the absence of mandatory provisions for applying the recommendations of environmental assessments, Regulation 216 does set out some clear advisory provisions. The regulation recommends that environmental review take place as early in the design or implementation of a proposed action as practical. This allows maximum flexibility to modify the action in light of the environmental review. The regulation also recommends the inclusion of mechanisms to monitor environmental changes in the design of proposed actions that require environmental assessment.

The regulation further implies how to apply the results of environmental assessments by setting out four points on A.I.D. environmental policy. The fourth of these points is quoted above. The other three points state that it is A.I.D. policy to:

> (1) Ensure that the environmental consequences of A.I.D.-financed activities are identified and considered by A.I.D. and the host country prior to a final decision to proceed and that appropriate environmental safeguards are adopted;
>
> (2) Assist developing countries to strengthen their capabilities to appreciate and effectively evaluate the potential environmental effects of proposed development

strategies and projects, and to select, implement, and manage effective environmental programs; and

(3) Identify impacts resulting from A.I.D.'s actions upon the environment, including those aspects of the biosphere which are the common and cultural heritage of all mankind.

Provisions of the Foreign Assistance Act Related to Environment

In 1986, Congress amended the Foreign Assistance Act to include specific provisions to conserve and manage tropical forests and to protect and conserve biological diversity in developing countries. Both provisions relate to fragile lands in that much remaining tropical forest occurs on fragile lands, as does much habitat that supports biological diversity. Moreover, many of the development actions that the legislation recommends are actions appropriate for fragile lands.

Tropical Forests

Amended Section 118 of the Foreign Assistance Act states that loss and destruction of tropical forests result in a shortage of wood and in ancillary adverse environmental impacts like siltation of rivers and extinction of species, as well as in "desertification and destabilization of the earth's climate." The law requires the U.S. government to take several steps toward improving tropical forest management through its international development assistance program. These include:

- Offering alternative employment and income to people who clear tropical forests;
- Avoiding colonization of forests;
- Supporting agroforestry and sustainable agriculture on lands that have already been cleared of forest;
- Increasing forest production on lands that have lost their original forest cover; and
- Improving forest harvesting and processing practices.

The law also requires denial of development assistance for purchasing logging equipment, converting forests to livestock raising, constructing roads in forests, or colonizing forested lands unless environmental analysis indicates such actions could and would be performed in an environmentally sound manner.

Biodiversity

Amended Section 119 of the Foreign Assistance Act allocated $2.5 million of the development assistance appropriation for fiscal year 1987 to conserve biodiversity. The new section requires

A.I.D. to include an assessment of national biological diversity in each of its country development strategy statements. The law also directs A.I.D. to support development actions to establish and maintain protected areas and to deny assistance for actions that would degrade national parks or similar protected areas.

Relating Environmental Laws and Regulations to Fragile Lands

Development activities sometimes occur on fragile lands that have experienced little or no prior development. In such cases, proposed development usually involves road building and other infrastructure development, forest clearing, timber harvesting, mining, and other activities that necessarily produce adverse environmental impacts. Typically, the proposed development entails greater adverse environmental impact than would occur in the absence of the proposed development.

More frequently, development proposals for fragile lands relate to lands that have already experienced some development. Typically, the existing development carries serious negative environmental impacts like severe soil erosion; deforestation; or overexploitation of local fish, game, and timber species. In these situations, the proposed development often expressly includes environmental enhancement among its goals. Examples range from proposals for soil conservation, to agroforestry, to natural forest management. Successful implementation of the proposed development would reduce adverse environmental impacts as compared to those that would continue in the absence of the proposed development.

A third type of development proposal, which neither creates adverse environmental impacts nor seeks to overcome existing adverse impacts, occasionally relates to fragile lands. Examples include nonintrusive development of parks and ecotourism on public or private lands. These types of development assume that it is possible to maintain environmental quality approximately at the level of the status quo prior to development.

Environmental analysis procedures under Regulation 216 apply to all three modes of proposed development as does the terminology used in the regulation. The terminology, "adverse impacts that cannot be avoided" and "mitigation measures," fit the first mode most closely, in which the analysis forecasts impacts resulting directly from the proposed development and makes recommendations on how to deal with those impacts. In the second mode, the analysis often concentrates on adverse impacts of the alternative of no action and explains how the proposed development will mitigate those impacts. Analysis of the third mode concentrates on ensuring that the proposed development is environmentally benign and on warning against potential adverse impacts that could result from improper implementation of the development.

The amendments on tropical forests and biodiversity also apply to all three situations: to channel development options on undisturbed lands toward those that most conserve forests and biodiversity to favor activities that will restore diverse vegetative cover to degraded lands and

to promote economic activities like scientific study and ecotourism that require undisturbed forest and high natural biodiversity to sustain their economic vitality.

ENVIRONMENTAL ANALYSIS OF FRAGILE LANDS DEVELOPMENT PROJECTS: CASE STUDIES

USAID Peru Central Selva Natural Resources Management Project

Setting

The Government of Peru in collaboration with USAID addressed the problems of uncontrolled agricultural colonization and inappropriate land use in the Palcazu valley of east-central Peru through the Central Selva Natural Resources Management Project. The principal development activity of this project is to implement sustained yield natural forest management. The intent is to do this while protecting the traditional culture of the Yanesha Indians who occupy the project area. Through local processing of timber by the Yanesha and natural regeneration of native tree species, the project "is expected to maximize sustainable productivity of the forest resources and to increase the income and social well-being of the indigenous communities and farmers. . ." (Hartshorn 1989:130).

The Central Selva project occupies the floor of the Palcazu river valley and the foothills of the Yanachaga mountains in east-central Peru. The project area covers approximately 950 square kilometers. The Yanachaga range is the most easterly range of the main chain of the Andes mountains at this point in Peru. The Palcazu river starts in the Yanachaga range and drains northward through the Palcazu valley, then turns east, eventually flowing into the Ucayali branch of the upper Amazon. The project area lies about 250 kilometers northeast of Lima. Under excellent weather and road conditions, it takes about 10 hours to drive from Lima to the project area.

Tropical wet climate characterizes the Palcazu valley; it receives at least 4,000 millimeters of rain annually and the foothills of the Yanachaga receive 6,000 millimeters or more. The high rainfall gives rise to large numbers of streams and rivers whose levels fluctuate widely with daily and seasonal precipitation. Elevations range from 270-2,000 meters above sea level with corresponding average annual temperature range of from a little over 25 degrees C to about 16 degrees C. West of the project area, the Yanachaga range reaches elevations of 4,000 meters. Soils vary in depth, but tend to be acidic and infertile with relatively low organic matter content. Forest, exhibiting great species diversity, constitutes the natural vegetation throughout the project area, supporting high species diversity in animals.

At the time of initiation of the Central Selva project in 1981, relatively little land had been cleared in the Palcazu valley. Large cattle ranches spread over the flattest lands in the lower valley and smaller farms existed in the upper valley. Nearly all cleared land was used for

pasture, very little for cultivation. Such agriculture as did occur tended to follow traditional patterns of cultivation on slopes and on river terraces in which land was cleared, burned (when weather was dry enough to enable burning), planted for two or three years to a succession of annual and longer cycle crops, and then left to forest fallow for a few years.

Land holdings in the Palcazu consist of a mosaic of large and small privately owned parcels, of which the large parcels tend to have title whereas the small parcels tend not to. There are also 14 Amuesha (Yanesha) Native Communities in the valley and mountain foothills. Upper elevations in the project area merge into publicly owned forest reserve lands and the Yanachaga-Chemillen National Park, which was established in 1983.

In 1981, the entire project area was roadless except for the very southernmost part of the valley, which was connected by a seasonally passable track to Villa Rica and from there to the national highway network. In the Palcazu valley, the rivers functioned as local highways and a series of air strips, served by regular passenger and cargo service, provided the main transport link to outside points. Most of the valley's population lived in isolated family dwellings or small settlements. The largest settlement, Iscozacin, held little more than 100 families, loosely grouped around the airstrip, and the local school, and along the Iscozacin and Palcazu rivers.

Three distinct social groups live in the Palcazu valley: the Amuesha native people, descendants of German colonists, and mainstream Peruvians. The Amuesha make up close to half of the total population of the valley, estimated in 1981 at 6,000-12,000 people (Miller and Martinez 1981). They practice traditional hunting and fishing and small-scale seasonal agriculture, with a recent trend toward some cattle raising. The German Peruvians own most of the large ranches, raise most of the cattle, and operate the larger commercial ventures, notably the slaughter houses and the air transport companies. Most of the mainstream Peruvians have arrived in the valley fairly recently. They operate small commercial ventures and practice subsistence farming and small-scale cattle raising. Some Amuesha work as laborers as do some mainstream Peruvians.

Fragile Lands Development Issues

The Central Selva Natural Resources Management Project responded to the choice of the Belaunde government of Peru, which took office in 1980, to concentrate national development efforts in the Amazonian region of the country in preference to the sierra or coastal regions. The project fit into a larger development thrust that centered around construction of the *carretera marginal*, a highway that would run along the eastern edge of the Andes from the border with Ecuador to the border with Bolivia. At the time the project was conceived, the Peruvian government intended to construct a branch of the *carretera marginal* into the Palcazu valley. The longer term plan was to connect this spur of the highway to the main *carretera marginal* that was to be built further to the east in the Pichis valley.

Several fragile lands development issues arose from the prospective presence of the highway. The highway would have direct environmental impacts related to its siting and construction, notably in provoking landslides and increasing siltation in streams. Far more significantly, however, a highway into the center of the valley and eventually all the way through would stimulate changes in land use that would almost certainly affect the environment adversely.

The predicted adverse environmental effects of the presence of a highway would result partly from expansion of existing land uses by the resident population, but primarily from the influx of new settlers into the valley. Anticipated adverse environmental impacts attributable to increased human activity in the project area included:

- Deforestation, especially on lands that had little potential for agriculture or livestock;
- Soil erosion on all but the least sloping lands;
- Increased siltation in rivers and streams and greater irregularity of stream flows;
- Overexploitation of fish and game animals prized for food;
- Local reduction of species diversity and possible extinction of certain plants and animals with restricted ranges; and
- Increased public health problems from poor sanitary conditions and contaminated water.

Another set of issues that the project had to deal with centered around the effect that development of the valley would have on the native Amuesha. They were already at the bottom of the social ladder and their possession of their ancestral lands was precarious because not all of the Native Communities were titled and some with titles suffered incursion from outsiders. Moreover, the Amuesha did not confine themselves to their community lands but used lands outside them for hunting and other purposes. If the Amuesha were forced to live entirely from the resources available to each community from its community lands, they would probably not have an adequate resource base (Smith 1981).

Environmental Analysis Approach and Process

Environmental analysis of the Central Selva project took place as part of the design of the project itself. The project identification document that the USAID Mission in Peru had prepared in early 1981 programmed several studies that the mission would use as sources in designing the Central Selva project. Most of these studies were performed as part of the environmental analysis that took place over a four-month period beginning in July 1981.

Seventeen specialists participated in the process, which resulted in a document containing a proposed design for the project, an environmental assessment in conformance with Regulation 216, and 15 separate consultant reports on topics related to both environmental and developmental aspects of the proposed project (Dickinson et al. 1981). These documents served as the information base from which the Project Paper for the project was written.

The environmental analysis team collaborated directly with the Pichis-Palcazu Special Project office, a Peruvian government agency that had been established for the purpose of administering organized development of the Palcazu valley and the adjoining Pichis valley. Special Project office staff accompanied the team in the field and conferred with them frequently in Lima.

As an early step in the project analysis process, a life zone map of the project area was prepared using the Holdridge system (Bolanos and Watson 1981, Holdridge 1967). The life zone mapping exercise demonstrated that the Palcazu valley was wetter than had been previously estimated. Most of the valley was tropical wet forest, not tropical moist forest, and the even wetter foothills of the Yanachaga were mostly premontane rain forest. Life zone mapping facilitated preparation of new estimates of land use capability in the valley. Reasonably good soil maps existed for the area. On the basis of these maps and the belief that the valley was less wet than it actually is, the Peruvian government had estimated that the Palcazu valley offered fairly high potential for agricultural development. Study of the Holdridge life zone map and the existing soil data gave rise to revised, far more conservative, estimates of the productive potential of the project area (Tosi 1981). The Tosi report, which covered approximately 95,000 hectares at lower elevations in the Palcazu, gave the following estimates of land use capability:

Agriculture	7,000 hectares
Pasture	13,000
Permanent crops	14,000
Production forestry	44,000
Protection	15,000
Riverbeds	2,000

These estimates indicated that only about 40 percent of the valley had the potential for sustainable agriculture and livestock production. The rest would have to remain in forest cover to avoid serious — possibly irreversible — environmental damage. The land use capability estimates in the Tosi report served as the principal basis for the recommendations on project design that eventually resulted in the Central Selva Natural Resources Management Project.

Capsule of Project Design: Application of Results of the Environmental Analysis

The recommended design for the Central Selva project concentrated development activities in natural forest management, allocating roughly one-third of project resources to the forestry component. The forestry component advocated introducing a previously untried silvicultural

technique, now often referred to as the "strip clearcut method," which was designed to imitate the natural dynamics of tropical wet forest regeneration. The forestry component also advocated felling and extraction techniques that maximized yield and minimized environmental damage and small-scale, but diversified, wood processing industries right in the valley, close to the source of raw materials (Tosi 1982).

Much lower levels of concentration were recommended for project activities in agriculture and livestock, reflecting both the low capacity of the Palcazu area for these activities and the reasonably high level of existing development, at least of cattle, in the valley through the efforts of the private sector. Other, relatively small recommended project components were focused on infrastructure for improved social services in the valley — schools, health posts, drinking water, sanitation, and communications. An additional component, contingent upon the Peruvian government formally declaring and demarcating the Yanachaga-Chemillen National Park, would develop a management plan for the park and begin putting the plan into effect. Finally, the recommended project design called for a monitoring component that would perform natural resources inventories, update them periodically, and maintain continuous comparisons of actual land use to land use capability.

A special project component oriented toward the Amuesha had been considered by the design team, but was not incorporated in the final design. Instead, each project component would have up to three implementation modes — one appropriate to the Amuesha, one appropriate to the well-established valley residents with large landholdings, and one appropriate to newly arrived settlers with limited financial resources.

The project did not deal directly with the question of the road into the Palcazu valley. Road construction was financed separately and the project was viewed as an adjunct to the road that sought to mold the development the road would engender along environmentally sound lines.

Project design, then, primarily sought environmental soundness by concentrating development efforts on the best quality and most abundant natural resources, the natural forests. A high level of sustainable production was sought to meet the development expectations of the Peruvian government and residents of the Palcazu valley for increased production and improved standards of living.

USAID Guatemala Maya Biosphere Reserve Project

Setting

Early in 1990, the Guatemalan government established the Maya Biosphere Reserve in the Peten, the country's most northerly province, situated in the south-central part of the Yucatan Peninsula. The western, northern, and eastern boundaries of the reserve coincide with Guatemala's national boundaries with Mexico and Belize. The reserve has an area of 14,000 square kilometers. It contains numerous ruins of the Maya civilization, most notably Tikal. The

project area includes all of the reserve, plus a strip 15 kilometers wide along the southern edge of the reserve intended to function as a buffer zone. The buffer zone and reserve together bring the project area to about 20,000 square kilometers.

The entire project area exhibits a subtropical moist climate. Annual rainfall over the area averages 1,200-1,500 millimeters. The wet season begins in May and lasts into December. The dry season is fairly intense, and in particularly dry years drought can occur in March and April. Base elevation of the project area is about 100 meters above sea level. Much of the terrain is sharply accidented limestone karst with hills rising about 200 meters above base level, except for the Lacandon Mountains in the southwestern part of the reserve, which reach elevations of 1,000 meters. Soils vary in fertility, depth, and drainage. Sharp terrain, poor drainage, and shallow soils pose greater constraints to land use than does soil fertility. The project area has relatively few surface streams but it does have numerous lakes and also an extensive marshy wetland in the northwest corner of the reserve.

Natural vegetation in the project area consists entirely of forest, which exhibits several distinct associations that reflect soil, drainage, and micro climate. Tall dense forest on bottomland sites contains a relatively high volume of mahogany and Spanish cedar as well as other commercial timbers. Shorter, sparser forest on slopes and ridges has much lower commercial potential. In addition to timber, the forests contain three other currently important commercial plants: xate palm, a small understory plant harvested and exported for use in the floral industry; chicle, a large tree whose sap is the source of chewing gum; and allspice, a tree whose fruits produce the spice that gives it its name. The varied vegetation supports a correspondingly varied fauna. In addition to permanent animal populations, the project area is an important wintering ground for migratory birds from Canada and the United States.

Inside the reserve most land is publicly owned. Consistent with the general practice for Biosphere reserves around the world, lands within the boundaries of the reserve have been designated as core areas, whose principal function is protection of biological and cultural resources, and multiple use areas, where extraction of natural resources is permitted so long as the extraction does not compromise the protective function of the core areas. The Maya Biosphere Reserve includes seven core areas, four of which existed prior to its establishment, and three of which were established concurrently with the establishment of the reserve. The most noteworthy core area is Tikal National Park, which the Guatemalan government has maintained under strict protection, even though it is readily accessible, for many years. The designated multiple use areas currently provide timber for the logging industry and wild sources of xate, chicle, and allspice, and it is anticipated that they will continue to do so.

Outside the reserve, most land is privately owned. In the buffer zone, nearly all the original forest has been logged and much of it has been cleared. The most productive and accessible sites for agriculture support permanent farms. Extensive pasture with low stocking levels and scrubby secondary forest are by far the most common land uses outside the reserve.

Flores, the capital of The Peten Province, lies on the south shore of Lake Peten Itza about 30 kilometers south of the boundary of the reserve. A city of 30,000-40,000 people, Flores is connected to the rest of Guatemala by an unpaved highway and by regular air service to its international airport, which can handle up to midsized jets. A paved road goes from the airport to Tikal, a distance of 70 kilometers. Unpaved roads, in rough condition but passable throughout the year, form an east-west transport axis from the border with Belize at the town of Melchor de Mencos, through Flores, to the border with Mexico near the town of El Naranjo. Seasonally passable tracks branch off this base network of roads into the reserve and throughout the buffer zone. Numerous small population centers dot the road system. Most are outside the reserve, but a few are inside it. The main trunk roads are publicly maintained but many of the small access roads, especially timber extraction roads inside the reserve, are built and maintained by logging companies. The logging roads provide a transport network for extractors of xate, chicle, and allspice, and for hunters and loggers.

The whole project area is in a state of social flux. Most residents have migrated to the area within the last few years. Some have come to settle permanently as large landholders, business investors, small farmers, traders, or laborers. Some come as seasonal residents to plant a crop of maize, harvest it, and return to other parts of Guatemala. Others come as transients, on their way to Mexico, Belize, or beyond. A few Guatemalans come as tourists but most of the 75,000 tourists who visit each year come from outside Guatemala. Population in The Peten Province is growing at 7 percent per year, higher than anywhere else in Guatemala except Guatemala City. The rapid population expansion strains social services and infrastructure. Health care and education services are rudimentary and many people to not have reliable, clean water supplies or sewage disposal services.

Fragile Lands Development Issues

The Maya Biosphere Reserve Project has three main development objectives: to secure the strict protection of the core areas inside the reserve, to increase productivity in the forest extraction and tourism industries in ways that do not conflict with the reserve's central conservation function and to increase public information about the economic and environmental benefits the reserve provides and to build constituencies in support of the reserve.

Protection. The project's protection objective raises the development issue of how to provide a permanent government presence that will prevent incursion into the core areas of the reserve. Guatemala has a good track record for protecting Tikal National Park from incursion by settlers, loggers, and hunters, although the park had been partially logged a few years ago. But the Biosphere Reserve is much larger than Tikal; it has seven areas set aside for strict protection, some of which are remote from centers in Guatemala but easily accessible from Mexico, and none of the other areas demonstrates the close relationship between pristine environmental condition and high volumes of tourism that Tikal does.

Production. The natural resource-based production objectives of the project raise the most complicated development issues. With regard to logging, it is clear that mahogany will be exhausted in the northern Peten within a few years and that the timber industry, therefore, faces a transition. The most desirable transition appears to be toward incorporating more tree species into the industry and introducing improved technology into all aspects of the timber extraction and transformation process. This transition implies concentrating the logging effort on the best stands of trees and ensuring the continuous regeneration of these stands. The other extraction industries — xate, chicle, and allspice — require similar intensification.

Several obstacles stand in the way of environmentally responsible intensification of the extractive industries. For one thing, the sustained yield capacity of the reserve and the buffer zone to support each type of extraction is still unknown. For another, optimum technologies for extraction, transformation, and regeneration of each extractive resource need to be designed and applied. In addition, social mechanisms to restrain current harvesting levels in favor of maintaining a continuous long-term supply of raw materials are not in place. Finally, each of the extractive uses competes for land with other conflicting uses that would remove the forest to replace it with settlements, agriculture, and livestock raising.

Similar obstacles confront environmentally sound tourism development. The best sites need to be selected, their carrying capacity determined, and appropriate facilities put into operation.

Information. The development issues with regard to the information objective of the project begin with the need to identify the interest groups inside and outside the reserve and determine their attitudes toward it. This sets up an information dynamic in which project personnel explain the Maya Biosphere Reserve and its development to the public and the public expresses its attitudes toward the reserve and its expectations from the project.

Environmental Analysis Approach and Process

The environmental analysis process for the Maya Biosphere Reserve Project took place between late February and early May 1990. A DESFIL team of 14 consultants, with close collaboration from the USAID/Guatemala Mission staff and six Guatemalan counterparts, prepared an environmental assessment, social analysis, economic analysis, institutional analysis, and technical analyses for each prospective project component (USAID/Guatemala 1990).[1]

The team did not collect any data in the field, although they did travel over the project area extensively and talk to numerous officials and other people who would be affected by the project. For data on soils, forest associations, social parameters, and so forth, the team relied on existing information available through USAID and Guatemalan government agencies. Mid-way through the project development process, the team presented its preliminary ideas on project design at a seminar attended by 30 representatives of Guatemalan agencies with a stake in the development of the Peten.

The environmental analysis and project design process unfolded against a background of complementary activities within the Guatemalan government, by other international development assistance agencies, and in the private sector. The team worked closely with three Guatemalan agencies that had been established within the previous year. They were the National Council on Environment and the National Parks Council, which would have primary responsibility for managing the Maya Biosphere Reserve, and the National Agency for Coordination of Development of the Peten, which had more generalized functions pertaining to all aspects of development for the whole region. The Peten development agency was working closely with the German Agency for International Technical Cooperation (GTZ) to put together a development master plan for the region and to update basic inventories of soils and forests. Several Guatemalan and international NGOs were already working in the reserve, demarcating the new core areas and instituting protection and research activities. The Guatemalan forest service and the national tourism agency were also involved in the consultation process for project design. Interinstitutional coordination emerged as an important element of the project design process and will also figure prominently in project implementation.

Capsule of Project Design: Application of Results of the Environmental Analysis

The environmental analysis process for the Maya Biosphere project resulted in project recommendations that emphasized four points for implementation: institutional strengthening and social organization, research and information, training, and technology development.

Institutional strengthening entails increasing the managerial capacity of each of the major government institutions with responsibilities in the project area to carry out their prescribed functions: the National Council on Environment to set policy for the whole reserve and surrounding buffer zone that balances interests in protection and production, the National Parks Council to demarcate and protect the core areas of the reserve and manage the parks for scientific study and tourism, the national forest service to regulate timber harvesting and oversee forest regeneration in the multiple use areas and in the buffer zone, the national cultural agency to protect Mayan ruins in the reserve and to make them available for tourism and scientific study, and the national tourism agency to promote increased tourism to the project area that is compatible with both its conservation and its development goals.

Institutional strengthening also supports the private sector organizations working in the reserve, notably Guatemalan universities and national and international conservation NGOs.

The social organization component is directed primarily at the people involved in extraction of xate, chicle, and allspice and is intended to help them pool their skills, place extraction on a sustained yield footing, and strengthen their economic position through a system of licensing that would allocate a specified level of access to the extractive resources to each person engaged in extraction. It also relates to conflict resolution among social groups with differing interests in the reserve and in the project.

Research and information will focus primarily on gathering and analysis of baseline data about the quality and extent of the renewable and cultural resources in the project area, their current levels of yield, their regenerative capacities, and optimal technologies for their extraction and marketing. It will also include public opinion surveys of residents and visitors, and information programs aimed at social groups and resource users in the project area.

Training will consist of formal and on-the-job training for administrators, natural resources managers, and field personnel in the public and private agencies that will implement the project. It will also entail informal training of resource users and private sector groups with interests in the reserve.

Technology development will design and promote technologies for timber and resource harvesting, transport, processing, and marketing that increase income while simultaneously ensuring continued resource availability.

The USAID project design team, based on information gathered and recommendations of the DESFIL team, proposed a project with three elements.

- Protection and management of the Maya Biosphere Reserve that would establish a formal presence in the reserve; demarcate core areas and multiple use areas; prepare a management plan for the reserve assigning institutional responsibility for various aspects of management; and hire, equip, train, and post park guards in the core areas.

- Environmental education, public awareness, and policy that would strengthen formal environmental programs in schools and universities; institute informal public awareness and environmental education programs in the project area and nationally by way of newsletters, public meetings, conferences, and workshops; and research and inventory of policies that affect the reserve and the project.

- Sustainable resource management for income generation that would establish a demonstration forest for natural forest management to serve as a research site and demonstrate sustainable timber harvesting and forest regeneration techniques; take inventory of extractive resources, develop improved technologies for harvesting and marketing them, and institute a licensing system for extractors; and strengthen public tourism agencies and private sector tourism, manage selected tourism sites, and generate and circulate improved information on tourism in the project area.

Comparison of the Environmental Analysis Approach for the Central Selva and Maya Biosphere Reserve Projects

Ecological and Biological Complexity

Both the Palcazu valley and the Peten are ecologically and biologically complex. Each has a warm, moist climate and a variety of land forms that provide an array of terrestrial and aquatic habitats. Both exhibit high biodiversity, the Palcazu even more so than the Peten. Biological and ecological complexity complicate development for two reasons. First, especially after enactment of the revisions to the foreign assistance act, biodiversity itself becomes a development issue and its conservation becomes an express objective of development. Second, standard development options for conventional agriculture and cattle raising on pasture are problematic in areas of high ecological complexity because they differ dramatically from the forest vegetation that naturally occurs. This makes for increased problems with weeds, insects, and reversion of cultivated land to forest.

Low Productive Capacity for Agriculture and Livestock

Neither project area has high capacity for agriculture or livestock production. In the Peten, highly accidented terrain, shallow soils, and erratic availability of surface and ground water inhibit productive capacity. In the Palcazu, which has relatively lower potential for agriculture and livestock than the Peten, the excessively wet climate, infertile soils, and steep terrain limit productive capacity.

Focus on Forest-based Production

Both projects emphasize forest-based production as the key to development of the respective project areas. In the Maya Biosphere Reserve Project, this approach builds on existing extractive industries and reflects low levels of existing agriculture and livestock raising, at least inside the boundaries of the reserve, although these activities are increasing. In the Central Selva project, this approach acknowledges existing livestock and agriculture and seeks to improve them, but not to expand the area of land they occupy, while concentrating development efforts on introducing new land uses and technologies in forestry.

Protection as an Important Development Objective

Protection of core areas of the newly established Maya Biosphere Reserve is one of the principal reasons that the project was proposed. In the case of the Central Selva project, protection is an important corollary to general economic development. In both instances, protection serves several development objectives. These include contributing directly to development through scientific study and tourism; and contributing indirectly to development by regulating water flows, controlling erosion, and maintaining biodiversity.

General Commonalities between the Two Projects

The physical and ecological characteristics of the lands in both project areas mark them as fragile lands, that is lands with high susceptibility to deterioration if subjected to conventional agricultural and livestock use (Bremer et al. 1984). Both projects, therefore, allocate few project resources to these conventional uses but instead emphasize protection and forest-based production. In each instance, environmental analysis took place early in the project design process. By identifying environmental limitations and proposing development activities consistent with sustainable productive capacity, environmental analysis influenced the shape of each project.

Environmental Information for Fragile Lands Development

Environmental Information Sources

Several types of documents form a bridge between environmental assessments, which are site and activity specific, and the general informational needs of environmental education and development planning in developing countries. On the one hand, these documents provide facts and insights to inform environmental assessments and development decisions. On the other hand, they provide the general reader with an overview of a country's environment, a sense of what the important environmental issues are in that country, and some idea of the array of responses to the issues. Perhaps most importantly, most of these documents seek to influence national development policy toward taking environmental considerations more fully into account.

Environmental Profiles

A.I.D. began producing environmental profiles in 1979 as part of the U.S. government's participation in the worldwide Man and the Biosphere Program. Two types of environmental profiles exist: desk studies that have been prepared for nearly all of the 60 countries that receive development assistance from A.I.D.; and field studies that have been prepared for about 15 countries, mostly in Latin America (Baker and Tunstall 1990).

The desk studies rely on documents available in the United States to describe the environments of developing countries and highlight major national environmental problems. The field studies rely on an expanded information base that includes documents available in the country, material obtained from interviews of knowledgeable national sources, and field observations. Neither type of profile process produces information through field-level research.

Some of the field studies were performed almost entirely by consultants with limited participation by national professionals. Others were primarily national efforts, partially assisted by overseas consultants. The *Environmental Profile of Honduras 1989* falls into the second category (Daugherty, ed. 1990). The Honduras profile was written in Spanish by a team of Hondurans associated with public and private organizations under the leadership of the

Secretariat for Planning. The DESFIL project provided technical assistance and logistical support to the Honduran national effort. Preparation of the profile was integrated into a broader national process of environmental awareness and natural resources management that has continued after the publication of the profile through the transition from the previous government to the current one.

Table 10.1 shows the status of environmental profiles for Latin American and Caribbean countries.

TABLE 10.1 ENVIRONMENTAL PROFILES FOR USAID-ASSISTED LATIN AMERICAN AND CARIBBEAN COUNTRIES

COUNTRY	DESK STUDY	FIELD STUDY
Barbados	1982	
Belize	1982	1984
Bolivia	1979	1980;1986
Central American Region	1987	
Costa Rica	1981	1982
Colombia		1990
Dominican Republic		1981
Ecuador	1979	1983
El Salvador	1982	
Guatemala	1979	1984
Guyana	1982	
Haiti	1979	1985
Honduras	1981	1982;1989
Jamaica	1982	1987
Nicaragua	1981	
Paraguay		1985
Peru	1979	1986

Source: Baker and Tunstall 1990.

Biodiversity Assessments

Since the revision of the Foreign Assistance Act in 1986, A.I.D. has begun to prepare biodiversity assessments in the countries it works in. The assessments take stock of a nation's biological diversity, describe its condition and the factors that affect its conservation, and recommend measures that A.I.D. might take, or might induce the country to take, to ensure biodiversity conservation.

The biodiversity assessment for Ecuador, for example (Cabarle et al. 1989), draws from continuing work on describing the flora of Ecuador, as well as the most up-to-date information available on laws, policies, and institutions that deal with conservation and natural resources management. The assessment recommends the way the A.I.D. program in Ecuador can incorporate biodiversity conservation into economic development.

National Conservation Strategies

National conservation strategies derive from the World Conservation Strategy published in 1980 by the International Union for the Conservation of Nature and Natural Resources (IUCN). The World Conservation Strategy highlights points of conflict between development, especially the type of development financed through international development assistance, and conservation. It also, however, supports development as essential for the welfare of the peoples of the planet. The strategy particularly champions development that is effective economically yet harmonious environmentally, that is, "sustainable development."

The World Conservation Strategy constitutes the central work performed thus far on defining sustainable development and establishing processes to attain it. The strategy served as a principal starting point for the Brundtland Commission, which explored world environmental problems and called for concerted international action to resolve them. Amended Section 119 of the Foreign Assistance Act directs A.I.D. to "look to the World Conservation Strategy as an overall guide for actions to conserve biological diversity."

The World Conservation Strategy is not self-implementing. It anticipates implementation through national conservation and development strategies. Currently, only a few countries have completed national strategies, but many countries have them under preparation (Baker and Tunstall 1990).

National Forestry Action Plans

National forestry action plans are national expressions of the worldwide Tropical Forestry Action Plan (TFAP), a blueprint for investment in forestry development in tropical countries, prepared by the FAO in 1987. Most tropical countries have produced national forestry action plans or have them under preparation. Each plan projects the country's investment needs in five areas

of forestry development: land use, forest industries, fuelwood and energy, ecosystem conservation, and forestry institutions.

State of the Environment Reports

A handful of countries have produced national state of the environment reports and quite a few more have them under preparation (Baker and Tunstall 1990). Typically, NGOs, working within general guidelines evolved by the UNEP, produce the reports, often through collaboration among national and international organizations. The reports describe a nation's environment and the social and economic factors that affect it with an eye toward predicting future conditions.

Processes for Influencing National Development Policy through Environmental Information

The influence that environmental documents have on national development policy is related to their content, but more importantly to the processes for producing them and to the processes that they generate. The attributes that make an environmental document influential in a country include the quality of the information it contains and the authority of its authors, participatory processes for preparing and reviewing the document, and follow-on processes for discussion and implementation generated by the document. The processes build constituencies for environmentally sound development. Environmental information processes flow in two directions. In one direction, they fit into the national framework for environmental education and extension (see Chapter Eleven). In another direction, they fit into the legislative and administrative framework for policy formulation and implementation (see, for example, Eigen 1987; Chapter Eight, this volume).

Costa Rica illustrates the positive effect of environmental information processes on environmental policy and environmental education. Costa Rica has prepared a field study environmental profile (Hartshorn et al. 1982), a state of the environment report (Ramirez and Maldonado 1988), a national conservation strategy (Quesada 1990), and a national forestry action plan (Salas 1990).

The preparation of these four documents reflects a high level of awareness of environmental issues in Costa Rica and a high technical capability to present them in a well-informed manner. At the same time, the processes the documents have engendered have kept environmental issues continuously in the forefront of national discussions of development policy. The government has reorganized the agencies that deal with natural resources management into the Ministry of Natural Resources, Energy and Mines. The new ministry has overseen declaration of an emergency forestry decree and preparation of the national conservation strategy and the national forestry action plan.

The national conservation strategy process explored 19 sectors of national life through formation of investigatory commissions for each sector. The sectoral commissions performed their work by way of public meetings and preparation of sectoral reports. The process

culminated in a series of public expositions, on each sector and on the whole national conservation and development strategy, presented at the National Theater in October 1988. The national strategy proposes a continuous process and a permanent administrative framework for national environmental planning.

After the presentation of the national strategy in 1988, but before publication of the final strategy document in 1990, Costa Rica elected a new government that represents the party in opposition to the government that initiated the national conservation and development strategy. The current government has moved forward with continued strengthening of the Ministry of Natural Resources. It has also issued a statement of environmental policy that sets out a strong commitment to environmental quality and sustainable development (Partido Unidad Social Cristiana 1989).

Costa Rica appears to have attained consensus on the importance of environmentally sound economic development that spans the national political spectrum. This consensus should lead the way to national efforts in environmental education and extension that will turn commitment into accomplishment of fragile lands management.

Almost every other country in Latin America and the Caribbean has begun national environmental planning processes similar to those in Costa Rica. The DESFIL project can facilitate these processes as illustrated by the example of Honduras. It can also affect these processes at the level of broader public information and awareness through environmental education and extension, a topic explored in the following chapter.

ENDNOTE

1. The DESFIL consultant team was composed of the following persons with the indicated specialties:

Dennis McCaffrey:	team leader, environmental analyst
Pierre Berner:	natural forest management specialist
Joshua C. Dickinson III:	geographer
Brian Houseal:	parks and protected areas planner
Donald Kass:	agroforester
Vicente Molinos:	forest industries specialist
James D. Nations:	specialist in extractive reserves
J. Kathleen Parker:	social forester
Richard Rice:	economist
Refugio Rochin:	economist
Marianne Schmink:	specialist on women in development
Clyde Stoneaker:	parks management specialist
Peter L. Weaver:	research forester
Maryla Webb:	institutional analyst

REFERENCES CITED

Baker, D. S. and D. B. Tunstall, eds.
1990 *Directory of Country Environmental Studies*. Center for International Development and Environment, World Resources Institute.

Bolanos M., R. A. and V. Watson C.
1981 "Report on the Ecological Map of the Palcazu Valley." In J. C. Dickinson III et al., Central Selva Natural Resources Management Project: Project Synthesis Paper. McLean, Va.: JRB Associates.

Bremer, J., T. Babb, J. Dickinson, P. Gore, E. Hyman, and M. Andre
1984 "Fragile Lands: A Theme Paper on Problems, Issues, and Approaches for Development of Humid Tropical Lowlands and Steep Slopes in the Latin American Region." Contract study for USAID, Bureaus of Science & Technology and Latin America and the Caribbean. Washington, D.C.: Development Alternatives, Inc.

Cabarle, B. J., et al.
1989 Assessment of Biological Diversity and Tropical Forests for Ecuador. USAID/Ecuador. Washington, D.C.: World Resources Institute.

Code of Federal Regulations
1980 22 CFR Part 216, Environmental Procedures.

Dickinson III, J. C., M. Dourojeanni, D. McCaffrey, D. Pool, and R. C. Smith
1981 Central Selva Natural Resources Management Project: Project Synthesis Paper. McLean, Va.: JRB Associates.

Daugherty, H. E., ed.
1990 *Perfil Ambiental de Honduras 1989*. Secretaria de Planificación, Coordinación y Presupuesto de Honduras, DESFIL, and USAID. Washington, D.C.: Development Alternatives, Inc.

Eigen, J.
1987 Information Management System for Environmental Planning and Management (EPM) in Cyprus. The Environmental Profile of Cuprus. Government of Cyprus and UNDP/OPE.

Hartshorn, G. S., et al.
1982 *Costa Rica Country Environmental Profile*. San José, Costa Rica: Tropical Science Center.

Hartshorn, G. S.
1989 "Sustained Yield Management of Natural Forests: The Palcazú Production Forest." In J. O. Browder, ed., *Fragile Lands of Latin America*, pp. 130-138. Boulder, Colo.: Westview Press.

Holdridge, L. R.
1967 *Life Zone Ecology*. San José, Costa Rica: Tropical Science Center.

International Union for the Conservation of Nature and Natural Resources
1980 World Conservation Strategy: Living resource Conservation for Sustainable Development. Intenational Union for the Conservation of Nature and natural resources (IUCN). Switzerland: United Nations Environment Program/World Wildlife Fund.

McCaffrey, D., comp.
1991 "The Maya Regional Environmental Management Project (MAYAREMA) Project Identification Document." DESFIL Technical Report. Washington, D.C.: Development Alternatives, Inc.

Miller, C. I. and H. Martinez
1981 An Analysis of Planned Agricultural Development in the Palcazu Valley, Pasco Peru: Power Relations, Land Tenure, and Resource Utilization of Natives, Colonists, and Government Workers. Report to USAID/Peru, Lima.

Partido Unidad Social Cristiana
1989 Plan de Acción Recursos Naturales Renovables 1990-1994. Costa Rica.

Quesada Mateo, C.
1990 Estrategia de Conservación para el Desarrollo Sostenible de Costa Rica. Costa Rica: Ministerio de Recursos Naturales, Energia y Minas.

Ramirez Solera, A. and T. Maldonado Ulloa, eds.
1988 Desarrollo Socioeconómico y el Ambiente Natural de Costa Rica. San José, Costa Rica: Fundación Neotrópica.

Salas, J. L.
1990 Plan de Acción Forestal de Costa Rica. San José, Costa Rica: Ministerio de Recursos Naturales, Energia y Minas.

Smith, R. C.
1981 "Land, Natural resources, and Economic Development of the Amuesha Native Communities in the Palcazu Valley." In J. C. Dickinson III, et al., *Central Selva Natural Resources Management Project: Project Synthesis Paper*. McLean, Va.: JRB Associates.

Tosi, J. A.
1981 "Land Use Capability and Recommended Land Use for the Palcazu Valley." In J. C. Dickinson III, et al., *Central Selva Natural Resources Management Project: Project Synthesis Paper*. McLean, Va.: JRB Associates.

Tosi, J. A.
1982 Sustained Yield Management of Natural Forests. Forestry Sub-Project, Central Selva Resources Management Project, Palcazu Valley, Peru. San José, Costa Rica: Tropical Science Center.

USAID/Guatemala
1990 Maya Biosphere Reserve Project (MAYAREMA). Project Paper.

United States Congress
1986 Special Foreign Assistance Act of 1986.

CHAPTER ELEVEN

ENVIRONMENTAL EDUCATION AND EXTENSION

by

Sam H. Ham
and
David S. Sutherland

INTRODUCTION

Environmental education (EE) represents an important strategy for augmenting the management of fragile lands. EE is

> the most realistic and practical way of disseminating what is known about fragile lands issues to those most affected by them — and is also the first step in translating this knowledge into action. It acts to build a constituency for the conserving use of resources, independent of donor support (DESFIL 1988b).

Many environmental problems and threats to fragile lands are the result of uninformed human actions — or inactions, for example, contamination of local water or coast lines through improper latrine placement, deforestation caused by shifting cultivation and fuelwood cutting, poaching of wildlife and trees, limited public participation in environmental planning, and lack of popular support for political candidates with strong environmental agendas. To some extent, all such problems lend themselves to communication treatment, that is, EE.

Whether in the context of "formal" (school-based) programs or "nonformal" programs (extension efforts, park and zoo interpretive programs, mass media campaigns, and so forth), EE represents an attempt to influence human behavior in the short term and the long term by raising consciousness of the relationship between sustainable quality of life and the natural resource base. In this context, EE is a communication strategy, not an autonomous information function. Its fundamental precept is that stewardship of fragile lands will be easier and more effective if it is carried out in concert with an enlightened public. Who this "public" is and which outcomes — formal and nonformal — EE programs should ultimately produce, as well as examples of attempts to produce them, are the subjects of this chapter.

RAISING PUBLIC CONSCIOUSNESS THROUGH ENVIRONMENTAL EDUCATION

Regardless of its form, context, or approach, EE is a communication strategy for indoctrinating human beings into an environmental ideology — that is, for raising public consciousness regarding human dependence on unspoiled water, soil, air, and other basic resources typically associated with fragile lands. Indeed, in this context, the word "fragile" reflects our recognition that such lands furnish resources that are easily rendered unsuitable for sustainable human use. At their most fundamental level, EE programs attempt to inoculate their audiences with both an understanding and appreciation of this basic principle. As this is accomplished, we will expect support for fragile lands management to increase at all levels of society, and human action to become more environmentally sound. Raising public consciousness is therefore EE's principal goal.

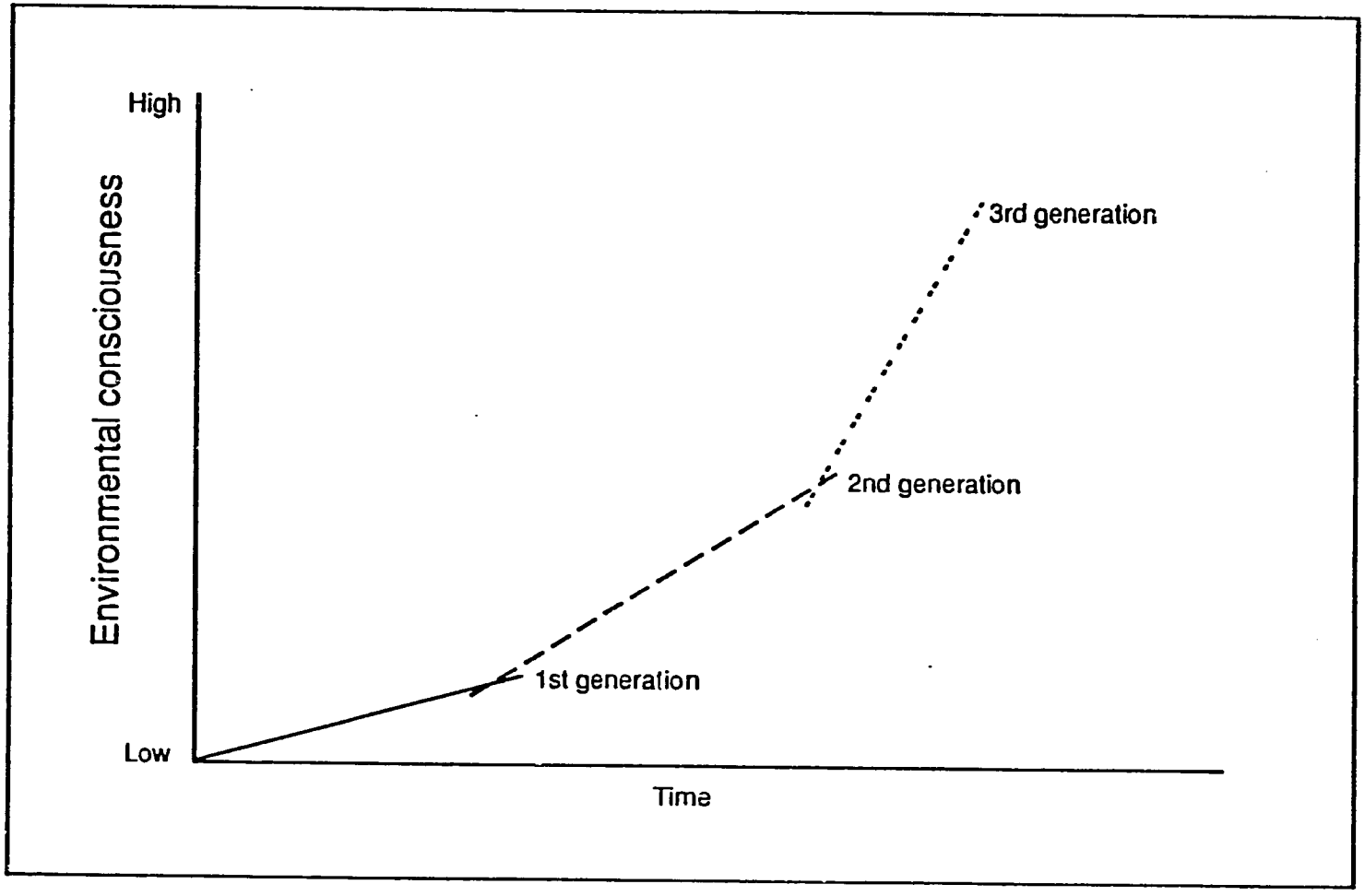
But raising consciousness is a difficult task, complicated by the sheer diversity of audiences EE must address; the multitude of media and methods that may be appropriate to reach each audience; and the prevalence in most developing countries of poverty, inequitable land tenure, policy shortcomings, and massive foreign debt that combine to encourage disregard for long-term environmental values.

Also perplexing is that the intended results of EE programs are, by nature, slow to manifest themselves and, therefore, difficult to assess. Feedback is generally not immediate, making evaluation difficult and methodologically inconvenient. This means that EE approaches to fragile lands management require patience and a degree of faith that intended outcomes will ultimately materialize. Unfortunately, the comparatively short life span of most development projects do not permit realistic assessment of EE outputs.[1]

This relationship is illustrated in Figure 11.1, which depicts how public ideologies can change over time as a result of successful consciousness raising. In the figure, the "first generation" is the initial audience of an EE program. Depending on the compatibility of the new ideology with established beliefs and traditional thinking, the first-generational effect is usually modest. Some individuals are deeply influenced, but the net effect on consciousness is small. In the 1950s, for example, we saw little reduction in the amount of garbage on U.S. highways despite the appearance of antilitter propaganda in the mass media. Still, the foundation for a new social norm related to littering was being built (Sligar 1974).

The "second generation" begins its consciousness raising from a higher baseline, which accounts for the steeper slope of its curve. In the 1970s, for example, government agencies, foundations, and citizen action groups were beginning to coalesce specifically around the litter issue. Well-funded, multitrack public education programs such as the nationwide campaign launched by Keep America Beautiful, Inc. in 1970 (Keep America Beautiful 1970) were developed and distributed through schools, communities, and print and broadcast media. Slogans such as "Every Litter Bit Hurts" and labels such as "Litterbug" gradually made their way into popular vocabulary and the second generation's culture. This generation also helped

Figure 11.1. Hypothetical Generational Effects of Continuous Public Environmental Awareness Campaigns.



pass the earliest state and local antilitter ordinances, probably abetted by first-generation converts who had since reached some degree of opinion-leader status. Because they are relatively young, EE programs in Latin America and the Caribbean — including DESFIL's programs — may be best compared to first- (and possibly second-) generation efforts.

The "third generation" (in our example, this would be today's "20-Something Generation") (see Gross and Scott 1990), stands to inherit an even higher baseline of antilitter ideology. Maturation of first- and second-generation effects were reflected in the rapid growth of policies and laws created in the late 1970s and 1980s to keep the environment clean. Today, enforcement of these laws is more common than it has been at any previous time.

With 40 years of hindsight, it is easy to see the obvious change in U.S. environmental ideology — littering being but one of many examples (see Geller et al. 1982). Just as clear, however, is the multigenerational time frame that was required before the public awareness effects of programs like the Keep America Beautiful campaign could be achieved and evaluated. Few international development projects enjoy such a life span.[2]

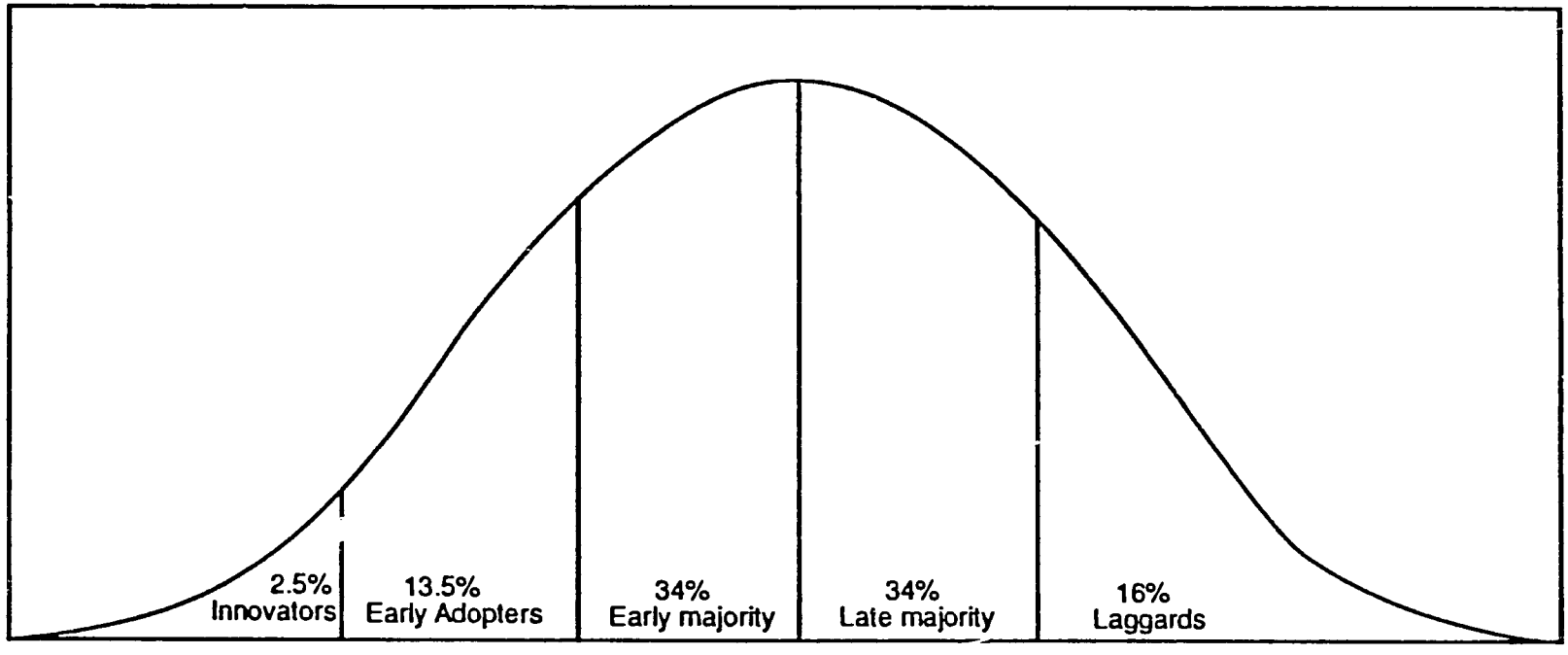
The obvious challenge for developing countries faced with unprecedented demands on finite natural resource lands is to accelerate the generational effects — that is, to create a society more receptive and supportive of fragile resource management before sustainable management of those resources becomes impossible. As Medina (1989) has argued, EE programs in Latin America and the Caribbean must produce an immediate as well as a long-term effect on public consciousness:

> Many children are not in school so they are not reached by school programs. The average South American [for example] does not go beyond the 4th grade in school. Latin America and the Caribbean do not have the luxury to wait for today's children to grow up. Unless their behaviors change now there will be little tropical forest left to save.

ENVIRONMENTAL EDUCATION AS A DIFFUSION AND ADOPTION AGENT

The theory of diffusion and adoption advanced by Rogers and Shoemaker (1971) provides a basis for understanding how this acceleration of effects might operate in a developing country, and how development projects can view their accomplishments and chart future directions. Rather than viewing the generations in Figure 11.1 as age-bound cohorts (as in the antilitter example), they might instead be seen as different kinds of adopters. In Rogers' and Shoemaker's typology (see Figure 11.2), adopters may be categorized as (1) innovators — that venturesome 2.5 percent of the population that first adopts a new idea or technology; (2) early adopters — the 13.5 percent that typically includes opinion leaders, community role models, and high-credibility spokespersons; (3) the early majority — the 34 percent that constitutes the "first wave" of popular acceptance of a new idea; (4) the late majority — the next 34 percent who, because of

Figure 11.2. Typology of Adopters



(adapted from Rogers and Shoemaker 1971)

the early majority's acceptance, eventually overcomes initial skepticism; and (5) laggards — the remaining 16 percent who cling most tenaciously to established traditions and beliefs, and hence are the last to embrace a new ideology or technology.

An important implication of this model, and one that has been supported by more than a half century of research, is that identification and educational targeting of individuals and groups who possess innovator and early adopter characteristics can markedly decrease the time necessary for adoption of a new idea to take place in a society (Muth and Hendee 1980, Rogers and Shoemaker 1971). Therefore, a key strategy for accelerating the adoption of environmental ideology and associated behavior is to choose target audiences with the potential to be change agents — that is, those individuals and groups whose early adoption may hasten the subsequent adoption of the ideology by others. These audiences and examples of DESFIL's attempts to reach them through its EE programs are the subjects we take up next.[3]

KEY AUDIENCES FOR FRAGILE LANDS ENVIRONMENTAL EDUCATION

As previously suggested, EE occurs in two different kinds of settings: formal and nonformal (the latter invoked to parallel the accepted Spanish term "no formal") (see Ham 1989b). Formal EE takes place in the formal school system consisting of primary, secondary, and postsecondary levels. In contrast, nonformal EE is presented outside of a formal, highly structured learning environment to audiences whose presence and participation is largely voluntary and internally motivated. Within the formal and nonformal sectors in Latin America and the Caribbean, several key audiences emerge as potential early adopters who may subsequently encourage others to embrace environmentally sound ideas and related behaviors. Because of the cultural and socioeconomic diversity of these audiences, and their access to different information sources, EE approaches must be tailored to each group. Put differently, a multitrack educational approach involving both the formal and nonformal EE sectors is necessary to reach the important audiences and to hasten the consciousness-raising process. Toward this end, DESFIL sponsored and facilitated Honduras' First Environmental Education Meeting in 1989. The meeting (see Valencia 1990, AHE 1989) brought together 62 people representing EE interests in government, schools, universities, parks, foreign development agencies, and the private sector. The results were that key audiences were identified for formal and nonformal EE in Honduras, and a five-year national strategy for reaching these audiences was developed In addition, DESFIL activities have reached key audiences in both the formal and nonformal sectors elsewhere in Latin America and the Caribbean. The following discussion examines each of these audiences in more detail and presents examples of corresponding DESFIL activities.

Formal Environmental Education Programs

Formal EE programs take place within school systems. As such, their purpose is to prepare the next generation of adults to be conscientious and informed resource consumers and stewards. Elementary school children are considered an important audience for EE because their

environmental knowledge and values are generally less rigid and more impressionable than those of adults (see Walters 1989, Ministerio de Educación Pública/Honduras 1989). Postsecondary students are also important because they are on the verge of entering the work force, often at the professional or paraprofessional level (see, for example, Barborak and Ham 1989; Gonzalez et al. 1989). Indeed, the need for formal school curricula to address EE needs has become a predominant issue internationally. It was the main topic at the Subregional EE Training Seminar for the Caribbean (UNESCO-UNEP 1988), at the Central American Seminar on Universities and the Environment (Gonzalez et al. 1989), and at the DESFIL-sponsored First National EE Meeting in Honduras (AHE 1989).

Years of experience in the development of international formal EE curricula have yielded at least four important lessons. First, interdisciplinary curricula that integrate EE material into a variety, if not all, subjects may be cheaper, easier to implement, and less demanding of primary and secondary teachers who are justifiably skeptical about adding new subjects to an already overcrowded curriculum (UNESCO-UNEP 1989, Ham 1990a, Ham and Sewing 1988). In addition, interdisciplinary EE makes sense pedagogically, especially in relation to fragile lands management. Complex interactions among human culture, values, traditions, and the biophysical environment do not lend themselves to compartmentalization in a single subject because they pertain to many facets of life. Social sciences, mathematics, music, language, art, natural sciences, and even physical education all have an environmental connection (Tanner 1974). Second, at the postsecondary level, adding EE as a separate course or discipline required of students in all specializations has been seen as a preferred strategy by some (Gonzalez et al. 1989).

A third lesson is that although many excellent EE curricula and teaching materials have been developed for use in U.S. schools and subsequently translated into Spanish, they are probably inappropriate for use in rural schools in developing countries. Typically, EE materials designed for U.S. schools assume a college-educated teacher and access to basic teaching resources not necessarily available to teachers in developing countries (Ham and Castillo 1990), and they may miss the mark both culturally and in biological subject matter (Ham 1989a). Fourth, it is generally accepted that foreign assistance must be geared to empowering nationals to develop their own approaches to EE, and that such efforts must be sanctioned if not coordinated by appropriate government agencies in each country (Ham et al. 1989). This is especially true in development of curricula and teaching materials for public schools. In Honduras, for example, several excellent EE programs that could be used nationally have been developed by private groups. Yet public education policy mandates standardization of school curricula and instructional materials. The result is that the materials remain unused outside of their areas of origin and a national EE curriculum remains undeveloped. Still, development of diverse approaches to EE makes sense because local efforts can address local realities better than the broad brush of a standardized approach. A major policy question for many developing countries will be whether a diversity of EE programs can be accommodated by education ministries.

Formal EE activities under the DESFIL project include the previously mentioned planning conference in Honduras (AHE 1989), as well as other activities designed to strengthen EE in schools (see Table 11.1). Among these is the St. Kitts' Southeast Peninsula Project, which initiated its EE activities in island schools with presentations on ecological topics, development of audiovisual aids, investigative field trips for school children, and a project-sponsored art and poetry contest (Walters 1989). In addition, DESFIL has provided technical assistance in several other projects that have specifically identified school children as an important audience. These include USAID's Northern Zone Consolidation Project in Costa Rica, the Assessment of Biodiversity in Peru, and the Tropical Forestry Action Plan written for Belize (DESFIL 1988a). Although in each instance the projects seem to be achieving their objectives, the impact of DESFIL's EE efforts has not yet been evaluated. Indeed, it is too soon to be able to make an informed judgement about the long-term impact.

Thus far, the main focus of DESFIL's efforts in formal EE has been primary schools, and to a lesser extent, secondary schools. Postsecondary EE has received comparatively little attention, both within the DESFIL project and elsewhere. In Honduras, however, two DESFIL-sponsored activities have helped to clarify potential roles for Honduran universities working in EE. The previously mentioned national meeting held in Tela in August of 1989 (AHE 1989) brought together several professors from the Universidad Nacional Autónoma (UNAH) in Tegucigalpa and the Centro Universitario Regional del Litoral Atlántico (CURLA) in La Ceiba. An important contribution to the meeting was a discussion about the responsibility of Honduran universities to incorporate EE into career programs, including teaching, engineering, medicine, journalism, chemistry, pharmacy, and natural-resource-related fields such as forestry, wildlife management, agriculture and biology. A second important contribution is the 1989 *Perfil Ambiental de Honduras* — the 1989 *Honduras Environmental Profile* (Daugherty, ed 1990) — that was coordinated and produced by DESFIL and Honduras' Ministry of Planning, Coordination and Budget (SECPLAN). Although implications for EE are included throughout the 346-page profile, Chapter Ten is devoted entirely to an analysis of EE's status in the public and private sectors in Honduras. Among the recommendations offered is a suggestion that UNAH create an EE specialty within its teacher education career, and that UNAH, SECPLAN, the Secretary of Public Education, and private environmental groups meet periodically to exchange information.

Formal EE programs represent a **long-term** educational tool to address fragile lands management problems. They are an investment in the sense that their goal is to nurture an informed future citizenry (Wood and Wood 1987). That today's youth are tomorrow's resource consumers and caretakers underscores the importance of such an investment. Yet formal EE programs usually do not address the immediate, short-term needs for accelerating the diffusion and adoption of environmental ideology, as previously discussed. And as some have suggested (Medina 1989, Wood and Wood 1987), an overemphasis on school children may have led to the neglect of other audiences more strategically important in the immediate protection of fragile lands and the resources they contain. With rare exception, these influential, potentially early-adopting audiences are reachable only through nonformal EE programs.

TABLE 11.1 SELECTED DESFIL PROJECTS THAT ADDRESS CRITICAL AUDIENCES FOR ENVIRONMENTAL EDUCATION

	FORMAL	NONFORMAL					
PROJECT	(Schools)	Subsistence-Oriented Rural People	Teachers & Extension Agents	Middle/ Upper Class	Influential Citizens	Foreign Tourists	World Audience
First Nat'l Conf. on EE (Tela, Hond.)	X	X	X	X	X		X
SE Peninsula Project (St. Kitts	X	X	X	X	X	X	
No. Zone Consol. Proj. (Costa Rica)	X	X					
Assessment of Biodiversity (Peru)	X			X	X	X	
Trop. Forestry Action Plan (Belize)	X						
Assoc. High Valley Project (Bolivia)		X					
National Agroforestry. Program (Haiti)		X					
Land Use Mgmt Plan. (Sumaco, Ecuador)		X	X		X		
DESFIL Newsletter							X
DESFIL Publications							X

Nonformal Environmental Education Programs

Nonformal EE programs take place outside the formal education system. Typically, they are directed at such audiences as visitors to parks, protected areas, zoos, museums and botanical gardens, extension program recipients, participants at workshops and meetings, industry and labor organizations, members of clubs and community groups, political organizations, political decision makers, and consumers of print and broadcast media. Although myriad potential audiences exist, the following six have emerged repeatedly as being most important because of (1) the direct relationship between their actions and the condition of fragile lands, or (2) their capacity to influence other people and thus accelerate the adoption process (see, for example, Wood and Wood 1987, Medina 1989, Ham et al. 1989).[4]

1. Subsistence-Oriented Rural People

People whose daily activities directly affect fragile lands resources are an obvious EE audience. Key among these groups are those who live at the subsistence level on or adjacent to fragile lands. As many have argued (Galeano 1973, Nations and Leonard 1986, Wood and Wood 1987, Ham et al. 1989, McNeely et al. 1990, Hammond 1990), it is convenient to blame such people for the ecological damage their activities produce, but they usually are not aware of the effects they create, nor more importantly of economically viable alternatives to their current lifestyle. EE as part of extension and outreach programs in agriculture, natural resources, and health may offer the best strategy for showing these people what alternatives exist, if any, and how to incorporate them into their lives. Alternatives which are perceived to be advantageous to income or health will be embraced by this audience; and to the extent they continue to be advantageous, the new ideas they foster may eventually become part of local tradition, enduring long after the extension effort has ended. Designed at the appropriate scale and delivered with the sensitivity and clarity that exemplifies effective extension efforts (for example, see Bunch 1982; Rogers and Shoemaker 1971), successful programs of this type may thus produce relatively quick and enduring improvements in the environment-related behaviors of their audiences.

Several DESFIL-sponsored agriculture projects have EE components directed to some extent at subsistence-level audiences (see Table 11.1). For example, the DESFIL-assisted Northern Zone Consolidation Project in Costa Rica, the Associated High Valley Project in Cochabamba, Bolivia, and the Land Use Management Plan developed for the Gran Sumaco, Ecuador have all addressed the need for raising the environmental awareness of local populations — many composed primarily of *campesinos* (Tolisano et al. 1989, Dickinson et al. 1988, Hanrahan 1989, Hanrahan and Pereira 1990). In addition, DESFIL's workshops on "Conservation and Development," which brought together local people directly impacted by the presence of seven Ecuadorian protected areas, served not only to better acquaint rural populations with the values of nearby fragile lands, but to establish a communication link between the affected populations and political decision makers (Dickinson 1990, Kernan and Ramos 1990).

DESFIL's EE experience with subsistence-level audiences has underscored the necessity of backing environmental rhetoric with cost-effective and economically sound technologies for farmers (Chapter Three). One of the important lessons gleaned from the National Agroforestry Program in Haiti is that EE messages that emphasize long-term benefits or romantic appeals (for example, "for Mother Haiti," or "for your children's children") may not be nearly as convincing as appeals that address the farmer's immediate needs for food and income (Gow 1989). This experience corroborates a growing recognition that the most effective EE programs for subsistence-level audiences do not present highly conceptual, affective, or romantic appeals that promise only intangible future benefits (Jones 1989). Rather, they stress immediate improvements in the farmer's economic and physical well-being. As Richard Donovan, manager of BOSCOSA (a USAID/Costa Rica forest conservation and management project), observed:

> If we want the forest to be preserved, the bottom line is we have to produce cold, hard cash for the *campesino*. . . . The *campesino* cannot find what he's looking for in a conversation about global warming; he's looking for sustenance (Jones 1989).

Extension is in many ways a microcosm of the larger EE challenge, although focused on a more narrowly defined audience (Ham 1990b). Personal contact between extensionists and their audiences still constitutes the most effective communication strategy — depending, of course, on the acceptability and credibility of the extensionist in the eyes of the community (Bunch 1982). But other media are increasingly used by extensionists — blackboards, flipcharts, flannel boards, film strips, slide projectors, tape recorders, and even video tape (see Muñoz and Peña 1990, Bajimaya and Fazio 1989, and Bunch 1982 for useful comparisons of the advantages and disadvantages of different media). For example, an FAO forestry education campaign in the Peruvian highlands includes filmstrips, videotapes, posters, flipcharts, books, calendars, a practical forestry newspaper (*El Arbol*) aimed at adults and children in over 80 communities, plus weekly radio broadcasts both in Spanish and Quechua (December 1986). Radio is increasingly recognized as a powerful communication medium for rural audiences (AED 1989, AED 1990, Ham and Castillo 1988, Dodd 1987). Radio offers several advantages: (1) it is a common source of information in rural areas where print and other broadcast media are either inaccessible or too costly for rural families; (2) it does not require literacy, allowing children and illiterate adults to easily comprehend its messages; (3) it does not require electrical current and lends itself to group listening, thus reaching many people; and (4) listening to radio is a popular form of recreation in remote rural areas. According to Bunch (1982), radio's main disadvantages are its expense, its reliance on "outsiders," and its one-way quality. As a sole communication medium, radio is certainly limited by the shortcomings pointed out by Bunch; but as part of a multitrack education program, its many advantages should be carefully considered.

2. Educators: Teachers and Extension Workers

Educators can be change agents in a community because of their high profile and credibility, and because their work brings them into contact with many sectors of the community. In Latin America and the Caribbean, teachers and extension workers are important change agents, especially in rural areas where they may be held in particularly high esteem (Biesanz et al. 1987, Werner and Bower 1982, Werner 1980). This position in the community makes them important potential spokespersons for the environment, and suggests the need to keep them well informed. Even though teachers and extensionists are typically viewed as an EE delivery system rather than an EE audience, their potential to be change agents through the multiplier effect dictates that they be knowledgeable, factual, and credible when it comes to issues or topics related to fragile lands. The urgent need for educating teachers about the environment is a consistent theme in international EE conferences, and was the highest priority indicated in a worldwide survey of environmental educators (UNESCO-UNEP 1990). Short-term awareness-building activities such as field trips, workshops, meetings, short courses, and other kinds of training programs represent appropriate mechanisms for meeting this need.

Results of a recent study in Costa Rica suggest that school teachers may serve a previously undocumented role as environmental change agents. Sutherland (1991) has observed that some environmental content taught to children in the classroom may later surface in discussions at home or through the course of parents helping children with homework. EE designed specifically to raise the consciousness of teachers may therefore reach parents and siblings and, through them, other community members. Not surprisingly, key variables in this relationship appear to be the amount of interaction parents have with their children and their openness to learning from them.

DESFIL has been involved with several EE efforts aimed at teachers and extensionists (see Table 11.1). The St. Kitts' Southeast Peninsula Project has sponsored several activities: (1) environmental and tourism awareness workshops for teachers presented by the national Tourism Department and the Caribbean Tourism Organization (Walters 1989); (2) an EE newsletter (SKNED) developed specifically to reach teachers, government employees, and interested citizens; and (3) preparation of a development plan for the Southeast Peninsula National Park that recommends that teachers from the St. Kitts/Nevis school system be invited to attend interpretive tours free of charge (Wilcox 1989). In addition, teachers and extensionists were identified as important audiences in the five-year strategy developed at the DESFIL-sponsored EE planning conference in Honduras (AHE 1989).

3. Middle- and Upper-Class Nationals

Increased environmental awareness is urgently needed among the affluent classes in Latin America and the Caribbean. These people have both the leisure time and discretionary income to visit protected areas and to join environmental interest groups. In contrast to subsistence-oriented rural people, they enjoy social status, education, and political leverage to

lobby for environmental reforms. Their social position gives them opinion-leader status and makes them frequent trend setters — that is, influential early adopters.[5] On-site interpretive programs, awareness campaigns through mass media, and other appeals have the potential to influence these citizens and to create a greater sense of urgency about fragile lands and the environment than currently exists. Politicians, too, may respond to environmental messages — either directly by internalizing their communication content, or indirectly as their constituents express opinions.

Nongovernmental organizations that promote national environmental awareness can be a key impetus, as well as delivery systems, for efforts of this type. Although conservation NGOs are on the rise in Latin America and the Caribbean (Fernandez 1989), a strong environmental movement like that in the United States has not yet developed — and may never, giving way instead to a movement based on each nation's own values and cultural prerogatives. According to many (for example, Fernandez 1989, Ham et al. 1989, Hypki and MacKenzie 1987), this is as it should be if these groups are to succeed in their conservation efforts. Although foreign organizations may play central roles in helping to organize and finance the conservation movement in Latin America and the Caribbean, the main impetus must come from within and be based on local realities. Sometimes, middle- and upper-class nationals reject ecological reasoning because it is assumed to be a foreign force in sovereign territory, sometimes attributed to U.S. interference in domestic affairs. To the extent that these people see conservation as their own national priority, they will be more inclined to support or even participate in their country's environmental movement. And according to some (McNeely et al. 1990, Ham et al. 1989), in-country nationals must see consistency between proposed conservation models and what they perceive to be their national reality.

An example, and one that strict preservationists sometimes fail to appreciate, is that the "Just Say No to Development" philosophy espoused by wilderness activists in the United States (Nash 1988) may be impractical or impossible in Latin America and the Caribbean where reality says that fragile lands must pay for themselves or perish (see Kakabadse 1988). As Reid et al. (1988) have argued, the hallmark of sustainable development is its goal to maximize the options for protecting ecological values while at the same time meeting present needs. In their words (1988:1):

> One sure lesson of the failures of past development aid is that there will be as many answers to the question "how do we achieve sustainable development?" as there are ecological, political, and cultural systems. Success in development will be achieved not by focusing on "proven" methods or technologies but by broadening the choice of solutions to specific problems. Just as we value diversity of species, we should value diversity of approaches to development.

In this context, sustainable development, rather than uncompromising protectionism, emerges as an important theme for EE programs aimed at middle- and upper-class nationals. Both in on-site interpretive programs and off-site environmental awareness campaigns, messages about

fragile lands might emphasize how and why protected lands can pay for themselves, and counter the attitude that protection or restrictive management only locks up needed resources (see, for example, Peters et al. 1989). Other important topics include the irreplaceability of some resources (including water, soil, wildlife, and plants), the tangible values of national biodiversity, and how the selfish actions of some people can deprive others of their right to a healthy environment. Especially important is to give this audience (which may have political influence) clear suggestions for where and how to act on its new knowledge.

When feasible, these ideas can be communicated at fragile lands sites through conventional interpretive media (talks, exhibits, signs, or audiovisual programs) or off-site through print and broadcast media. As many have stressed (AED 1989, Muth and Hendee 1980, Rogers and Shoemaker 1971), using the power of mass media can significantly accelerate adoption. The latter might include televised nature programs featuring important fragile land sites; radio and television commercial spots; magazine and newspaper feature stories; highway billboards; comic books; inserts in commercial product containers such as bread, soap, milk, shortening and cereal; and myriad other approaches (Ham 1989b).

Although they are expensive compared to traditional interpretive media, mass media approaches to EE are beginning to appear in developing countries. For example, several television features on fragile lands and environmental issues have been produced recently by conservation NGOs in Honduras (Asociación Hondureña de Ecología) and Ecuador (Fundación Natura). In Colombia, *The Adventures of Professor Yarumo (Las Aventuras del Profesor Yarumo)* reaches a weekly television audience of more than 2 million (Arboleda et al. 1989); and, in India, instructional television is capitalizing on new transmitter technology to take EE into homes throughout the country (Essman 1988).

Unlike subsistence-level audiences, middle- and upper-class audiences may respond more favorably to patriotic or romantic appeals. In some countries, EE campaigns have effectively used charismatic wildlife as mascots (for example, Smokey the Bear in the United States, Púhl the Armadillo in Costa Rica, and Mac the Macaw in Trinidad and Tobago). Experience has shown that linking environmental ideology to a loveable yet knowledgeable animal personality makes it more interesting and acceptable to the lay public. Charismatic humans (such as national sports and entertainment celebrities) can have a similar effect. For example, in Costa Rica, the idea of sponsoring a soccer team with an environmental identity has been discussed.

Clearly, communicating effectively with middle- and upper-class nationals will require financial resources beyond the means of most developing countries. Long-term financing and technical assistance from outside sources will be necessary to launch the campaigns that are needed.

The strategic priority of middle- and upper-class nationals as an EE audience has received comparatively little attention until recently (for example, Barborak and Ham 1989; Ham et al. 1989). Outside of the examples cited above, few serious EE efforts addressing this audience

have been launched in Latin America and the Caribbean — in part, due to their high cost, and, in part, to a preoccupation in some sectors with formal EE. Through its outreach and technical assistance activities, DESFIL is helping to show country governments, NGOs, and foreign assistance organizations why middle- and upper-class nationals are a critical target audience for EE, and it is helping to explore ways to reach this important segment of the population (see Table 11.1). Participants at the DESFIL-sponsored National EE Meeting on Environmental Education in Honduras (AHE 1989) were encouraged to build partnerships with private corporations as a strategy for financing mass media EE campaigns aimed at this audience (see Harn 1989b). And with Peace Corps assistance, this idea is already being implemented by the Government of St. Vincent and Hairoun (a local beer brewing company), which have launched a joint nationwide campaign for the protection of the endangered St. Vincent Parrot. The campaign features "Vincie," a charismatic parrot mascot, who appears on newsletters, billboards, newspapers, and also on bumper stickers advertising Hairoun beer ("One love, one bird, one beer"). Elsewhere in the Caribbean, DESFIL recommendations for St. Kitts' Southeast Peninsula National Park include strong arguments for both on-site interpretive development aimed at Kittian tourists and a series of environmental workshops for local landowners, tour companies, guides services, and other businesses. According to the plan (Brown and Norton 1989), educating local developers and landowners about the values of protected areas, native vegetation, and wildlife is a primary concern. Recommended were a series of presentations which would show the need and rationale for careful, cooperative management. One such presentation is a videotape, "Road to the Future," produced by DESFIL as a part of the St. Kitts project.

4. Influential Groups and Citizens

Influential groups and citizens are a diverse and complex audience for environmental educators, yet possess enormous potential as change agents. As informed recipients of EE, they may serve as convincing spokespersons and powerful activists to advance positive environmental changes.

Influential people occur at all socioeconomic levels of a society, and may be identified within all of the audiences mentioned in previous sections. In a town or local setting, they may be individuals such as village elders, leaders of indigenous groups, priests, or high-profile innovators (such as farmers who are perceived to always be at the forefront of new technology). Alternatively, they may be members (often leaders) of organized groups such as Rotary International, Lions Club, Boy Scouts, housewife groups, and parent associations. At the national level, influential individuals may be military officers, politicians, clergy, members of the print and broadcast media, environmental activists, entertainment and sports celebrities, artists, and writers and leaders of labor organizations and other private institutions.

Rogers and Shoemaker (1971) recommend that change agents such as environmental educators work with influential leaders or groups throughout the social structure so that a given problem can be addressed at many levels. Their research has shown that skeptical individuals are most likely to accept innovations or new ideas from others of the same or slightly elevated social status.

Different groups may exert influence on the environment in various ways. For example, local opinion leaders may use informal communication channels, capitalizing on their position as respected community role models; politicians may use more formal channels to alter legal and political structures; and military and police forces may enforce regulations supporting wise, sustainable use of natural resources. Indeed, military organizations may represent a strategic audience for EE since they often possess enormous de facto power within governments, making them (like politicians) potentially key architects of environmental policy, and because there are obvious links between national security and a sustainable natural resource base. As McNeely et al. (1990:131) argued:

> In most parts of the world the defense services are a dominant force politically, socially and economically. While their primary task is to defend the nation's political viability, the defense services are increasingly coming to recognize that political, economic and ecological viability are closely interrelated. Yet they have seldom been systematically approached to provide their support for positive action in conservation of biological resources.

EE directed at influential groups and citizens typically takes the form of organized, nonformal workshops and leadership seminars presented by NGOs, international donor agencies, or government groups. These people also receive information through the print or broadcast media that are available to them given their physical location and socioeconomic position.

Many DESFIL activities have addressed the need for targeting influential citizens with EE programs (see Table 11.1). In conjunction with Ecuador's Forest Service, DESFIL organized a series of seven "Conservation and Development" workshops held near Ecuadorian protected areas. Participants included influential spokespersons from many socioeconomic levels (such as small farmers, land owners, developers, leaders of indigenous groups, and village representatives). The workshops helped to foster an understanding among the participants that their future was linked to resource conservation on fragile lands, and also stressed the value of protected areas. As a result, a majority of the participants expressed willingness to commit to local conservation actions. This important outcome reflects at least the short-term success of DESFIL's strategy to accelerate adoption by targeting a visible and locally respected audience for the initial EE program. At the conclusion of the workshops, a synthesis of results was presented in a special seminar to national top-level decision makers from public and private institutions (like government ministers, chiefs of the state petroleum company and agricultural credit bank, and NGO presidents). Based on this conference, delegates drafted the "Río Napo Declaration" to the President of Ecuador, calling on him for personal leadership and direction

in a national conservation effort (Dickinson 1990, Kernan and Ramos 1990). Elsewhere in Ecuador, DESFIL prepared the Land Management Plan for Ecuador's Gran Sumaco. The plan emphasizes the need to raise the environmental awareness of local residents through education programs aimed initially at leaders of federations of indigenous peoples (Hanrahan 1990, Hanrahan and Pereira 1990).

The Southeast Peninsula Project on St. Kitts has initiated several awareness-building activities for influential audiences (see Russo 1989, Walters 1989). Project-sponsored field trips to nearby islands for members of the local Land Development and Planning Board showed them the results of environmentally insensitive development. EE presentations on St. Kitts have been given at town hall meetings, to the Chamber of Industry and Commerce, Rotary Club, and at additional EE workshops targeting landowners and developers. In addition, the project's SKNED newsletter was specifically designed to reach local influential audiences.

In Honduras, the DESFIL-coordinated Environmental Profile stressed that national EE projects should include the involvement and education of the military "so that they will support actions being carried out by other institutions involved with the conservation of natural resources" (Daugherty, ed 1990:303). In addition, discussions at the DESFIL-sponsored EE Planning Conference included references to the military, government, and church organizations as strategic audiences for EE efforts.

5. Foreign Tourists

Although they are not directly involved in the daily decisions affecting fragile lands, foreign tourists may be a strategic audience for EE programs, whether they be on-site interpretive efforts, guide services, or tourism promotional materials. Ecotourists are emerging as an important international market segment with considerable revenue-generating potential (see Lindberg 1991, Budowski 1990, Mudge 1989, Ingram and Durst 1987, Wilson and Laarman 1987). For example, between 1986 and 1988, twice as many foreigners visited Costa Rican national parks as nationals, and tourism overall accounted for 13 percent of Costa Rica's foreign income — ranking third as a foreign exchange generator behind coffee and bananas (Budowski 1990). Similarly, a DESFIL-sponsored analysis of the fiscal impact of tourism development on St. Kitts' Southeast Peninsula concluded that "government revenues generated from development will far exceed government expenditures" (Foster 1989:ii). Although their impacts must be carefully managed, foreign tourists represent a potentially crucial source of exchange for some developing countries.

Because foreign tourists like to receive information about the places they visit, EE must be seen as part of the service they pay for, and which they expect. Simply put, EE constitutes the intellectual part of the experience tourists seek. Interesting information presented in an entertaining way adds to the quality of the experience, creates satisfied customers, and gives the tourism entrepreneur an important competitive edge against other companies (Mudge 1989, Ham 1985).

EE for foreign tourists can lead to at least three desirable outcomes. First, by enhancing visitor experiences it can help foster conservation of natural features. The revenue foreign tourists generate helps to support small and large businesses whose livelihood, in turn, depends on the protection of the natural features that attract the tourists. Such businesses include rental shops (for horses, bicycles, boats, snorkeling equipment, surf boards, cars, and so forth), local artisan cooperatives, souvenir shops, restaurants, snack bars, gasoline stations, small- and large-scale lodging establishments, clothing stores, guide services, travel agencies, and others (Jackson 1989, Budowski 1990). For such businesses, protecting the natural quality of local attractions will be a high priority as long as tourists continue to come to see them. As Budowski (1990:29) observed in Costa Rica:

> It is interesting to note how some businessmen have understood that their enterprises depend directly on the natural resources surrounding their property. In many instances they have stopped cutting down the forest which attracts the ecotourists. They have also invested in lands bordering their properties so as to maintain the natural forest. . . . These nature-oriented businesses actively participate in research and conservation projects.

Second, nationals who notice increasing numbers of foreign nature seekers in their country may be stimulated to explore it themselves (Budowski 1990). And third, foreign tourists may return to their own countries as valuable spokespersons for the conservation of fragile lands and sustainable development (Budowski 1990, Ham et al. 1989).

In Latin America and the Caribbean, foreign tourists may encounter a model of protected area management that is fundamentally different from the one they are used to. Farming, fuelwood collecting, tree cutting, and permanent human settlements around and within the boundaries of a protected area may seem inappropriate to the conservation-minded tourist accustomed to a more restrictive model of natural area management. Although different models more akin to those in Latin America and the Caribbean are being tried in the United States (Wright 1984, Shelton 1989), most nonspecialists may need careful explanations of the rationale and values of permitting sustainable human development within or adjacent to protected areas. Multilingual exhibits or brochures with titles like "Logging in the Park?" or "How Farmers Help the Reserve" could help diffuse the surprise or even outrage that some foreign tourists might feel upon encountering such activities. With raised consciousness about different models of conservation and the concept of sustainable development, some tourists might return to their home countries with even more resolve and better information to seek solutions to international conservation problems. Similarly, interpretive materials developed for middle- and upper-class nationals could be translated, if needed, and adapted for foreign tourists as well (Ham et al. 1989).

Past DESFIL activities have not generally emphasized strategies for reaching this audience. One exception is the Southeast Peninsula Project on St. Kitts. Recognizing the importance of EE as a service for foreign nature tourists, the Parks and Recreation Development Plan suggests offering natural and political history tours and brochures to inform visitors about the value of the natural resources of the Southeast Peninsula (Brown and Norton 1989, Wilcox 1989).

6. World Audiences

As the ideal of sustainable development becomes the yardstick by which humankind measures it progress and charts its course, we will need increasing amounts of information regarding the successes and failures of development approaches (Reid et al. 1988). This track record and related information on fragile lands management will be of interest not only to professional and scientific audiences, but also to lay people. Likewise, it will be useful in fueling professional debate and stimulating research, exposing valuable projects in need of funding, disseminating workable development models to other areas, and encouraging people to visit protected areas, demonstration sites, and other fragile lands in Latin America and the Caribbean. By popularizing the concept of sustainable development, EE may make its longest-term contribution to global conservation.

Methods and media appropriate for this diverse audience include (1) scientific and semitechnical project reports; (2) presentations at national and international symposia; (3) articles in multilingual magazines such as *Américas* published by the Organization of American States; (4) NGO bulletins and newsletters such as *Connect*, which is published in several languages by the U.N.'s Environment Program (UNEP) and Educational, Scientific and Cultural Organization (UNESCO); (5) English and non-English scientific journals; and (6) articles in semipopular publications such as Costa Rica's *Biocenosis*. In addition, especially interesting projects can be brought to the attention of national and international news media.

Environmental educators, themselves, are an important international audience. Often, nationals who are in a position to launch formal or nonformal EE efforts are reluctant to do so because they lack experience, funds, and access to appropriate models and materials (for example, see Daugherty, ed 1990; Ham and Castillo 1988; Ham and Enriquez 1986). The creation of regional information clearing houses could expedite the collection and much-needed exchange of ideas and state-of-the-art information on EE and fragile lands. They could house both published and unpublished works, directories of institutions, sources of technical assistance in EE and fragile lands management and planning, audiovisual programs, teachers' guides, examples of management plans, project reports, and biological inventories and databases on regional fragile lands and protected areas.

Finally, regional and national conferences (such as the DESFIL-sponsored EE planning conference in Honduras) and traveling exhibitions such as the Smithsonian Institution's "Tropical Rain Forest: A Disappearing Treasure" (a Spanish version of which is now in circulation)

represent additional strategies for attracting regional and worldwide attention to sustainable development and fragile lands issues.

Sharing what it is learning has been a DESFIL priority. The project has gradually built up a rich literature based on its experience, and has developed numerous channels for disseminating its work to international audiences (see Table 11.1). Through the quarterly *DESFIL Newsletter*, readers are kept informed of the status of DESFIL's current and future activities, issues in sustainable development related to fragile lands, and new books and other publications. Since its inception, DESFIL has published more than 30 reports and has either sponsored or participated in several conferences and symposia (for example, the Conference on Sustainable Uses for Steep Slopes held in Ecuador; the Second International Symposium on Conservation and Development held in the Dominican Republic; the International Symposium on Agroforestry Planning held in Fullman, Washington; and the Humid Tropical Lowlands Conference held in the Republic of Panama). Numerous DESFIL publications are available in Spanish, English, or both, greatly facilitating dissemination of DESFIL's accumulated knowledge, and accelerating its application.

EVALUATION AND ASSESSMENT

As earlier discussed, evaluation of environmental awareness programs is difficult because the long-term impacts they are designed to produce (that is, their intended generational effects) usually do not materialize until well after most development projects have ended. Typically, this means that assessment of program impacts have to be inferred from short-term evaluations using proxy indicators of desired long-term results. For example, the short-term evaluation of an extension program designed to promote sustainable aquaculture practices in a rural community might use indicators such as amount of money spent on the extension effort, number of workshops held, number of people from the target audience trained, number of fish ponds actually constructed, and the average survival rate of fish. In a program aimed at sustainable development, use of such indicators involves the implicit assumption that they are indicative of long-term, sustainable impacts. Whether this assumption is valid, of course, is a different question — one whose answer requires long-term monitoring.

As previously suggested, educational targeting of key audiences can accelerate the generational effects of public awareness programs. Consequently, whether these audiences are being reached may be an important short-term criterion for evaluating EE efforts. Using this criterion, DESFIL's efforts in EE appear commendable (see Table 11.1). DESFIL programs have either reached or helped lay the groundwork for reaching all of the seven key audiences. In addition, although DESFIL activities have contributed both to formal and nonformal EE programs, its relative emphasis on the latter is noteworthy given the previously cited overemphasis on formal, school-based EE.

This assessment is based on two assumptions. First, it is assumed that the seven audiences are equally important to achieving long-term impacts on public environmental awareness. Second, it is assumed that no single project, such as DESFIL, can be expected to cover all audiences well. In fact, it probably makes more sense that different projects specialize somewhat. In so doing, they might learn more about appropriate EE methodologies from intensive efforts with a limited number of audiences than they would by giving comparatively superficial attention to a wider range of audiences. A more realistic evaluation of EE programs in Latin America and the Caribbean would look beyond the efforts of a single project or donor agency, and attempt a more comprehensive view of what the several projects and agencies are doing in each country. Such an analysis would provide much-needed direction to foreign assistance agencies that wish to know real EE priorities so that they can wisely allocate limited resources and money to needed programs.

RECOMMENDATIONS FOR FUTURE ACTION

Development planners, policy makers, national governments, and donor agencies have an opportunity to build on previous accomplishments in EE and to capitalize on what has been learned. Based on the preceding discussion, it is recommended that the relative emphasis on nonformal programs be enhanced in projects and programs designed to address the issues of fragile lands management. Formal EE activities should not necessarily be excluded (especially where school programs are envisioned to augment fragile lands management directly), but for reasons previously outlined, a systematic focus on audiences outside of the formal education system could have more immediate impact on the environmental awareness of strategic population segments. Possibly most important among these audiences are (1) influential groups such as military, clergy, and government leaders; (2) subsistence-level audiences; and (3) visitors to parks, forests, zoos and museums (an audience that comprises middle- and upper-class nationals and, in some countries, foreign tourists).

Programs for influential groups might include specially designed seminars in which key environmental issues are presented in lay terms, and each group's relationship to these issues is analyzed. These seminars, held separately for military, church, and government audiences, could then be followed by a series of meetings in which strategies for each organization's response to the issues could be discussed.

For many environmentally oriented projects, including DESFIL, emphasis on extension and outreach for subsistence-level audiences could be expanded in at least two ways. First, short-term training courses in interpretive methods and applied communication could be offered for extensionists. Such courses should stress basic communication skills and practical, inexpensive media that extension workers can learn quickly and use immediately in their work. CTTA, an AID/S&T/RD centrally funded project implemented by AED, has applied these methods in Honduras and Ecuador with considerable success. Second, extensive use of radio programs to reach rural families should be explored. Centrally produced and locally customized

programs such as the following might be developed: multiepisode dramas featuring *campesino* characters, talk shows that include interviews with local farmers, music programs with environmental interludes, radio field trips in which a roving reporter visits farmers in the field and discusses their problems and successes, and regular commercial spots and short features on topics related to fragile lands. Testimonials or other use of spokespersons from influential groups might also be incorporated in such programs. As a beginning, one or two pilot communities in two or three different countries might be selected to field test a modest radio campaign of this type. The initial step would involve meeting and obtaining the support of local station managers, and exploring the logistical and programming needs such a campaign would have. Early consultation with organizations with experience in such programs (for example, the FAO in Perú and the Academy for Educational Development in Washington, D.C.) is highly recommended.

Visitors to protected areas, zoos, and museums can be contacted through on-site interpretive programs, as well as through the mass media. Resident staff at fragile land sites (as well as private sector tour guides) would greatly benefit from interpretive training. Techniques for greeting and guiding visitors, preparing low-cost exhibits and information centers, constructing self-guided trails, and presenting talks and tour narrations would be the topics emphasized in such training. Technical assistance for small-scale interpretive developments at selected protected areas might be considered, as might centrally produced and locally customized features for urban print and broadcast media.

DESFIL (or a similarly oriented project) should consider taking a lead role in developing the first repository of EE materials and information discussed earlier in this chapter. Working in concert with a permanent institution (such as a university, NGO, or consortium), efforts could be made to design, develop, and locate stable funding for the continued operation of such a clearinghouse. Complete collections of DESFIL reports and other publications could make an important contribution to these repositories.

DESFIL and similar projects could share what they are learning with an even wider audience by encouraging project staff to publish their work in academic and semipopular journals, in nonproject newsletters that reach a wide audience, and by developing, when feasible, multilingual audiovisual programs, exhibits, and printed materials for nontechnical audiences. Besides disseminating valuable information to a wider audience, such efforts would accelerate project learning processes through a much expanded system of communication and feedback. In the case of refereed journal articles, peer reviews would foster continued technical improvement, and accepted publications would bolster project credibility both within the scientific community and among donor organizations.

Attracting the interest of news media in its projects is another way that fragile lands projects could broaden their communication with world audiences. For example, the Conservation Development Workshop in Ecuador received first-page newspaper coverage (Dickinson 1990). DESFIL, specifically, might actively explore opportunities to lend its

considerable technical expertise to outside groups that produce magazines and mass media programs related to fragile lands in Latin America or the Caribbean.

With growing recognition of EE's role in development projects worldwide, DESFIL's experience in EE training, national planning, and program implementation may offer a significant resource to other projects for years to come. Well-formulated programs of EE addressed to key audiences can positively influence fragile lands management across a broad, interrelated spectrum of activities from policy and planning to technology transfer, income generation, institutional strengthening, local stewardship of resources, and tourism development.

ENDNOTES

1. AED has developed substantive evaluation procedures for the EE aspects of A.I.D.'s Communication for Technology Transfer in Agriculture Project (CTTA), which purportedly provide immediate feedback. However, such feedback provides indicators only of current results. It is not a means of determining or even reliably predicting long-term results, that is, the staying power of EE.

2. The litter example is intended to illustrate the time frame involved in achieving ideological and behavioral changes with regard to environmental problems. It is certainly true that, if behavioral change is accompanied by economic cost, the desired changes will likely be more difficult to achieve and may require a time frame greater than three generations. Because the EE focus on fragile lands problems in Latin America and the Caribbean only began in the 1980s, there are not yet any fragile lands examples.

3. This typology of adopters crosscuts the typology of six key audiences presented in the next section. Theoretically, each type of adopter may be found in each type of audience.

4. There is no intent to imply that the six audiences are always mutually exclusive. Indeed, it is quite possible for an individual to belong to more than one in the same way that any person belongs to many different social categories (or "market segments" as they are called by consumer scientists). The fact that an individual is included in more than one audience simply means that she/he will be targeted by more than one communication strategy.

5. However, they will not necessarily have any significant influence over the behavior of subsistence farmers. On the contrary, in many parts of Latin America an antagonistic relationship exists between these two groups.

REFERENCES CITED

Academy for Educational Development (AED)
1989 "Education for Social Development." *Academy News* 12(2):1-3,5-7. Washington, D.C.: Academy for Educational Development.

Academy for Educational Development (AED)
1990 "Nepal: Teachers Receive Training by Radio." *Academy News* 13(1):7. Washington, D.C.: Academy for Educational Development.

Asociación Hondureña de Ecología (AHE)
1989 Memoria del Primer Encuentro Nacional sobre Educación Ambiental, Tela, Atlántida, Honduras, 27 agosto - 1 septiembre. Tegucigalpa, D.C., Honduras: Asociación Hondureña de Ecología.

Arboleda, J., J. Orejuela, E. Murgueitio, and D. Glick, eds.
1989 Memorias del Taller sobre Areas Silvestres y Necesidades Humanas. Cali, Colombia: Fundación para la Educación Superior.

Bajimaya, S. and J. R. Fazio
1989 Communications Manual: A Guide to Aid Park and Protected Area Managers to Communicate Effectively with Local Residents. Kathmandu, Nepal: Department of National Parks and Wildlife Conservation/FAO-UNDP.

Barborak, J. R. and S. H. Ham
1989 Central American Regional Environmental and Natural Resource Management Project: Environmental Awareness, Protected Areas and Biodiversity Component. Gainesville, Fla.: Tropical Research and Development, Inc.

Biesanz, R., K. Z. Biesanz, and M. H. Biesanz
1987 The Costa Ricans. Englewood Cliffs, N.J.: Prentice Hall.

Brown, M. T. and R. Norton
1989 Terrestrial Park and Recreation Plan for the Southeast Peninsula of St. Kitts/Nevis. In, The Southeast Peninsula Project in St. Kitts: Volume III — Parks and Recreation Plans. DESFIL Technical Report. Bethesda, Md.: Development Alternatives, Inc.

Budowski, T.
1990 Ecotourism. *Tecnitur* 5(27):28-30. San José, Costa Rica.

Bunch, R.
1982 *Two Ears of Corn: A Guide to People-Centered Agricultural Improvement.* Oklahoma City: World Neighbors.

Daugherty, H. E., ed.
1990 *Perfil Ambiental de Honduras 1989.* Secretaria de Planificación, Coordinación y Presupuesto de Honduras, DESFIL, and USAID. Washington, D.C.: Development Alternatives, Inc.

Dembner, S. A.
1986 Developing Social Forestry in Perú. Forestry Project Profile 1:1. Rome: U.N./FAO.

DESFIL
1988a DESFIL Progress Report for July-December 1988. Washington, D.C.: Development Alternatives, Inc.

DESFIL
1988b DESFIL Workplan for Fiscal 1989. Washington, D.C.: Development Alternatives, Inc.

Dickinson, J.C.
1990 Conservation and Development. DESFIL Newsletter 3(4):1,6.

Dickinson, J. C., M. Painter, M. Erlich, E. C. French, and J. Oosterkamp
1988 The Associated High Valleys Project in Cochabamba, Bolivia. DESFIL Technical Report. Bethesda, Md.: Development Alternatives, Inc.

Dodd, R. E.
1987 Mass Communication Campaigns for Environmental Education in Developing Countries: Honduras Case Study. San Jose, Calif.: Masters thesis, Department of Journalism and Mass Communication, San Jose State University.

Essman, J.
1988 First Year Efforts Set Stage for TV Production. CEETV Year One Report 1(1):1-2. Syracuse, N.Y.: College of Environmental Sciences, State University of New York.

Fernandez, L.
1989 Private Conservation Groups on the Rise in Latin America and the Caribbean. World Wildlife Fund Letter 1:1-8.

Foster, R. D.
1989 The Potential Fiscal Impact from Southeast Peninsula Development 1989-1994. DESFIL Technical Report. Bethesda, Md.: Development Alternatives, Inc.

Galeano, E.
1973 *Open Veins of Latin America: Five Centuries of the Pillage of a Continent.* New York: Monthly Review Press.

Geller, E. S., R. A. Winett, and P. B. Everett
1982 *Preserving the Environment: New Strategies for Behavior Change.* Permagon General Psychology Series. New York: Permagon Press.

Gonzalez, E., F. Paredes, J.J. Lopez and J. C. Cruz
1989 Memoria del Primer Seminario Centroamericano sobre Universidad y Medio Ambiente. San José, Costa Rica: Universidad Nacional, Facultad de Ciencias Exactas y Naturales.

Gow, D.
1989 Agroforestry in Haiti. DESFIL Newsletter 3(1):3,5-6.

Gross, D. M. and S. Scott
1990 Proceeding with Caution. Time 136(3):56-62 (July 16).

Ham, S. H.
1985 Interpretation Aboard the North Star — The Role of Information Services in Enhancing the Experiences of Cruise Ship Passengers. Seattle, Wash.: Exploration Cruise Lines, Inc.

Ham, S. H.
1989a Problems in Transferring U.S. Environmental Education Models to Developing Countries — A Case Study from Honduras. In, Research Proceedings, National Association for Interpretation Workshop, St. Paul, Minn., November 5-10.

Ham, S. H.
1989b Reflexiones sobre la Educación Ambiental en Honduras y Recomendaciones para su Desarrollo. In, Memoria del Primer Encuentro Nacional sobre Educación Ambiental, Tela, Atlántida, Honduras, August 27-September 1, pp. 13-23.

Ham, S. H.
1990a Obstáculos para la Educación Ambiental. In, Memoria del Tercer Taller sobre Educación Ambiental, La Estación Biológica La Selva, Costa Rica, March 9-11. San José, Costa Rica: Organization for Tropical Studies.

Ham, S. H.
1990b Taller de Interpretación y Educación Ambiental: Informe Final. Tegucigalpa, D.C., Honduras: U.S. Agency for International Development, Office of Agriculture and Natural Resources.

Ham, S. H. and L. Castillo
1988 Análisis de la Situación de las Educación Ambiental en las Escuelas del Area Rural de Honduras. Moscow, ID: Idaho Forest, Wildlife and Range Experiment Station, College of Forestry, Wildlife and Range Sciences, University of Idaho, Publication No. 441.

Ham, S. H. and L. Castillo
1990 Elementary Schools in Rural Honduras: Problems in Transferring U.S. Environmental Education Models. *Journal of Environmental Education* 21(4):27-36.

Ham, S. H. and J. R. Enriquez
1986 Observaciones y Recomendaciones para Planificación, Programación y Entrenamiento Interpretativos en los Parques Nacionales y Areas Equivalentes del Ecuador. Moscow, ID: Idaho Forest, Wildlife and Range Experiment Station, College of Forestry, Wildlife and Range Sciences, University of Idaho, Publication No. 310.

Ham, S. H. and D. S. Sewing
1988 Barriers to Environmental Education. *Journal of Environmental Education* 19(2):17-24.

Ham, S. H., D. S. Sutherland and J. R. Barborak
1989 Role of Protected Areas in Environmental Education in Central America. *Journal of Interpretation* 13(5):1-7.

Hammond, A. L., ed.
1990 *World Resources: A Guide to the Global Environment*. New York: Oxford University Press.

Hanrahan, M.
1989 Management of Natural Resources in Central America. DESFIL Newsletter 3(1):7.

Hanrahan, M.
1990 Land Use Management in Ecuador. DESFIL Newsletter 3(4):3,5.

Hanrahan, M. and J. Pereira
1990 Manejo de la Zona del Gran Sumaco, Provincia del Napo, Ecuador. DESFIL Technical Report. Bethesda, Md.: Development Alternatives, Inc.

Hypki, C. and M. MacKenzie
1987 The Potential Role of Environmental Education in Central America: Confronting the Realities of the Region. Ann Arbor, MI: Masters thesis, Department of Natural Resources, University of Michigan.

Ingram, C. D. and P. B. Durst
1987 Nature-Oriented Travel to Developing Countries. Research Triangle Park, N.C.: Southeastern Center for Forest Economics Research, Forestry Private Enterprise Initiative, FPEI Working Paper No. 28.

Jackson, I. L.
1989 Conditions and Trends in Caribbean Tourism Influencing the Development of the Southeast Peninsula. DESFIL Technical Report. Bethesda, Md.: Development Alternatives, Inc.

Jones, L.
1989 Project Offers Campesinos Alternatives. San José, Costa Rica: The Tico Times 33(1024):10 (July 14).

Kakabadse, Y.
1988 "Ecuador: The Promise and Problems of Wilderness in the Third World." In V. Martin, ed., *For the Conservation of Earth: Proceedings of the Fourth World Wilderness Congress*. Golden, Colo.: Fulcrum Press, pp. 180-182.

Keep America Beautiful, Inc.
1970 Fact Sheet: Litter is a National Disgrace. New York: Author Press.

Kernan, B. and H. H. Ramos
1990 Informe Final de los Talleres y la Conferencia sobre Conservación y Desarrollo. DESFIL Mission Report. Bethesda, Md.: Development Alternatives, Inc.

Lindberg, K.
1991 *Policies for Maximizing Native Tourism's Ecological and Economic Benefits.* International Conservation Financing Project. Washington, D.C.: World Resources Institute.

McNeely, J. A., K. R. Miller, W. V. Reid, R. A. Mittermeier, and T. B. Werner
1990 Conserving the World's Biological Diversity. Gland, Switzerland: International Union for the Conservation of Nature and Natural Resources; and Washington, D.C.: World Resources Institute, Conservation International, World Wildlife Fund-US, and the World Bank.

Medina, G.
1989 Campesinos and Conservation: Joining Forces Through Environmental Education. Washington, D.C.: World Wildlife Fund.

Ministerio de Educación Pública (Honduras)
1989 La Filosofía Emergente de la Educación Ambiental. In, Asociación Hondureña de Ecología, Lecturas Seleccionadas Sobre Educación Ambiental — Primer Encuentro Sobre Educación Ambiental, Tela, Atlántida, 27 de agosto, 1989. Tegucigalpa, D.C., Honduras: Asociación Hondureña de Ecología.

Mudge, S.
1989 Recommendations of the USAID/FEPROTUR Nature Tourism Working Group. Quito, Ecuador: U.S. Agency for International Development, Natural Resources.

Muñoz, M. G. and B. Peña
1990 Selección y Utilización de Ayudas Educativas. Tegucigalpa, D.C., Honduras: Secretaria de Recursos Naturales, Departamento de Comunicación Agropecuaria.

Muth, R. M. and J. C. Hendee
1980 "Technology Transfer and Human Behavior." *Journal of Forestry* (March):141-144.

Nash, R. F.
1988 "Why Wilderness?" In V. Martin, ed., *For the Conservation of Earth: Proceedings of the Fourth World Wilderness Congress*. Golden, Colo.: Fulcrum Press, pp. 194-201.

Nations, J. H. and H. J. Leonard
1986 Grounds of Conflict in Central America. In A. Maguire and J.W. Brown, eds., *Bordering On Trouble: Resources and Politics in Latin America*. Bethesda, Md.: Adler and Adler, Inc., pp. 55-98.

Peters, C. M., A. H. Gentry, and R. O. Mendelsohn
1989 Valuation of an Amazonian Rainforest. *Nature* 339(6227):655-656.

Reid, W. V., J. N. Barnes, and B. Blackwelder
1988 Bankrolling Success: A Portfolio of Sustainable Development Projects. Washington, D.C.: Environmental Policy Institute and National Wildlife Federation.

Rogers, E. M. and F. F. Shoemaker
1971 *Communication of Innovations: A Cross-Cultural Approach.* New York: The Free Press.

Russo, S.
1989 St. Kitts Project Successfully Completed. DESFIL Newsletter 3(3):1,6.

Shelton, N.
1989 MAB Notes. *Park Science* 9(4):14.

Sligar, D. L.
1974 A Communications Approach to Litter Control. Pullman, Wash.: Masters thesis, Washington State University, Department of Forestry and Range Management.

Sutherland, D. S.
1991 Child-To-Parent Transmission of Environmental Ideology in Costa Rican Families. Moscow, Idaho: Masters thesis, Department of Resource Recreation and Tourism, University of Idaho.

Tanner, R. T.
1974 "Conceptual and Instructional Issues in Environmental Education." *Journal of Environmental Education* 5(4):48-53.

UNESCO-UNEP
1982 "World Survey on EE Trends, Needs and Priorities." *Connect* 7(3):3-7.

UNESCO-UNEP
1988 "EE Field Reports: Subregional EE Training Seminar for the Caribbean." *Connect* 8(2):1-2.

UNESCO-UNEP
1989 "Developing an Environmental Education Curriculum." *Connect* 14(3):1-2.

UNESCO-UNEP
1990 "Environmentally Educated Teachers: The Priority of Priorities?" *Connect* 15(1):1-3.

Valencia, I.
1990 Managing the Honduran Environment. DESFIL Newsletter 3(4):4,6-7.

Walters, R.
1989 Environmental Education in St. Kitts. DESFIL Newsletter 3(2):1,6.

Werner, D.
1980 *Donde No Hay Doctor*. Palo Alto, CA: Hesperian Foundation.

Werner, D. and B. Bower
1982 *Helping Health Workers Learn*. Palo Alto, Calif.: Hesperian Foundation.

Wilcox, E. S.
1989 Marine Park and Recreation Plan for the Southeast Peninsula of St. Kitts/Nevis. In, The Southeast Peninsula Project in St. Kitts: Volume III — Parks and Recreation Plans. DESFIL Technical Report. Bethesda, Md.: Development Alternatives, Inc.

Wilson, M. A. and J. G. Laarman
1987 Nature Tourism and Enterprise Development in Ecuador. Research Triangle Park, NC: Southeastern Center for Forest Economics Research, Forestry Private Enterprise Initiative, FPEI Working Paper No. 27.

Wood, D. S. and D. W. Wood
1987 How to Plan a Conservation Education Program. Washington, D.C.: International Institute for Environment and Development/U.S. Fish and Wildlife Service, Office of International Affairs.

Wright, R. G.
1984 "The Challenges for Interpretation in the New Alaskan Parks." *Journal of Interpretation* 9(1):39-46.

CHAPTER TWELVE

LOOKING TO THE FUTURE:

FRAGILE LANDS MANAGEMENT IN THE 1990s AND BEYOND

by

Philip D. Young

In this final chapter we draw some conclusions based on the discussions in the preceding chapters. We then recommend what we believe would be the most effective foci for continuing efforts toward sustainable management of fragile lands and we suggest useful methodologies for the implementation of fragile lands interventions.

SUMMARY OF THE FRAGILE LANDS PROBLEM IN LATIN AMERICA

The 1980s have been described as a period of economic stagnation in Latin America (WRI 1990). It has not been a period of stagnation, however, with respect to natural resources. Resources during the decade, especially the soils of steeplands and the lowland forests and all they contain, were being depleted at an alarming rate. Two major factors account for most of this resource depletion: internal pressures from the poor and the landless, and the need of governments for greater export earnings to service mounting external debt. Both have led to increasing use — more accurately, misuse — of the more marginal, fragile lands of the region, particularly the steep slopes of Central America and the Andes, and the tropical lowlands. The increase in exploitation of fragile lands actually began in the 1950s as governments sought to avoid addressing problems of inequity by encouraging colonization of thinly populated areas (which were sometimes referred to as "empty lands"). The late 1970s and early 1980s witnessed an acceleration of the process. The result is what we have termed the fragile lands problem: unsustainable uses resulting in depletion of resources, including tropical forests, the impressive biodiversity they support, and the very soil itself on steep slopes. Continued mismanagement may result in irreversible damage; in some cases, the damage is already so extensive (for example, parts of the central provinces of Panama, particularly Veraguas and Los Santos, and parts of the Amazon basin) that recovery will take decades if, in fact, recovery is possible within a time span meaningful to humans.

Previous Page Blank

A disturbing aspect of the fragile lands problem in Latin America is that much of the current degradation might have been avoided through a combination of political will, policy reforms, more equitable distribution of resources, and appropriate application of existing knowledge and technologies. This is not to downgrade the complexity of the problem; it is to point out that much of Latin America is characterized by a lack of political will, policies that encourage the depletion rather than the conservation of resources, the least equitable distribution of arable land in the world, a shortage of well-trained scientists and technicians (the knowledge gap), and frequent use of inappropriate agricultural production technologies either out of ignorance (the poor colonists) or greed (the wealthy).

As the degradation of fragile lands in Latin America became increasingly evident and acute in the early 1980s, A.I.D. looked for effective ways to address the problem. The DESFIL project, a cooperative endeavor between the Bureaus of Science and Technology and Latin America and the Caribbean, was designed as a major effort to address the fragile lands problem on steep slopes and in humid tropical lowlands, and to seek solutions. DESFIL was charged with pursuing solutions in two ways:

(1) By assisting USAID missions in the assessment of site- and country-specific factors contributing to the problem and helping to design, implement, or evaluate interventions intended to alleviate the problem and lead in the direction of sustainable use of fragile lands; and

(2) By conducting synthesis research to assess relevant existing knowledge in several disciplines, and the effectiveness of its application in particular cases.

These two ways of seeking solutions have been pursued as a coordinated effort. The current study has been based both on the field project experiences and the research activities of DESFIL staff and associates.

Over the five-year course of Phase I of the DESFIL project, the focus has been on the steeplands and lowlands of Latin America. As noted in Chapter One, the majority of Latin America's fragile lands are made up of steep slopes and humid tropical lowlands. During the 1970s and 1980s, these two zones have been subjected to ever-increasing exploitation pressures from the poor and landless on the one hand, and governments, the wealthy, and corporations on the other.

The fragile lands problem is created and driven by a multitude of interrelated variables that include (but are not limited to) population increase, poverty, inequitable distribution of land, inadequate tenure security, policy failures, market failures, and use of inappropriate technologies (see Chapter One). To seek a root cause — a variation of the ever-popular "keep it simple" approach — and to base programs and projects seeking to achieve sustainable use of fragile lands on such an approach is to deny the real complexity of the problem and unnecessarily handicap the development process. The assumption that poverty is caused by insufficient economic

growth (see Chapter Two) is one example of root-cause thinking. The results of development interventions based on this premise are not encouraging. Poverty is one of many causes (and may also be an effect) of misuse of fragile lands. Solutions to the fragile lands problem are much more likely to be found in an integrated, multifaceted approach. Such an approach can be based on a dynamic systems model that incorporates assumptions of limited growth, stewardship, and adaptability in the face of uncertainty (see Chapter Two).

SUMMARY OF CONCLUSIONS OF THIS REPORT

In this study, the factors we have examined most carefully that bear upon the fragile lands problem are technology, institutions, local stewardship of resources, the economics of resource use, incentives, planning and policy, natural forest management, and the role of environmental assessments and environmental education. A chapter has been devoted to each. Here we present what we believe to be the essence of the conclusions of each chapter.

Technology

Wilken views technology not just as tools, materials, and procedures but also as including information and experience. He argues that technologies per se are neither appropriate nor inappropriate; rather, what is appropriate, efficient, or feasible depends on site-specific contexts and conditions that include a multitude of biophysical, sociocultural, and economic variables.[1] Because of the number of variables involved in choosing an appropriate technology for sustainable management of any particular fragile lands site, Wilken argues for the development of a systematic procedure of technology assessment. Such a procedure would ideally seek the objective of sustainable production through the optimization of three interrelated dimensions: ecological soundness, economic viability, and sociocultural acceptability. The task is to match site-specific problems with solutions that meet these three criteria. Wilken argues that what is needed is an analytic framework and inventory of technologies and conditions to develop best-fit solutions for specific situations. He advocates the application of decision-tree analytic methods to inventories to accomplish this, and suggests what the content of the inventories would look like. Although the task of data entry would be time-consuming, modern computer hardware and software make the analytic tasks feasible and provide the ability to manipulate both selection and value of variables within simulation models. The results of such simulations could provide a range of workable solutions for a particular case rather than a single best-fit solution.

In the case of steeplands, the prevailing view is that several viable technologies exist that can be appropriately matched to specific situations (DESFIL 1988, Hanrahan 1988). In the case of humid tropical lowland ecosystems, most technologies are still either in the experimental stage (for example, various natural forest management technologies such as strip clear cutting) and not yet proved to be sustainable over the long term; or are sustainable at the expense of habitats and biodiversity (for example, plantation systems — not necessarily a bad thing, but it is important to be aware of the nature of the trade-offs); or have proved unsustainable even in the short term

(for example, cattle raising in many parts of the Amazon). The only technology that has proved to be ecologically sound over the very long term in the *terra firme* of the Amazon is slash-and-burn agriculture under traditional conditions of very low population density. And some would justifiably argue that this technology is economically viable under modern conditions. These examples are given to illustrate the need for continuing research on potentially viable technologies for the sustainable use of humid tropical lowlands.

It is also worth emphasizing again, as has been noted elsewhere in this volume, that technology alone will not provide solutions to the fragile lands problem. Technology appropriate to the biophysical characteristics of a given situation is necessary but by itself not sufficient. It must also be economically viable and culturally acceptable to the resource users. And, even then, other variables intervene to complicate the issue.

DESFIL experience in Haiti (DESFIL 1990), the Dominican Republic (Hanrahan, et al. 1990), and Jamaica (Koehn, Tai, and LeFranc 1989) demonstrates that there are technologies that are appropriate and acceptable and display great potential for long-term sustainable use of fragile lands while satisfying resource users' needs for short-term gains.

Institutions

Effective fragile lands management requires trade-offs between short- and long-term gains and between local needs and national priorities. McKay focuses on the role of national, regional, and international institutions, both public and private (NGOs), in fragile lands management. In Latin America, the effectiveness of institutions is constrained by lack of long-term continuity and flexibility and of sharp focus on sustainable land use. Effectiveness is further hampered by overlapping jurisdictions, contradictory or inconsistent policies, lack of interinstitutional cooperation, and unmoderated proliferation. Resulting interinstitutional conflict further diminishes management capacities.

These constraints make the need for institutional strengthening a high priority for FLM. DESFIL experience with the Honduran Environmental Program (Daugherty, ed. 1990; Valencia 1989), the St. Kitts Southeast Peninsula project (Brown, ed. 1989; Hanrahan, Russo, and Valencia 1990), the Watershed Management project in Haiti (Pierce 1988), and the Forestry Sector Development project in Ecuador (Orellana, Hanrahan, and Young 1991) all illustrate the need for institutional strengthening as well as varied means and possibilities for achieving it: establishing credibility for new institutions, working with existing institutions, facilitating links, coordination and cooperation among institutions, sharpening domains of responsibility, facilitating the delegation of responsibility when appropriate by promoting the distinction between internal capacity (the ability to do something) and process capacity (the ability to get someone else to do it) (Honadle and VanSant 1985), and fitting the institution to the situation. A final point is that we know relatively little about institutional sustainability itself with reference to the numerous environmentally oriented institutions such as local NGOs that have emerged in response to the new environmental awareness and the availability of donor funding for the

support of fragile lands and natural resource management activities. The short time frame of most projects makes consistent monitoring of the process of institutional development as well as the process of change in established institutions problematic. Yet sustainable FLM requires that we place as much emphasis on the process as on the product of institution building.

Local Stewardship

Putting responsibility for stewardship in the hands of the resource users through community organizations or families and individuals is a form of decentralized control. As such, it is problematic and subject to resistance by state/provincial and national public agencies accustomed to centralized control, as is the case throughout Latin America.[2] Yet, sustainable management of fragile lands cannot be effectively carried out from a distance. A substantial degree of local control is often necessary. Among the benefits of local stewardship are greater livelihood security and stimulation of the process of empowerment leading to greater equity and, in theory, a potential reduction of poverty. Although local stewardship does not guarantee the sustainable management of fragile lands, it does provide the poor with a greater range of options from which to choose and an appropriate incentive for choosing one that leads to sustainable use.

Among the long list of lessons provided by Gow and Young at the end of Chapter Five, two conclusions especially merit highlighting. The first is the critical need for tailoring forms of local resource management to the cultural context. As the example of Haiti (DESFIL 1990; Murray 1979,1983) well illustrates, local farm families rather than local organizations may be the appropriate and certainly expedient vehicle for resource stewardship when no cultural tradition of control of common property by local organizations exists or where such control is viewed with antagonism, as in Haiti. The second, by now common, knowledge is the recognition that management by local organizations (as opposed to individual families or national institutions) may be required for some types of resources such as irrigation systems.

Determining the appropriate form of resource management at the local level should of course be done in consultation with the resource users themselves. This highlights the need for participatory development in FLM and also the need for those, often dreaded, baseline studies, in this instance focussing on the details of local social organization. And here our interest should not be simply in norms but in permissible variations and the circumstances under which they may occur. As agents of change seeking to introduce innovations that will improve FLM, we need to know not only how things are normally done but also what might be acceptable, what might be tolerable, and what is proscribed.

The Economics of Fragile Lands Management

Hanrahan has examined the impact of resource and environmental degradation on economic development and also the costs and benefits associated with the conservation of resources and environmental amenities. He defines economic development as income and its growth, consumer and producer welfare, and equity. Although studies of the economic effects of resource

depletion are still in their infancy, Hanrahan draws conclusions on the basis of available data that are worthy of serious consideration.

Productivity losses associated with resource degradation worsen through time. Resource conservation generally has the opposite effect. Conservation involves the maintenance of quantity and quality through time. This serves to preserve options for future generations, but at a certain cost to those living now. We can manage resources in ways that use them up over short time periods or we can manage them to provide a steady flow of benefits over long time periods. Future generations must live with the consequences of our decisions. Although this is an ethical consideration, there are compelling economic arguments for choosing conservation over rapid resource depletion.

When evidence is available it shows that conservation practices in Latin America have tended to increase the value of production inputs such as land and agricultural labor. Increased revenues and lower production costs generate profits, rents, and production-side surpluses. Very limited demand side estimates of consumer surplus for Latin America point in the same direction. The collection of evidence on consumer valuation should be a high priority in resource economics for the region.

The evidence also suggests that macroeconomic costs over the long term of resource degradation are considerably greater than the costs of mitigative or preventive measures entailed in conservation practices. The macroeconomic costs include major increases in public expenditures for abatement measures, negative trade impacts, lost tourism revenues, and foregone agricultural and forestry output. Furthermore, the effects of resource depletion and environmental degradation persist over very long time periods.

In sum, nondegrading, that is sustainable use of resources is cost-effective. The evidence indicates that sustainable resource use generates economic development and growth while resource destruction does not. We would add to Hanrahan's conclusions that long-term sustainability requires that economic growth be limited to levels that will not exceed the inherent capability of the land. Technological innovations may extend these capabilities in the future as they have in the past; but it would be the wiser course of action to err on the side of caution rather than push whole ecosystems beyond the point where the damage is reversible.

Incentives

Incentives motivate certain behaviors and inhibit others or make them less attractive (disincentives). They may be categorized as policy, economic, and cultural (moral) incentives. Gamman has examined the complex issues surrounding the selection and use of incentives to motivate actions that will lead to the sustainable management of fragile lands and natural resources. He points out that a careful examination of the role of interest groups in the public policy process is essential to the process of designing an appropriate incentive program, and he advocates stakeholder analysis to achieve this. However, he also highlights the difficulties of

conducting such an analysis in countries where political processes are not open and where the relationships among interest groups, unorganized stakeholders, and political leaders may be hidden.

Incentive programs, to be effective, must operate at several levels simultaneously, must be well coordinated to achieve desired results, and should not produce undesired results. This is a tall order and difficult to achieve. What motivates one person to enthusiastically engage in an activity may be precisely what motivates another to uncompromisingly resist the same activity. Environmental, political, economic, and cultural conditions must all be taken into account. Discovering incentives that will motivate the desired behavior requires a particularly deep understanding of the local cultural context and of what is valued and what is not. Gamman points out that the successful use of incentives has occurred largely at the local level. When used at the national level, outcomes of incentive programs vary widely, reflecting greater complexity and the unintended consequences that often result.

Examining cases where incentive programs have worked, Gamman extracts a set of guidelines for the formulation of incentive programs for future projects: coordinate the incentives with national policies to eliminate conflicts, design the incentives to address root problems as locally perceived, target material incentives to meet special needs of project participants, seek a mix of material and nonmaterial incentives, remember that economic incentives work best in a well-functioning market, ensure that desired behaviors are compatible with everyday activities of participants, and realize that long-term effort over many years is required.

Incentives are not, of course, independent of other factors to be considered in fragile lands management, but they are perhaps as basic to successful outcomes as appropriate technologies. Incentives (and disincentives) exist within all development interventions although often they remain unexamined, unanalyzed, and hidden from view. The trick is to make them explicit so that their potential impact on project outcomes may be anticipated. All project designs intended to promote the sustainable management of fragile lands should be carefully scrutinized for hidden structures of incentives and disincentives that may significantly interfere with the achievement of project objectives.

Planning and Policy

Strategic planning is essential to the process of linking general policies to action programs. Hanrahan had argued on the basis of DESFIL experience that six significant issues affect ENR planning and policy:

1. Institutions proliferate, personnel rotate, human and financial resources are scarce, and non-ENR policy interests are abundant. This leads, among other things, to short-range vision in resource allocation and use and conflicting policies.

2. Income growth and equity are generally seen as incompatible with conservation and sustainable use of natural resources.

3. Policy and planning are often divorced from implementation programs. Planning thus has little impact.

4. Beneficiary professionals, institutions, and governments seem unable to develop or implement high impact policies and plans.

5. A balanced range of interests may not be represented in policies and plans or in implementation programs, and the interests of some significant stakeholders may not be represented at all.

6. Environmental impact assessment remains isolated from most policy making and planning.

Focusing on the way the policy and planning process might overcome these issues, Hanrahan argues that, whereas the predominant focus in ENR management is on implementation, DESFIL experience suggests a much greater emphasis on the planning process itself is needed. Using DESFIL case materials from St. Kitts, Honduras, and the ROCAP RENARM design, he shows that iterative, participatory planning can have a significant impact on the efficacy of ENR programs. This is so because participatory planning results in greater awareness of problems associated with nonsustainable use of resources and their relevance to problems of growth and equity. Although the process is far more time-consuming and expensive than externally designed programs, it is also far more likely to result in high impact successful programs because the participant-users have an important stake in implementing the results of their own planning efforts that incorporate their own ideas.

Like other factors affecting fragile lands management, participatory strategic planning will best contribute to successful outcomes not in isolation but as one component of an integrated approach.

Managing Humid Tropical Forests

Dickinson and Putz focus attention on the competing demands for use of forested humid tropical lowlands, which they categorize in general terms as preservation, exploitation, and conversion. The central issue is the potential for sustainability of various systems of forest management. Dickinson and Putz argue, as have other authors in this volume, that sustainable uses will involve seeking some optimum balance among ecological, sociological, and economic dimensions. In combination, these dimensions affect what is feasible and what is sustainable.

Any use of the tropical forest other than as an effectively protected biological reserve will result in changes in forest structure, species composition, growth rates, and overall functioning

of the ecosystem. But we must remember also that, like other ecosystems, tropical forest ecosystems are dynamic changing systems in their "natural" state. Human activity, depending on the level of intensity and frequency, speeds up some processes and may slow down others. Possible uses of the forest range from total protection to total conversion — replacement of the forest ecosystem with something else, such as a tree plantation or pasture.

We still do not understand much about tropical forest ecosystems and much that we may never know if these systems are not carefully managed in a variety of ways. Social and economic considerations make total protection of remaining tropical forests unrealistic. Ecological considerations as well as the potential for gaining knowledge that will be useful in meeting economic and social needs in the future make some protection necessary. The general lesson from the tropical forest is that we should mimic the diversity of the forest in a diversity of management strategies for use of forest lands. A three-pronged approach may yield the greatest overall sustainable benefits: choose uses that are least damaging to the forest ecosystem as a whole while still meeting economic and social needs; seek multiple uses and benign technologies that optimize yield and minimize damage; and put major effort into increasing yields from existing managed forests, based on the assumption that this will decrease the pressure to exploit unmanaged forests.

Environmental Assessment

Environmental assessment is essential to the development of sustainable uses for fragile lands. McCaffrey notes (Chapter Ten) that, of the four points of environmental policy in the CFR, the fourth has particular relevance for FLM:

> Define environmental limiting factors that constrain development and identify and carry out activities that assist in restoring the renewable resource base on which sustained development depends (CFR 1980).

Fragile lands by definition (see Chapter Two) exhibit limiting factors that constrain development. In addition, the Foreign Assistance Act as amended in 1986 places particular emphasis on the conservation and sustainable management of tropical forests and the protection and conservation of biological diversity in developing countries. In Latin America (and elsewhere), much remaining tropical forest is found on fragile lands as are numerous habitats that support high biological diversity.

The importance of life zone mapping using the Holdridge classification system (see Chapter Nine, Appendix) as an integral part of the environmental impact assessment process is well illustrated by the USAID-assisted Palcazu valley project in Peru's central *selva*. In this instance, environmental assessment took place as part of the project design process. The results showed that initial estimates of the agricultural potential of the valley (based on soil maps and the belief that the valley was not as wet as it actually is) needed to be drastically revised if irreversible environmental damage was to be avoided. Recommendations in the A.I.D. project

design were based on the revised estimates. This example also makes clear the importance of fully incorporating environmental assessment in project design rather than at some later stage.

Beyond the site-specific environmental assessments conducted in conjunction with individual projects, the gathering of environmental information is essential to environmental planning and policy formulation and reform at the national level in developing countries. The preparation of documents such as environmental profiles, biodiversity assessments, national conservation strategies, national forestry action plans, and state-of-the-environment reports are all important to the planning and policy process. They form a part of the database essential for future project planning. DESFIL experience in Honduras (Daugherty, ed. 1990) demonstrates the crucial importance of intensive involvement of local professionals and a broad spectrum of public and private institutions in the data gathering and document preparation process. Commitment to environmentally sound economic development is established and intensified through this participatory process.

In Latin America, consensus across the political spectrum on the importance of environmentally sound development appears to have been achieved only in Costa Rica. Honduras may now be close to such consensus. Sustainable management of fragile lands is heavily dependent upon the achievement of such consensus. There is still much work to do in this regard.

Environmental Education

Environmental education (EE) is an essential link in the process of achieving sustainable management of fragile lands. Environmental degradation and unsustainable use of resources are often the result of uninformed human action. Well-planned, systematic communication of knowledge about the relationship of human actions and environmental consequences through both formal and informal education programs will make a substantial contribution to environmentally sound economic development. It will raise public consciousness and serve to foster an environmental ideology. The extent to which the EE process will have a positive impact on FLM is dependent on reaching several audiences ranging from resource users at the local level to policy makers at the national level.

Ham and Sutherland identify seven key audiences for fragile lands EE. The first consists of students in the setting of formal education. The other six must be reached mainly through nonformal education: subsistence-oriented rural people (included in the category referred to elsewhere in this volume as local resource users), educators including teachers and extension workers, middle- and upper-class nationals, influential groups and citizens, foreign tourists, and world audiences. Although one might quibble with the particular categories of audiences and point out that in some instances individuals would belong to more than one audience, the points that Ham and Sutherland stress are well taken: namely, that to be maximally effective EE must reach a diversity of audiences, and that a variety of communication methods and media techniques will need to be tailored to specific audiences to achieve maximum impact.

Ham and Sutherland make several recommendations that would enhance the effectiveness of projects like DESFIL. In general, they advocate an increase in emphasis on nonformal programs. Of specific importance would be an expansion of extension and outreach activities for resource users at the community level. This could be accomplished first by providing more short-term training courses for extensionists in interpretive methods and applied communication. Courses should stress basic communication skills and the use of practical, inexpensive media. Second, extensive use of radio programs designed to appeal to rural families should be implemented.

Well-formulated programs of EE addressed to key audiences can influence fragile lands management in a positive way across a broad, interrelated spectrum of activities from policy and planning to technology transfer, income generation, institutional strengthening, local stewardship of resources, and tourism development.

GENERAL RECOMMENDATIONS

Several lessons have been learned that we believe can serve as general guidelines for the sustainable development of steeplands and tropical lowlands in Latin America, and in other world regions, and possibly for other types of fragile lands. Some of these lessons are not new, but bear reiteration for at least two reasons, one scientific and the other pragmatic. The scientific reason is that confirming the results of one experiment through multiple replications lends validity to the result. If the results are the same on each successive try, we are justified in having increasing confidence that we understand the phenomenon under study. The pragmatic reason is that if old lessons have, in fact, been learned, it is not clear that they are being incorporated into the conceptual frameworks and models that serve as templates for the ways in which we design development interventions.

An Illustration of the Complexity of the Problem

A general lesson is that the achievement of sustainable use of fragile lands requires that we simultaneously address the multiple causes of unsustainable use. To cite just one example, arresting deforestation and degradation of fragile lands in eastern Ecuador and working toward sustainable uses for these lands will require, at a minimum:

- Site-specific environmental assessments to determine inherent capabilities through use of the Holdridge life zone classification (Chapter Nine Appendix) and extent and potential reversibility of existing damage (Chapter Ten);

- National-level policy reform to remove incentives for deforestation (Chapter Eight; Hanrahan & Pereira 1990);

- National and local institutional strengthening (Chapter Four);

- Coordination among agencies having responsibility in the area (Hanrahan and Pereira 1990);
- Introduction of technologies and types of use more appropriate to the inherent capabilities of specific sites (Chapters Three, Nine);
- Appropriate incentives to get the resource users to use alternate technologies (Chapter Seven);
- Forms of local stewardship appropriate and acceptable to the different ethnic groups occupying the area (Chapter Five);
- Appropriate valuation of the natural resources of the area including their (potential) value as amenities, for ecotourism, and for the preservation of biodiversity (Chapter Six);
- Environmental education programs that reach all segments of society having a stake in these lands (from policy makers to local resource users) (Chapter Eleven); and
- Carefully designed long-range strategic plan to accomplish all this (Chapter Eight; Hanrahan, Russo, and Valencia 1990).

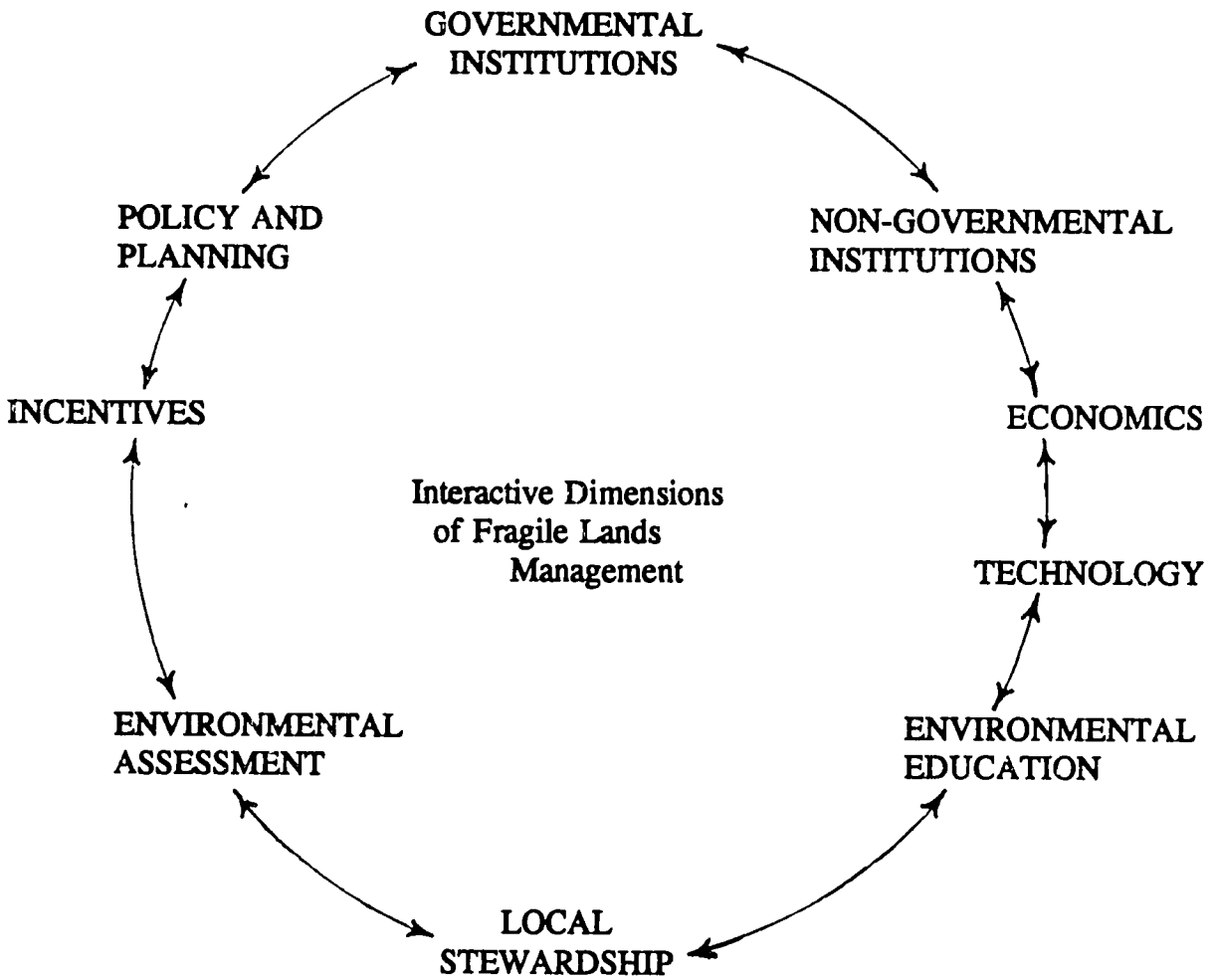
And it may turn out that, for much of the area, agriculture and cattle raising will not be sustainable uses and some form of natural forest management (Chapter Nine) may need to be implemented.

In other words, what is needed is an integrated approach to fragile lands management. If this sounds like a resuscitation of the integrated rural development approach popular in the 1970s, we make no apology. In a way, it is. The significant differences are that we now understand better the complexities involved, the management requirements, and especially the need for flexibility in the approach. An integrated approach is not the same thing as a formulaic approach.

Procedural Recommendations

We view FLM as involving the interdependent dimensions of policy and planning, governmental institutions, NGOs, economics, technology, environmental education, local stewardship, environmental assessment, and incentives (see Figure 12.1). To achieve sustainable FLM, each of these dimensions must be addressed for any site where development interventions are planned. This does not mean that a single project must address them all. It does mean that projects addressing these dimensions, whether of the same donor or different donors, must be well coordinated, communicate frequently, and exchange information and engage in strategic

FIGURE 12.1. INTERACTIVE DIMENSIONS OF FRAGILE LANDS MANAGEMENT



NOTE: The total of all possible interactions among the nine dimensions is 9 factorial or 362,880. Even assuming that only about 10 percent of these might actually occur in real situations, this is still an impressive number and serves to illustrate the complexity of the FLM problem.

planning through periodic seminars and workshops. All stakeholders and especially the local resource users should be represented at and participate in such seminars. We realize that this is an ideal goal difficult to achieve in practice. We believe it is worthwhile to hold such ideals as a part of a strategic plan that governs decision making and provides overall direction to the development effort.

Within the context of the integrated approach that we advocate, we recommend the following guidelines:

- Fit the technology to the site-specific ecological, economic, and social parameters, incorporating local knowledge, practices, and beliefs to the greatest extent possible;

- Sharpen institutional focus on FLM, strengthen management capacities, reduce to a minimum overlapping and contradictory responsibilities, and work toward more decentralization of responsibility;

- Encourage local participation in the FLM process and ensure that management options are consistent with local cultural forms;

- Insure appropriate valuation of natural resources in FLM through economic analyses that include consideration of amenity values;

- Design culturally sensitive incentive programs that take all stakeholders into account and that include appropriate nonmaterial as well as material incentives;

- Place much greater emphasis on the strategic planning process and involve local professionals and other stakeholders in the process from beginning to end;

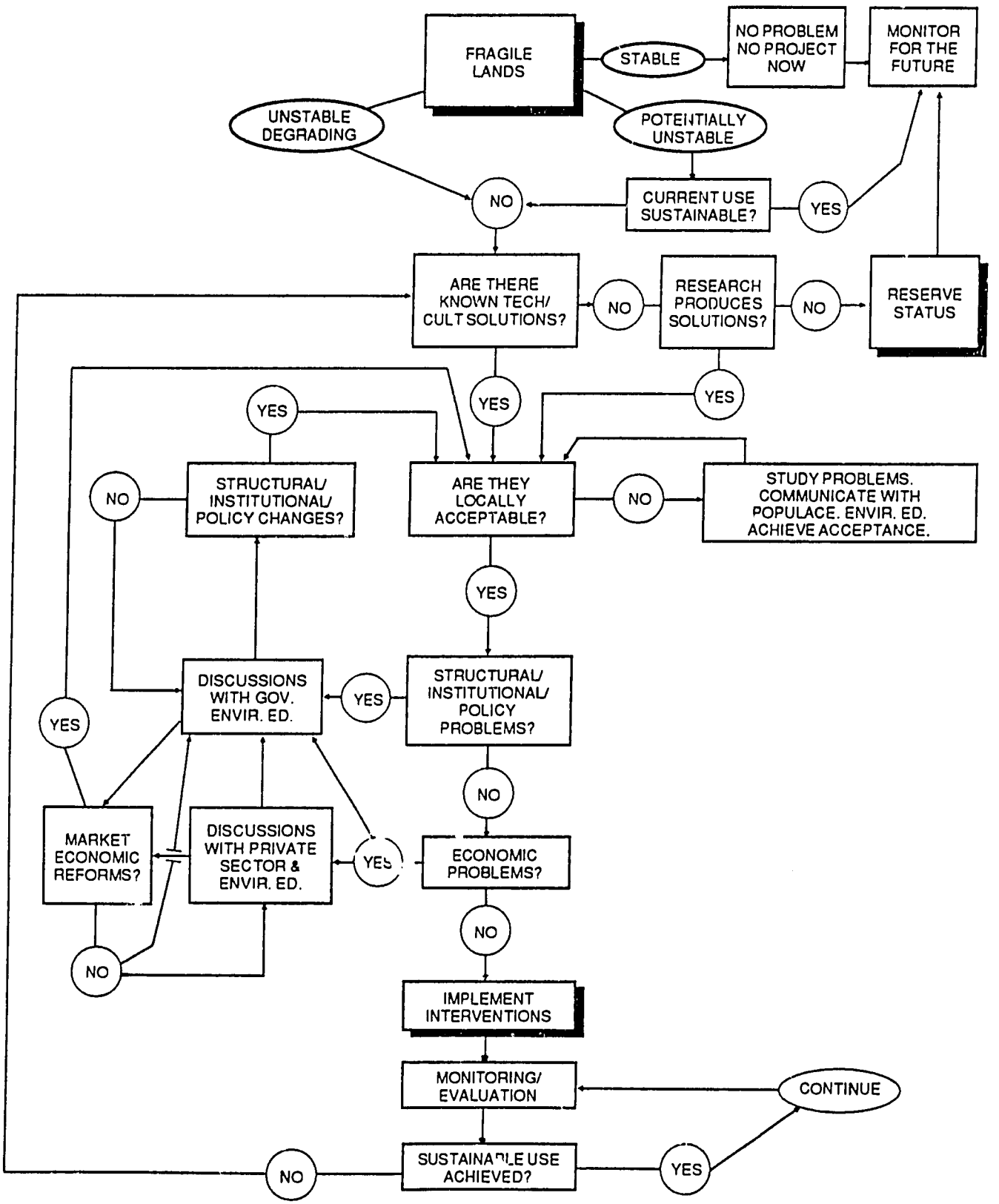
- Make sustainability, and habitat and biodiversity maintenance, foremost in choosing among use options for tropical forests;

- Use environmental assessment, including life zone classification, as an initial step in project design to determine site-specific inherent land capabilities that can then serve as the fundamental basis for project design options; and

- Employ environmental education using a variety of media and communication techniques appropriate to specific audiences, cultural settings, and available facilities to raise consciousness about fragile lands problems and insure broad-based support in their solution.

Figure 12.2 incorporates the above recommendations in a simplified decision tree model of the FLM process.

FIGURE 12.2 A SIMPLIFIED DECISION TREE MODEL OF FRAGILE LANDS MANAGEMENT: MANAGING FOR SUSTAINABILITY

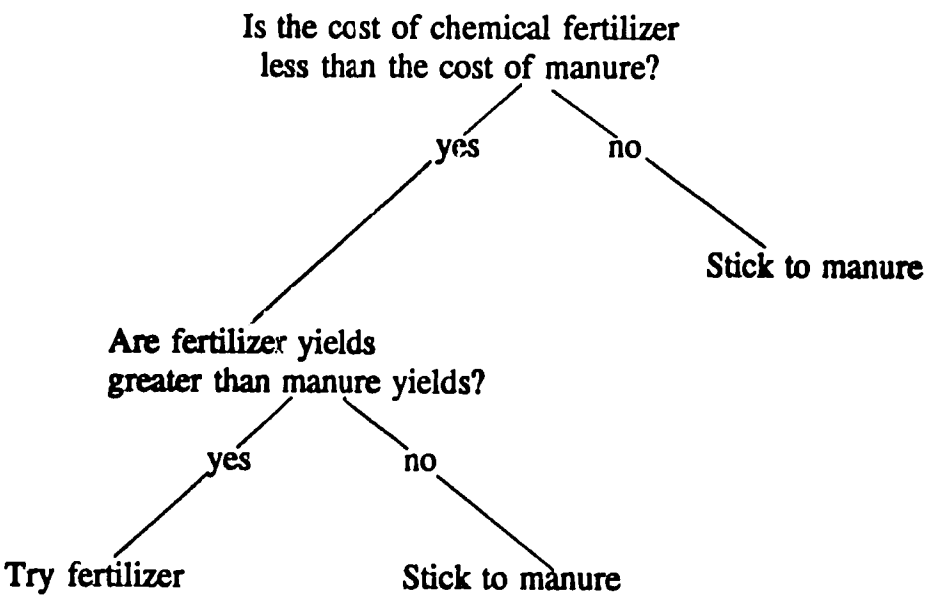


Methodological Recommendations

During the course of the DESFIL project, it has become evident that certain methodologies should be given more attention as useful tools for organizing and analyzing complex data sets. First, following Gene Wilken's lead (Chapter Three), more systematic use of computerized relational databases in FLM would permit both better control of accumulated data and, properly used, could produce preliminary sets of options for new sites based on analogues in the existing database. In practical terms, for example, this might mean that if a site in Nepal was being considered for development interventions that would lead to increased productive capacity or would reduce current levels of degradation, the database could be searched for sites elsewhere — perhaps in the Andes — with closely comparable altitude, slope, soil conditions, temperature, precipitation, and so forth. The resulting analogues would provide a starting point for considering potentially sustainable options that would then be passed through the filter of local sociocultural and economic conditions to make appropriate adjustments.

A second methodological tool for FLM, and for environmental and natural resource management in general, is stakeholder analysis. As Gamman (1990) and Chapter Seven, this volume) has illustrated, stakeholder analysis and consequent involvement of all stakeholders in the FLM process greatly enhances the chances for successful outcomes.

A third methodology that has proved useful in farming systems research and development is the use of decision trees (Gladwin 1979). Decision trees are intended to predict the decision most likely to be made by a resource user. The use of this method presupposes that appropriate information on the decision-making criteria of the resource user has been collected. Decision tree models are based on a theory of choice that people everywhere simplify their decision-making calculations rather than make complex calculations of the overall worth or utility of each alternative. Gladwin (1979) provides a simple illustration.



Finally, we would propose that FLM will also benefit by the use of expert systems analysis. An expert system is a computer-based program that mimics human decision making in a well-defined domain of knowledge. Expert systems require a knowledge base that consists of facts and rules and a set of procedures for manipulating the facts and rules. The majority of expert systems are based on rules of the IF...THEN variety (Guillet 1989a). Guillet (1989b) provides an illustration of an expert systems model of soil management in the Peruvian Andes based on local knowledge. Warkentin et al. (1990) discuss the application of knowledge-based expert systems to planning and design of agroforestry systems. Interestingly, their knowledge base is derived from professional agroforestry. We suggest that comparisons of results of expert systems analyses of particular knowledge domains based on local knowledge on the one hand and scientific knowledge on the other may yield interesting results with respect to sustainable uses for fragile lands. Certainly such comparisons would highlight areas of congruence and difference and provide an indication of what might be necessary in education and who needs to be educated, the local resource users or the scientists.

Both decision tree models and expert systems models can be applied to fragile lands management in at least the following knowledge domains: agroforestry, soil management, crop rotation, natural forest management, and watershed management.

LOOKING TO THE FUTURE

Based on the DESFIL experience, it is worthwhile to make some general observations that we believe should guide future planning in fragile lands management.

- Fragile lands problems are a subset of development problems in general. The procedures we have outlined above for solving fragile lands problems can and should guide development in general.

- FLM is a long-term proposition. Even five- and ten-year projects may not provide monitoring frames that are long enough to measure results.

- Development and conservation of resources can be compatible. Resource mining undermines economic development efforts in the long run while resource conservation and sustainable management greatly enhance the chances for success of these efforts.

- Solutions to the fragile lands problem must be site specific. However, some of the knowledge and experience gained at one site may be transferable to other sites.

- Social, institutional, and policy problems are by far the greatest impediments to the sustainable use of fragile lands.

- Privatization and local stewardship do not solve all of the problems of fragile lands management. The history of U. S. temperate forests makes it seem highly unlikely that privatization by itself will solve the problems of preservation of tropical forest ecosystems.

- Fragile lands management should focus on human needs now and for the future. To be truly effective, FLM needs to be decoupled from donor political agendas. "A steep slope has no politics" (Anon.).[3]

The 1990s will be a critical decade for development efforts worldwide. As expanding human populations place increasing pressure on Earth's resources, developing countries will seek to bring larger expanses of fragile lands under production. Unless this is done with considerable attention to environmental impacts, especially rates of resource depletion, the bounty derived from fragile lands may be very short-lived. One of our critical concerns should be to work with local policy makers, development professionals, and resource users, through technical assistance and environmental education programs, to insure the **sustainable** management of fragile lands. To achieve this, we and they will need to accept a conceptual framework and a development model different from those that currently drive development policies and actions.

A conceptual framework for sustainable development will need to incorporate the basic notion of sustainability as the optimization of ecological, economic, and sociocultural variables. Notions of flexibility to deal with uncertainty, of limited growth, and of humans as stewards rather than exploiters of nature should also be included.

A development model that incorporates the assumptions of this conceptual framework will represent a dynamic system (we may call it a dynamic socionatural systems model), with change rather than equilibrium assumed to be the normal state of the system. (There is abundant real-world evidence to support this assumption.) Our manipulation of the variables in this model, that is, our deliberate development interventions, will seek to achieve sustainability as the **primary** goal; economic growth in this model is a **secondary** goal and not to be achieved at the expense of sustainability or serious environmental damage (such as massive tropical deforestation or intolerable levels of pollution).

Current growth-centered development models subordinate sustainability to growth. In the case of fragile lands management, making growth a higher priority than sustainability invites negative and very likely irreversible long-term environmental consequences and is, in the long term, as unsound economically as it is environmentally.

To achieve environmentally sound development and sustainable use of resources, it will be necessary to transcend the set of values current in much of the world today, values that are fundamentally growth oriented, deterministic, and see the role of humans as dominators and controllers of nature. Such values need to be replaced with a more organic view of nature, one in which humans are seen as stewards of the Earth rather than controllers and exploiters, one

that will be consistent with humans living in harmony with the Earth as ecosystem — and, for that matter, in harmony with each other. And there is some cause for optimism. Heightened levels of environmental awareness in international donor agencies, among the populace in the United States, and to a more limited extent in the governments and among the populace of developing nations provide some evidence that this transformation of cultural values has begun. We must all do everything we can to accelerate this transformation within the development process so that the dawning of the twenty-first century will be the beginning of a truly bright future for humanity.

ENDNOTES

1. To an anthropologist, the term sociocultural includes economic and political phenomena. I have specified "economic" here to insure clarity.

2. In the past (and with few exceptions today), the existence of community or municipal control over resources was even at this level concentrated in the hands of one or a few powerful individuals, for example, *caciquismo* in Mexico, and represented the failure of national institutions rather than any deliberate policy of decentralization.

3. This observation is made in the spirit of the following excerpt from the Statement on Professional and Ethical Responsibilities of the Society for Applied Anthropology:

> We shall report our research and other activities accurately. We have the obligation to attempt to prevent distortion or suppression of research results or policy recommendations by concerned agencies.

REFERENCES CITED

Brown, M. T., ed.
1989 The Southeast Peninsula Project in St. Kitts, Vol. II: Constraints and Opportunities--A Synthesis of the Planning Process. DESFIL Technical Report. Washington, D.C.: Development Alternatives, Inc.

Code of Federal Regulations
1980 22 CFR Part 216, Environmental Procedures.

Daugherty, H. E., ed.
1990 *Perfil Ambiental de Honduras 1989.* DESFIL Technical Report. Washington, D.C.: Development Alternatives, Inc.

DESFIL
1990 National Program for Agroforestry in Haiti, Vols. 1 & 2. DESFIL Technical Reports. Bethesda, Md.: Development Alternatives, Inc.

Gamman, J.
1990 A Comparative Analysis of Public Policies Affecting Natural Resources and the Environment: Interest Group Politics in the Eastern Caribbean. DESFIL Technical Report. Washington, D.C.: Development Alternatives, Inc.

Gladwin, C. H.
1979 Cognitive Strategies and Adoption Decisions: A Case Study of Nonadoption of an Agronomic Recommendation. *Economic Development and Cultural Change* 28(1):155-173.

Guillet, D.
1989a Expert Systems Applications in Anthropology. *Anthropological Quarterly* 62(2):57-58.

Guillet, D.
1989b A Knowledge-Based-Systems Model of Native Soils Management. *Anthropological Quarterly* 62(2):59-67.

Hanrahan, M. and J. Pereira
1990 Manejo de la zona del Gran Sumaco Provincia del Napo, Ecuador. DESFIL Technical Report. Bethesda, Md.: Development Alternatives, Inc.

Hanrahan, M., B. Lynch, W. McAnlis, and J. Wolf
1990 Evaluation of the On-Farm Water Management Project in the Dominican Republic. DESFIL Technical Report. Washington, D.C.: Development Alternatives, Inc.

Hanrahan, M., S. Russo, and I. Valencia
1990 Strategic Environmental and Natural Resources Planning: Hypotheses, Case Studies, and Policy Conclusions from Latin America and the Caribbean. DESFIL Technical Report. Washington, D.C.: Development Alternatives, Inc.

Honadle, G., and J. VanSant
1985 *Implementation for Sustainability: Lessons from Integrated Rural Development.* West Hartford, Conn.: Kumarian Press.

Koehn, K., E. Tai, and E. LeFranc
1989 Process Evaluation of the Hillside Agriculture Project in Jamaica. DESFIL Technical Report. Washington, D.C.: Development Alternatives, Inc.

Murray, G.M.
1979 Terraces, Trees, and the Haitian Peasant: An Assessment of 25 Years of Erosion Control in Rural Haiti. Report submitted to USAID/Haiti. Port-au-Prince, Haiti: A.I.D.

Murray, G. M.
1983 Agroforestry Outreach: An Approach to Tree Planting in Rural Haiti. Port-au-Prince, Haiti: Pan American Development Foundation.

Orellana, J., M. Hanrahan, and P. D. Young
1991 Final Report on the Ecuador Forestry Sector Development Project (FSDP). (forthcoming)

Pierce, T.H.
1988 Watershed Management in Haiti: The STAB Experience. DESFIL Technical Report. Washington, D.C.: Development Alternatives, Inc.

U. S. Congress
1986 Section 118 of the Foreign Assistance Act of 1961, as amended in 1986. Washington, D.C.: U.S. Government Printing Office.

Valencia, I.
1989 Managing the Honduran Environment. DESFIL Newsletter 3(4):4,6-7.

Warkentin, M. E., P. K. R. Nair, S. R. Ruth, and K. Sprague
1990 A Knowledge-Based Expert System for Planning and Design of Agroforestry Systems. *Agroforestry Systems* 11:71-83.

World Resources Institute
1990 *World Resources 1990-91.* A Report by the World Resources Institute in collaboration with The Untied Nations Environment Programme and The United Nations Development Programme. N.Y. & Oxford: Oxford University Press.