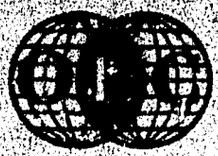
AID/afr-C-1171 GTS
OLC PN-AAE-144



Higher Education and Natural Resources Management in Southeast Asia

by

Jeff Romm

Ford Foundation

OLC Paper No. 13
February 1978

Overseas Liaison Committee
American Council on Education

American Council on Education

The American Council on Education is an organization whose membership includes over 90% of all doctorate-granting institutions in the United States, 80% of all bachelors and masters-granting institutions, 38% of all regularly-accredited two-year institutions, 191 educational associations and 57 affiliates. Since its founding in 1918, the Council has been a center for cooperation and coordination of efforts to improve American education at all levels.

The Council investigates educational problems of general interest; stimulates experimental activities by institutions and groups of institutions; remains in constant contact with pending legislation affecting educational matters; acts in a liaison capacity between education institutions and agencies of the Federal Government; and, through its publications, makes available to educators and the general public, widely used handbooks, informational reports, and volumes of critical analyses of social and educational problems.

The Council operates through its permanent staff, commissions and special committees. Its president, Jack Peltason, was formerly Chancellor of the University of Illinois at Champaign-Urbana. The Council is housed at the National Center for Higher Education at One Dupont Circle in Washington, D.C.

Overseas Liaison Committee

The Overseas Liaison Committee exists to provide a means of communication between American higher education, broadly conceived, and higher education abroad.

OLC is a working committee of the American Council on Education. It is comprised of distinguished academics and academic administrators appointed by the President of ACE. The membership is chosen with an eye to including on the Committee individuals who represent the broad diversity of American higher education and who at the same time are particularly well qualified to represent American higher education overseas.

Financial support for the work of the OLC consists of a mixture of funds, government and private, foreign and domestic. While the source of funding changes from time to time, the Committee has been fortunate from its inception to be the recipient of generous core-support grants from the Carnegie Corporation of New York.

OLC Members

Council

Elias Blake, Jr., President, Clark College, Atlanta

Cole Brembeck, Director, Center for International Studies in Education, Michigan State University

**Roy S. Bryce-Laporte,* Research Sociologist and Director, Research Institute for Immigration and Ethnic Studies, Center for the Study of Man, Smithsonian Institution

John A. Carpenter, Associate Dean and Director, Washington Education Center, University of Southern California

Candido de Leon, President, El Congreso Nacional de Asuntos Colegiales

**Alfredo G. de los Santos, Jr.,* Director, Institutional Planning in Bilingual Education, Southwest Education Development Laboratory

Harold L. Enarson, President, Ohio State University

Robert Good, President, Denison University

**Michael M. Horowitz,* Professor of Anthropology, State University of New York, Binghamton

**Eldon L. Johnson,* Vice President *Emeritus,* University of Illinois, Urbana, CHAIRMAN

Bryant Kearl, Acting Vice Chancellor, University of Wisconsin, Madison

**Selma J. Mushkin,* Director, Public Service Laboratory, Georgetown University

Samuel L. Myers, Executive Director, National Association for Equal Opportunity in Higher Education

Jack W. Peltason, President, American Council on Education, *ex officio*

Georgina F. Pesante, Vice President for Administration and Financial Affairs, Union Theological Seminary

**Wayne Schutjer,* Professor of Agricultural Economics and Rural Sociology, Pennsylvania State University, University Park

James Turner, Director, African Studies and Research Center, Cornell University

**Members of the Executive Committee*

Panel of Consultants

Karl W. Bigelow, Professor *Emeritus,* Teachers College, Columbia University

Philip H. Coombs, Vice Chairman, International Council for Educational Development

L. Gray Cowan, Dean, Graduate School of Public Affairs, State University of New York, Albany

James Dixon, M.D., Visiting Professor, School of Public Health, University of North Carolina

Arthur Lewis, Chairman, Department of Curriculum and Instruction, University of Florida

John S. McNown, Albert P. Learned Professor of Civil Engineering, University of Kansas

Glen L. Taggart, President, Utah State University

Higher Education and Natural Resources Management in Southeast Asia

by

Jeff Romm

Ford Foundation

OLC Paper No. 13
February 1978

Overseas Liaison Committee
American Council on Education

This report has been prepared under AID/afr Contract No. C-1171
The Agency for International Development, The United States Department of State

Preface

During the past few years, the effective management of natural resources has assumed a high priority in many developing societies. With it has come the need for new kinds of research and training in environmental matters; and, many institutions of higher education have developed new--and in some cases highly innovative--methods of meeting this need.

The present paper, 13th in the OLC series Rural Development Network Papers, skillfully shows how contemporary thought in Southeast Asia about environmental matters has had an impact on the research and training programs of that region. Dr. Romm describes in considerable detail efforts underway to create new programs which incorporate environmental considerations with development strategies.

The paper is useful from a number of perspectives. First, while the examples used are from Southeast Asia, the fundamental issues which the paper discusses may be important for every developing society. Second, the programs described in the paper certainly offer suggestions--and perhaps even models--for the creation of resource management programs in Africa, Latin America, and other developing areas. Helpfully, Dr. Romm has appended to his paper the names and addresses of those in Southeast Asia who have developed the programs described, and interested individuals elsewhere may enter into direct communication with them with respect to gaining further details about particular programs. Finally, the paper neatly complements other work being done in the field of higher education and development, most notably the two-volume study by Kenneth W. Thompson, et al., Higher Education and Social Change (Praeger, 1976). Like the Thompson work, this paper indicates that institutions of higher education in developing societies can and in many instances are of direct relevance to rural development.

Dr. Romm is a Ford Foundation Advisor in the area of natural resources and the environment. He is currently on sabbatical leave from Ford after having lived six and a half years in Southeast Asia. Currently affiliated with Resources for the Future, he will in 1978 join the Ford program in India.

Wayne Schutjer
Professor of Agricultural Economics
Pennsylvania State University,
and
Member of the Executive Committee
Overseas Liaison Committee

Table of Contents

Page Number		
1	I.	Introduction
11		Malaysia
12		The Philippines
12		Thailand
13		Indonesia
14		The Region
15	II.	Advances in Education for Resource Management
20		Professional Education in Resource Management
31		Education in Resource Planning and Policy Analysis
36		Education in Environmental Sciences
39		The Disciplines
41	III.	Summary
44		Appendix

I. INTRODUCTION

In the past five years, the growth of interest in natural resources and the environment has begun to transform higher education in Southeast Asia. Ecologically sound management of resources and the environment has become generally accepted as a necessary dimension of national development in the region. In the universities, a creative synthesis of ideas once separated as "environmental" and "developmental" is beginning to produce extensive innovations in scholarship and education. Thus far, innovations are better described by their directions than their tangible accomplishments; their full potentials will not be reached for a long time. But they are supported and encouraged by changes in governmental perceptions about the needs, means, and ends of development. They also benefit from a new academic freedom to organize the search for knowledge according to national preferences rather than the disciplinary heritage of Western scholarship.

This paper describes recent changes in higher education for the management of natural resources. There are two sections. The first shows how and why changes in higher education have occurred. Broad changes in relationships among population, resources, technology and welfare, in government strategies of development, and in the roles of universities in national life are considered. The second section describes new education programs in natural resource management, resource and environmental policy and planning, and environmental sciences, as well as changes in education within disciplines. An appendix contains the names of people able to provide further information about their education and research programs. Because of the limits of my information, comments are restricted largely to Thailand, Malaysia, the Philippines, and Indonesia.

Southeast Asia is a region of scattered lands bound by rich shallow seas. Its northwest is formed by the great continental river systems of the Indochina Peninsula and was settled over millenia by southward migration into the alluvial plains, deltas, and hills. The fertile volcanic crescent of the Indonesian-Philippine archipelago curves along its south and east; the humid forestlands of the Malay Peninsula, Borneo, and Mindanao stretch across its equator. These lands were settled from the sea, populations concentrating on the coasts and moving inland through the river valleys. Valley and coastal population densities in Southeast Asia are among the highest in the world. The interiors of the equatorial lands remain sparsely settled.

The region is richly endowed with natural resources. During colonial times, these were used primarily for subsistence livelihood and for exports of sugar, tin, timber, rubber, rice, and spices. After World War II, they became important sources of income and investment for achieving national economic growth and independence. National strategies of development concentrated scarce capital and skills in projects that would glean rapidly the apparent plenty of natural resources. These strategies produced revolutionary advances in agriculture, infrastructure development, capital formation, the generation of new technologies, and in endowments of skills, experience, and organization.

By the late sixties and early seventies, capital and skills had become sufficiently abundant to support the expansion of central governments, markets, and the extension of development policies and programs to populations hitherto outside national systems. The "green revolution" had begun to erode notions of a passive peasantry and to contribute to an emergent sense of technological optimism. Exports and incomes were rising, and

national economies were gaining stability through diversification. But other trends were also apparent.

From 1950 to the mid-1970s, national populations doubled; they will double again by the end of this century.[1] Urban populations, incomes, and industrial activities more than doubled in the last decade. Pollution-caused fish-kills and disease followed apace. Hydroelectric generation capacity increased by more than 50 percent in Indonesia, 100 percent in Malaysia, 200 percent in the Philippines, and 500 percent in Thailand.[2] Between 1960 and 1970, reservoir capacities increased by eleven times in Malaysia and sixty times in Thailand,[3] with people displaced to allow for them. Between 1965 and 1975, irrigated area grew by 50 percent in the Philippines and 75 percent in Thailand[4]; the rate of irrigation development continues to increase. Despite the advancing claims of urban, road, and reservoir development on paddy lands, the area under rice cultivation increased by about 20 percent.[5] Rice production increased by about 60 percent,[6] the amounts used of chemical fertilizer by between four and seven times,[7] and costs of pest control and damage by an unknown amount.

---

[1] United National Statistical Yearbook, 1975, United Nations, New York, 1976.

[2] Ibid.

[3] Economic and Social Survey of Asia and the Pacific, 1975, Economic and Social Commission for Asia and the Pacific, Bangkok, 1976.

[4] Production Yearbook, 1975, Vol. 29, Food and Agriculture Organization, Rome, 1976.

[5] Ibid.

[6] Ibid.

[7] United Nations Statistical Yearbook, 1975.

Within the past decade, the area in Thailand under sugar cultivation more than doubled, that under maize tripled, and that under tapioca increased fourfold.[8] Malaysia increased its area under oil palm cultivation by almost seven times.[9] These expansions occurred largely on lands previously under forest cover and created important new exports and incomes. Logging increased by an average of more than 50 percent. Log production in Indonesia grew ten times in the decade. Log exports tripled, and Southeast Asia now supplies about 75 percent of hardwood logs in the world market.[10] The number of landless increased concomitantly, and the population pushed further into the hills. Shifting cultivation cycles shortened as population densities rose. As a result of extraction and expanding cultivation, even larger portions of uplands are without productive or protective vegetation. The area under forest cover in Thailand and the Philippines declined by between 20 percent and 30 percent in one decade. Flood frequency and costs have increased drastically, as have those of land destruction by erosion and siltation.

The services of nature were becoming scarce, relative to the demands upon them. Sources of productivity, such as soil nutrients and structure, the growing stock of forests and fisheries, and the natural predators of crop pests, were being used up and not replaced. Natural quantities and qualities, such as water for irrigation or waste assimilation and land for settlement or cultivation, were being claimed in amounts approaching and surpassing their limited supplies. Natural monuments and wildlands were

---

[8] Production Yearbook, 1975.

[9] Ibid.

[10] Economic and Social Survey of Asia and the Pacific, 1975.

disappearing, as were the landscapes that had inspired cultural sentiments and identities. Activities and interests that in the past could be pursued independently, now came into conflict. Soil eroded from upland farms silted downstream reservoirs and irrigation canals. Wastes from factories polluted fisheries and village water supplies. Families escaping rural poverty migrated to areas already overburdened by their populations. As often happens, the outcomes of conflict usually favored the more powerful, and environmental costs of growth fell disproportionately upon the poor and upon future generations, groups with relatively weak political voice. Most important, the forces behind these changes seemed beyond control. Population growth and migration had their own life patterns, and economic progress was a universal aspiration no one rejected seriously.

By the early seventies, the governance of national development was beginning to face new demands related to the consequences of natural limits. What form should strategies of economic development assume when the locus of scarcity shifts from capital toward natural resources? One response has been the shift from a dominant philosophy of industrialization toward a much more active concern for agricultural development.

How can governments deal with growing disparities in distribution of the fruits of development among social classes, ethnic groups, and regions? We can observe responses in the rapid upsurge of rural, regional, and socially selective development policies throughout Southeast Asia. With economies intensifying and diversifying, people become increasingly dependent on distant sources of benefit and risk and contribute less to maintaining traditional controls of relations within local communities; these controls weaken as a result. What modes of conflict resolution and cooperation can be developed to handle effects of contemporary interactions

in local resource use? Some responses have been integrated rural development programs, cooperatives of many kinds, coordinating "area" agencies, and increasing attention to relationships between agencies and communities.

How can national governments gain productive contact with populations that are spreading beyond the reach of current national systems? The extension and decentralization of technical, social, and financial services are increasingly common developments in governance.

Environmentalists emerged as a force in the seventies, a social response of another kind to the consequences of development. In my view, responses previously mentioned would have occurred in any case. But environmentalists' entry into the political arena was to become important for a number of reasons. First, they were predominantly natural and technical scientists and, thus, representative of a rapidly growing intellectual elite that had been without political voice. Environmentalism drew scientists into politics as a group for the first time in Southeast Asia. Second, environmentalists brought a logic that might be described as "ecology" in the popular sense, permitting a comprehensive view of what might otherwise have remained fragmented responses to specific problems. They contributed the possibility of a conceptual structure that would guide technical and organizational responses to developmental needs under conditions of natural resources scarcity. Third, because environmentalists were largely associated with the universities, their entry into public affairs improved possibilities for cooperation between governmental and academic communities that had become progressively isolated from one another.

To understand why environmentalists came from the universities, it is useful to turn briefly to conditions in the universities themselves.

Universities in Southeast Asia have undergone an extraordinary rate of development over the past fifteen years. Whether one chooses to measure such development by level of expertise, size of enrollment, number of campuses, or quality of research and education, its rates are high among any measures of national growth. The reasons are complex, but several seem particularly important for explaining the origins of environmentalism.

First, strategies of national development required specialized knowledge. They were based on assumptions that specific actions could have predictable effects if enough was understood about cause-effect relationships, and that appropriate actions could be derived from systematic analyses of problems and experience. Universities gained priority as potential reservoirs of experts in matters ranging from the dynamics of genes and crops to those of world markets. The priority increased as universities proved their potential.

Second, the populace perceived education as the dominant means for upward economic and social mobility. Governments sought rapid expansion of educational opportunity in response to the pressures generated by this perception. Universities assumed importance as a primary focus of popular aspiration. They became centers of adjustment between national needs, social aspirations, and universal values of science, and of the synthesis of ideas. The mixture has been creative, volatile, and periodically threatening. Universities have reaped restraints on political expression as a result, but their growth and democratization have not been diminished.

By the early 1970's, Southeast Asian universities had become significant concentrations of expertise built to satisfy the specialized disciplinary requirements of the preceding decade. They had gained independence from governmental influence, belying the origins of many as agency training

institutes, but the quality of their expertise also isolated them from those with practical concerns; in this state, they were both protected and alienated from governmental interests.

Students were of increasingly diverse backgrounds and were increasingly separated from their forebears by different worlds of experience. They were sufficiently numerous to be insecure about prospects for future employment, sufficiently unified to be a political force, and sufficiently different from their predecessors to question prerogatives and the nature of national interests. The mixture of isolated and youthful expertise and a questioning attitude among students was to become a vigorous one.

The universities emerged as centers of scepticism about conventional notions of national identity, ideals of progress, and approaches to development. Meanwhile, governments were beginning to ask their own pragmatic questions about specific production problems, such as crop pest epidemics, reservoir siltation, and deterioration of lands, that specialized disciplinary analysis could not easily answer. The limits of natural resources and services had begun to shape development possibilities and raise public issues toward which intellectual energies could gravitate. University scientists had become part of the international surge of environmentalism and began to find in it an opportunity and a rationale for explaining their own countries' conditions.

In the early seventies, environmentalism was expressed in the terms of industrial-world concerns. In the nations of Southeast Asia, which were 70 to 90 percent rural, it provoked reaction by many who felt that "pollution" was an irrelevant distraction from requirements for increased food production, investment, and economic growth. But it directed attention to problems of the dominant cities in these countries, where power resided, and had

effects beyond the beginning of urban reforms that were to become more influential.

Environmentalism, legitimized by domestic problems and international interests, released intellectuals from accepted notions of national development with which they had become uncomfortable, and its meaning was sufficiently vague to offer wide latitude for selective interpretation. It provided a reason for organization among those with the propensity and need to interpret their world in "systemic" terms. In its promotion of ecological principles, environmentalism offered a quasi-scientific rationale for analysis and action that contrasted with the prevailing paradigms of commodity development and disciplinary analysis. These opportunities were exploited in distinctive ways.

From 1972 through 1974, there was an outburst of creative philosophy, organization, and scientific formulation. While their relative importance varied among nations, certain qualities seemed common to all. Ideas of nationalism, for example, were enhanced by the identification of national interests and enduring landscapes and cultures. At one level, these ideas invoked symbols of spiritual motherhood and nurturance. At another, they addressed problems of sustaining continuity, through present actions, between the heritage of the past and aspirations for the future. In political terms, these ideas asserted a collective responsibility for husbandry which, although prevalent in tradition, had not yet been absorbed in national scopes of action, and raised questions about the distribution of benefits from resource development among social classes, sectors, and regions.

Organizations were formed to pursue such objectives as increasing public awareness, influencing government policies and actions, improving

interagency communications, developing research and education programs, and promoting youth conservation projects. They provided a focus for student interests, with occasionally powerful impacts whose results will not be clear for a generation. They gradually moved toward a selection of environmental concepts that would improve the quality of development rather than restrain it.

Environmentalists found a response in the developmentally oriented who had started as adversaries and now perceived mutual interests in pragmatic issues. The merger of interests was most apparent among natural and technical scientists. These gained confidence in multidisciplinary analyses of problems and began to seek applications of ecological principles that would increase resource productivity and the welfare derivable from it. During this period, environmental interests expanded from their urban base to incorporate and eventually emphasize rural concerns. The "ecology of poverty" gained influence as an underlying concept with which both environmentally and developmentally oriented people were comfortable. In several nations, it so permeated academic and governmental thought that the distinction between environment and development disappeared.

By 1975, each nation in Southeast Asia had captured results of the preceding five years in the form of new laws, agencies, planning and budgetary priorities, and agency operations. The original coalitions of environmental interest had expanded, then dispersed, their purposes as catalysts largely accomplished. Their alumni shifted attention to solid research, education, and action programs in their home institutions.

Although the tendencies of change have been general throughout the region, their qualities and results differ among nations. Before describing

their effects on university programs, it may be helpful to contrast emerging national emphases.

Malaysia

Malaysia is a federation of peninsular and Borneo states separated by the South China Sea. Its average population density is about half that of Thailand and Indonesia, and less than a third that of the Philippines and Vietnam. Its development has been concentrated along the west coast of the peninsula and is based on production of rubber and tin for export and, increasingly, on urban industry. Faced with this geographic imbalance, related disparities of benefit among ethnic groups, and the congestion of western cities, Malaysia has turned toward rapid development of the extensive resource-rich interior and east coast of the peninsula.

Within the past five years, the nation has made remarkable progress in the planned redistribution of people, agriculture, and industry. Huge areas of forestland are being transformed according to comprehensive plans of settlement and transport patterns, agricultural and industrial growth and diversification, public services, environmental conservation measures, and long-term economic projections. Malaysia has also instituted the first forest policy in Southeast Asia that can be expected to achieve sustained-yield forestry, watershed conservation, park preservation, and the planned transition of suitable forestlands to agriculture and industry. Regional planning is becoming an effective instrument for integrating land, water, and forest development within the economic and social structure of the nation as a whole. A new environmental law complements policies for regional development and private technological innovation. Industries are taxed for discharges into the water and air, at rates that decline with the

distance from urban centers and increase with technical possibilities for improved waste utilization and discharge control.

The Philippines

The Philippines contains 7,000 islands and, aside from Singapore, is the most urbanized and densely populated nation in Southeast Asia. While Malaysian emphasis is on distribution of people and technologies with respect to extensive resource possibilities, the Philippines has made important progress in developing the organization and technologies for intensifying use of environments in the cities and settled countrysides.

Research is leading to management systems that combine food, forage, wood, fuel, fertilizer, fish and livestock production, as well as water, energy, and biological conservation methods, in complementary ways. These promise economically productive and environmentally stable livelihoods for people in diverse tropical areas, many of which are now unproductive and prone to deterioration. Novel organizational arrangements are being developed and they are most apparent in interagency planning and management of river basins, diversified agricultural intensification, research and development for lowlands, upland and semiforest conditions, and agency-community collaboration in irrigation and watershed management. Advances have also been made in the organization, planning, and management of metropolitan areas.

Thailand

Changes in Malaysia can be characterized by achievements in public policy, in the Philippines by innovations in technology and organization. In Thailand, they seem best described by specific issues around which interests, organizations, knowledge, and talents are moblized; shifts of policy

or organization are much less explicit. Among Southeast Asian nations, Thailand is furthest along in developing popular environmental education and a conservationist political constituency. It also leads in merging environmental considerations with attacks on socioeconomic inequalities, as well as in establishing systematic means for responding to specific issues. The nature of these issues has largely determined the direction of progress in resource management.

In recent years, urban-rural disparities have defined the most powerful issues. Thailand's population is less urbanized, but its urban population is much more concentrated (in Bangkok) than is the case in Malaysia, the Philippines, or Indonesia. Progress in resource management has been most notable in conflicts between urban and rural resource uses. This family of issues has, for example, included problems associated with multipurpose development of coastal and estuarine systems, land and water use in the urban-rural fringe, water control under competitive urban and rural needs, and environmental implications of alternative energy sources. It has come to involve large segments of the public, the government, and academic communities.

Indonesia

Indonesia extends 3,000 miles along the southern half of the region. Its land area is about six times greater than that of the Philippines, Malaysia, or Vietnam. But most striking is that two-thirds of its population live on the islands of Java and Bali, which have only 6 percent of its land area. The imbalance is fundamental to Indonesian environmental concerns and responses.

Advances in resource management are responding to the differences between the rural metropolitan islands and the vast remainder of the country.

The farmers of Java and Bali manage their natural resources with exceptional virtuosity. Farm and community-level methods display an unusual attunement between local economic and ecological processes. In recent years, scientists have begun to analyze these systems and to develop means for enhancing their productivity and stability, while generalizing from them to systems of resource management for river basins and land areas.

Indonesia is unique in the extent to which it is combining population and resource development policies and programs. The government is moving about 15,000 families per year from overpopulated watersheds on Java to resource development projects on the Outer Islands, simultaneously relieving environments of rural poverty and promoting settlement of those with unutilized resources. In the process, Indonesia is making significant advances in the management of frontier coastal agricultural areas and in policies and programs for the enhancement of the densely populated river basins.

The Region

Since 1970, the Southeast Asian nations have shifted from predominant economic and political ties with their former colonial nations toward stronger relationships with one another. This is important for the management of natural resources. Cooperative projects, active and proposed, emphasize increasing sustainable resource productivities, regional processing of raw materials, and regulation of exports and prices.

The Association of Natural Rubber Producing Countries (ANRPC), dominated by ASEAN, the Association of Southeast Asian Nations (Indonesia, Thailand, Malaysia, Singapore, and the Philippines), controls about 85 percent of the world's production of natural rubber. The Asian coconut and pepper communities and ASEAN tropical hardwood producers are also developing collective programs. These efforts tend to reduce competition among Southeast

Asian nations and diminish overexploitation of resources, to the benefit of all.

ASEAN has established eleven groups for planning complementary industrial development, including food and resource processing industries. It is undertaking cooperative projects in fertilizer production and is encouraging scientific exchange in water resources management and ecology. Cooperative efforts in marine fisheries management and professional education in resource and environmental management are on the horizon.

The Mekong Committee, established in 1958 for multinational development by the four nations of the Lower Mekong River Basin, sponsors the largest single program of resource and environmental planning in the region. In 1976, it established an environmental unit to coordinate its many ecological studies and to integrate them with basin planning procedures.

How are universities addressing the educational requirements these changes imply?

II. ADVANCES IN EDUCATION FOR RESOURCE MANAGEMENT

University initiatives in education for management of natural resources have tended to emerge from the concepts and research experiences university scientists gained in the process of their involvement with environmental issues. Research content and organization have changed dramatically since 1970. At that time, university research could be described in almost purely disciplinary terms; it was generally distant from the realities of development. Where ecological inquiry existed, it was largely descriptive and directed toward an understanding of pristine systems. Resource management research was defined within disciplines and oriented toward production "output," with minimal attention devoted to the sustenance of natural

"inputs." Research mirrored the national strategies and apparent needs of the time.

Today, university research in Southeast Asia, at least in the natural sciences and resource management professions, bears little resemblance to this earlier scene. The following multidisciplinary research themes are prevalent and, in many cases, are beginning to define the style of university life.

River Basin Research. In each country of Southeast Asia, research groups are pursuing knowledge of the physical, social, and biological dynamics of river basins, and how these can be manipulated for superior effect. Other groups are concerned with subsidiary issues. They study, for example, the ecology and management of irrigation systems, watershed forests and grasslands, water-borne disease, fisheries, settlement consequences of basin development, and mathematical means for modeling the interactions of climate, hydrology, soil, vegetation, cultivation, and settlement in a basin system.

Area Development Research. Groups are studying the ecology of comprehensive development in coastlands, estuaries and estuarine lakes, and regions of frontier upland. Others are examining in more detail subsidiary questions of mangrove ecology, engineering aspects of tides and currents, erosion and sedimentation, and patterns of land use and settlement.

Urban Environmental Research. The impacts of industrial and urban development on environmental health, land and water use, and social and economic well-being are being studied in each country. There are also studies of, for example, techniques for waste utilization and control, environmental impact assessment, movements and effects of chemical substances, and urban water balances.

Farming System Research. Throughout Southeast Asia, groups are studying and developing "farming systems" for increasingly varied conditions of rural life. As a whole, the concept implies diversified combinations of plants and livestock, social organization, and public interests in environmental conservation that produce the maximum benefits attainable within ecological and social limits. University research groups are studying, for example, the structure and functions of home gardens, multiple-cropping systems for upland, rain-fed and irrigated conditions in tropical and semi-tropical regions, agroforestry and multicrop plantation systems, and numerous combinations of fish-and-crop, fuel-fodder-fertilizer-livestock-crop, and livestock-fish-crop possibilities. Related studies are proceeding in pest ecology, forest and grassland management, soil and water conservation, and economic and social constraints on system applications.

Population, Resource, and Development Research. University scholars are giving increased attention to how future populations and technologies will be distributed relative to natural resource capabilities, what alternative patterns imply for the level and distribution of welfare, and how these patterns can be influenced by public policies. More specialized studies of population growth and migration, the spatial dynamics of human settlement and economic activity, and natural resource possibilities and limits have catalyzed interest in this kind of research and are now being strengthened by it.

Development of multidisciplinary education programs has followed that of research interests. Educational responses began with general "environmental appreciation" courses, and have grown into degree programs at graduate and undergraduate levels. Recently, special units have been formed to coordinate and assist the new relationships that multidisciplinary programs

involve, and to facilitate the exchange of ideas and expertise between government and academia that problem-oriented interests require. While the pattern is not consistent throughout Southeast Asia, its underlying themes have become fairly general.

Three trends are apparent in higher education. First, training in scientific analysis is increasingly based on knowledge about "ecological" rather than disciplinary systems. These are defined by the sets of processes that determine all outcomes of a particular interaction between human beings and nature rather than by modes of inquiry that have become differentiated in the evolution of scholarship. Teaching and research have shifted toward multidisciplinary approaches, with consequent emphasis on "team" teaching and analysis. Environmental science curricula have been developed in many universities; in several cases, university divisions have been created to operate them.

Second, training for research management professions--e.g., agriculture, forestry, fisheries, soil and water resource, and environmental engineering, and planning--has been broadened to incorporate ecological and social considerations. These had been given little emphasis previously but are now seen to be strong influences on the outcomes of professional effort. Public health and sanitary engineering have become environmental health and environmental engineering, with the titular changes having substantive basis. Forestry education is increasingly concerned with the development of skills to manage forestland for uses other than timber production. Agricultural education is increasingly oriented toward the management of agro-ecosystems, i.e., the intervention in natural processes to obtain their full benefit for sustainable growth of food productivity and farm welfare. Resource engineering programs emphasize biological and social determinants of the

benefits possible from physical alterations of the environment. Prospective planners are learning how and why demographic and ecological dynamics should be included in planning criteria. The changes are fairly general and have affected the scopes of most disciplines.

Third, training in resource management is moving to a level of abstraction at which the concepts and techniques of all resource management professions are reduced to a common framework and language. The purpose is to develop possibilities for communication among professions and organizations that are adequate to the needs of environmental systems. Degree programs in general resource management have been created. They typically contain a core of "principles" courses taken by all participants, a specialized option to develop a student's depth in a particular profession or discipline, and a common quantitative methods/research component to develop multispecialization analytic skills.

The trends are mutually enforcing and may not be separable from one another in practice. In the progress of multidisciplinary studies, methods of integration are developing more slowly than the organization and data base for them, and instructors are often bound by their own disciplinary roots, whatever their intentions may be. Synthesis is usually sought through a focus on common research problems. To an extent not yet known, however, its accomplishment must be primarily the student's.

I have divided the description of new educational programs into four categories:

1. Professional education in resource management;
2. Education in resource and environmental planning and policy analysis;
3. Education in environmental sciences; and
4. Discipline-oriented education.

As will be seen, the distinctions shade but are useful in characterizing the emphases of different universities.

Professional Education in Resource Management

The University of the Philippines at Los Banos, the Bogor Agricultural Institute (Indonesia), the Malaysian Agricultural University, and Kasetsart University (Thailand) are the centers of academic expertise in agriculture, forestry, fisheries, and agricultural engineering in their respective nations. They are oriented toward providing mid-level managerial talent to the public and private sectors, and toward improvements in rural welfare through applications of science. Resource management has become a dominant theme in each.

University of the Philippines at Los Banos. The University of the Philippines at Los Banos (UPLB) is the premier agricultural university in the region by virtue of its faculty's depth. The Southeast Asian Ministers of Education Organization has its regional center for agriculture (SEARCA) at UPLB, which has served to internationalize the graduate student body. The International Rice Research Institute (IRRI) is located nearby and provides continuing stimulation and collaborative opportunities in teaching, research, and education. The Philippines Council for Agriculture and Resources Research (PCARR) is located near the campus. It has given many faculty members the opportunity to consider and influence national strategies of research.

In the past five years, faculty and student interests, research, individual graduate studies programs, and course offerings have developed in an interdisciplinary direction, largely around themes of applied ecology. Campus tone has been colored by this trend, and ecological views of disciplines and professions are pervasive.

A Master of Science program in river basin management has been in progress for two years. Administered by the Department of Land and Water Resources and Technology, it is a cross-campus program, with students and faculty from many disciplines. All students must take a common set of courses in basic concepts of water resources management, and each takes a major and minor field in separate disciplines. For example, a student may have a major in soil science and a minor in resource economics, in statistics and engineering, in sociology with forestry as a minor, or other combinations, as well as the common set of conceptual courses. A student's advisory committee contains faculty representatives from each of the three components of his or her program. Thesis research by all students is undertaken within the program's common framework of river basin studies, but each student must also satisfy disciplinary criteria set by the individual advisory committees. Some students work in conjunction with IRRI water management experts, who also participate in the program as instructors. Students' career interests are academic in some cases, professional in others; the latter group is comprised largely of staff from water resources agencies.

The Institute of Human Ecology was also formed several years ago. It offers Bachelor of Science degrees in resource management, environmental planning, and human settlements planning. Deriving from a faculty of home economics, its emphases tend to be on social units, i.e., the individual, family, community, and city, and their relations with the natural environment. The curricula are broad; to satisfy them, the institute mobilizes teachers from around and off the campus. It also coordinates a university action-research extension program in rural development.

Research programs in upland ecology and management, agro-forestry, and farming systems are absorbing large numbers of staff and graduate students, and are being used to develop course content and mechanisms for interunit collaboration. The Upland Hydroecology Project includes about twenty faculty members from almost as many disciplines. It is addressed to problems of once-forested hill areas, the productivity and watershed qualities of which have been deteriorating under years of burning and poor use. Part of the project is devoted to the development of interdisciplinary methods for analyzing upland ecosystems. Development of techniques for rehabilitating deteriorated areas is another part, undertaken in collaboration with the National Irrigation Administration and the Department of National Resources. The project provides training opportunities for graduate students and staff from provincial universities, and a national network of research sites is being established with these institutions.

The Agro-Afforestation Project, also a cross-disciplinary effort, is developing combinations of horticultural crops that can protect hillsides while increasing residents' income levels. Combinations may include, for example, trees for fuelwood, fruit and nuts, fodder and soil nutrition and stability, vegetables and grains for sale and home consumption, and livestock. The project is related to programs of the Department of Natural Resources and the Philippine Coconut Commission, to provide suitable forest tree and horticultural seeds and seedlings to upland communities.

Farming system research is expanding and diversifying rapidly. IRRI multiple cropping research has been an important source of intellectual contribution, showing how combinations of field crops, interplanted and in sequence, can increase incomes through the biological and physical effects of one crop on another. UPLB scientists are pursuing these directions for

an increasingly wide variety of conditions. For example, some are exploring various farm combinations of forestry, livestock, fisheries, crop cultivation, and waste utilization enterprises. Others are studying the management of pest-crop relations and the implications of cropping systems for water management. The possibilities are very great. Ideas are springing up rapidly, many drawn from observations of actual farm practices. The PCARR has now established a program for systematic support of such endeavors.

A large portion of the UPLB faculty is associated with such activities and rely on them for teaching materials and examples. These are having a substantial impact on the content of disciplinary and professional education. Effects are most apparent in biology, forestry, engineering, soils, agronomy, horticulture, and animal husbandry. Ecology has gained eminence on the campus. In addition, the Institute of Agrarian Reform has sponsored studies of relationships between land tenure and water management, and the Institute of Agricultural Development and Administration has participated in the planning of Bicol River Basin development; the experiences feed into instruction. The Center for Policy and Development Studies, created as a channel for university exchanges with government agencies, has sponsored symposia on natural resource policy issues.

In 1977, the Program in Environmental Sciences and Management (PESAM) was created to (1) give university-level focus to the range of independent environmental activities; (2) facilitate cross-campus projects; (3) develop new undergraduate and graduate training programs in environmental science; (4) build faculty strengths where gaps for "systems" work are apparent; and (5) enhance the exchange of information within the university and between university and government. It is coordinated by a committee representing the spectrum of campus interests. The committee offers a mechanism for campus-wide activities that would not otherwise be possible.

Bogor Institute of Agriculture. UPLB programs have developed through the adaptation of disciplinary strengths to a climate of new management issues. At the Institute of Agriculture, Bogor (IPB), an ecological tone to education and research largely preceded the development of specialized strengths. It has permeated the Bogor community, an historic center of tropical biology, and the university for a long time. Rapid development of expertise in recent years has made possible programs which give explicit form to the institution's ecological propensities and attach them to resource management issues facing the nation.

In 1970, IPB staff created a program in quantitative methods that was to make available a common base in systems analysis to all disciplinary units of the university. They also became involved in problems associated with the settlement and tidal irrigation of coastal areas in Sumatra, and in the articulation of "ecology-and-development" issues at the nearby Institute of Tropical Biology (BIOTROP), a separate institution in the SEAMEO network of regional centers. By 1974, these ingredients had coalesced in a project to train junior staff in interdisciplinary research through an omnibus study of the ecology and management of Sumatran tidal irrigation settlement areas.

Tidal irrigation is a centerpiece of Indonesian efforts to move people from crowded Java and Bali to the vast frontier lands of Sumatra and Kalimantan. It can make possible the cultivation of coastal lands, now forested and uninhabited, that are estimated to be up to six million hectares. In this type of irrigation, the cyclical movement of tidal fronts up and down rivers is used to alternately dam and divert streamflow into irrigation canals, then release and drain these waters. With a minimum of physical

investment, deltaic lands can thereby be made productive if flows are properly regulated for the various soil and crop conditions that prevail.

The soils are vulnerable. Formed in forest marsh, they need a gentle balance of submergence and exposure to maintain their fertility and structure. How they should be watered and cropped, how migrant communities adjust to their new circumstances, and what combinations of ecological and social possibility can best sustain their development are questions of some importance.

Staff of the IPB, as well as of the Bandung Institute of Technology, have been involved with tidal irrigation since the early 1970's. The omnibus study, begun in 1974, was designed to monitor changes in the Upang tidal irrigation settlement on Sumatra, to improve knowledge of suitable management techniques, and, in the process of research, to develop the analytic skills of junior faculty participants. Analyses approached the ecology and management of soil, water, farming systems, fisheries, environmental health, settlements, forest, and markets as components of a single system. Participants also shared courses in ecology, resource planning and management, and analytic techniques. As one consequence of the project, and in conjunction with the efforts of other IPB staff in assessing river basin conditions throughout Java, the base and demand for a graduate program in resource management was established. A cross-campus Master of Science program was started in 1976.

The program is administered by the Division of Environmental and Natural Resource Management of the Graduate School. It is a four-semester program with three concurrent sets of courses: a core curriculum, intended to develop a basic background in the principles and practices of resource management; a specialized curriculum to provide depth in a particular aspect

of resource management; and a curriculum in quantitative methods and research, including a thesis, to develop analytic skills.

The core curriculum is taken by all students. Ecology and resource economics are taught in the first semester, environmental and resource management in the second, and environmental planning and administration in the third. There are seven options for specialization, chosen separately for each student. Options include resource economics, quantitative ecology, land use, water resource management (suboptions in physical, biological, socioeconomic, and pollution aspects), resource policy and administration, human ecology, and conservation. All students take the courses in quantitative techniques; they can begin thesis research after the first semester.

The Center for Natural Resource Management and Environmental Studies has been established recently to guide and support the growing range of resource management activities on the campus. It has three research programs. One expands upon the coastland study; a second focuses on upland management; and a third concerns water quality. The center also provides library and research facilities, administrative assistance, and access between the university and government.

Malaysian University of Agriculture. The Malaysian University of Agriculture (UPM) is only a few years old. It differs from UPLB and IPB in that its original concept and organization reflect the recent shift of priorities toward resource management issues and the resulting needs for suitably trained personnel. It has faculties of agriculture, fisheries, forestry, resource economics and agribusiness, and science and environmental studies, as well as mechanisms for easy interaction among them. It now concentrates on undergraduate education but will begin graduate and

in-service training programs when the hundreds of staff members now abroad for doctoral studies return.

The Faculty of Science and Environmental Studies provides all science courses for other faculties. It has established an undergraduate program in environmental studies that students can take either as a major or as a minor within programs of other faculties. The program is designed to train environmental managers for service in public and private sectors. An advisory committee, composed of all faculty deans and representatives of governmental and private organizations, functions to ensure the relevance of training, academic quality, cooperation on matters of environmental concern, and employment of graduates; it is chaired by the vice-chancellor, the highest administrator of the university.

The curriculum of each student has four parts. In the first year, all students take foundation courses to establish a common base of knowledge in science, mathematics, and communication skills. The second and third years are divided between specialization and core curricula. The former, divided between biology and chemistry, is intended to give students solid control in a particular scientific discipline; additional specializations in geology-geography, for example, are anticipated. The core curriculum is taken by all students to develop broad understanding and interdisciplinary abilities. It includes courses in resource economics, sociology, ecology, analytic techniques, and soil, water, and watershed management. The fourth year is devoted to unifying courses. These are taken by all students to integrate previous learning within a common framework of management techniques. It includes courses in, for example, project evaluation, waste management and pollution control, land and water use, and environmental policy and economics. In addition, professional seminars are required, and each student undertakes an independent study.

The minor requires the foundation courses, the introductory courses in environmental studies, and courses in meteorology and hydrology, land use and the environment, energy and society, natural resource economics, and tropical ecology.

The resource economics curriculum in the Faculty of Resource Economics and Agribusiness is the first of its kind in Southeast Asia. It has the following three components: (1) general education, including required courses in the social and natural sciences, communications, mathematics, and statistics; (2) required economics courses; and (3) elective economics courses. The elective courses are used to define a student's concentration in resource economics, agricultural economics, forestry-fisheries economics, or resource management. Courses also serve students from the forestry, fisheries, and environmental science faculties.

Among his or her required economics courses, a student majoring in resource economics would take introductions to economics, natural resources, and social science during the first year. In the second year, he or she would take micro- and macroeconomics, production economics, natural resource economics, price analysis, and separate courses in fisheries, forestry, and water resources economics. The third year would include environmental resource economics, forest utilization, land economics, human resource economics, the economics of agricultural development, and natural resource planning and development. In the final year, forest planning, development, and policy, as well as a number of courses in a student's field of concentration, would complete the economics program. The range of possible electives is large.

Kasetsart University. Thailand's Kasetsart University began a Master of Science program in environmental sciences in 1977. The reasons for its

program differ from those of its fellow universities in the region. The Faculty of Forestry has developed a concentration and breadth of resource management expertise that has not been accessible to the rest of the campus, raising questions about the efficient use of staff resources. Meanwhile, land under forest cover has declined drastically. General land use has shifted from single to multiple use patterns, and government agencies have broadened the disciplinary range of staff recruitment to be able to handle the land issues under their respective responsibilities. The university is participating in a number of multidisciplinary research programs, including the Mekong Committee's omnibus study of the effects of the Nam Pong river basin development and their implications for basin planning and management. The staff have been looking for means to facilitate cross-campus activities. The university is moving to a rural location in which the mixes and conflicts among resource use are readily at hand. Finally, most universities in Thailand are developing environmental programs of one sort or another, from their comparative strengths; and Kasetsart is following its advantages in land and water resource management.

The M.S. program is administered by a cross-campus Environmental Sciences Committee, coordinated by the Department of Conservation in the Faculty of Forestry. It accepts twenty students per year, each drawn from a different disciplinary background. Students have two major subjects and one minor; their supervisory committees contain staff from each subject as well as from the program committee.

One major, environmental sciences, is taken by all participants. It is designed to progressively develop understanding of what an environmental system is, how it is analyzed, and how it can be managed. It includes required courses in human ecology, environmental science overview,

environmental economics, environmental systems analysis, environmental management, and a seminar.

Second majors are oriented toward the development of a student's specialized background. Current options are toxicology (e.g., pesticides, pollution), soil and water conservation (e.g., soil-plant relations, watershed management), conservation education and communication, socioeconomics (e.g., demography, environmental economics), natural environments (e.g., ecology), and urban environments (e.g., environmental engineering, public health, urban planning and design).

Thesis research is undertaken in a student's undergraduate specialization, which constitutes a minor subject. A core research program, with which most thesis research would be associated, is being designed.

In addition to the environmental sciences program, Kasetsart University is also developing new graduate programs in watershed management, insect ecology, and irrigation water management; all are departures from previous disciplinary emphases and faculty alignments.

While there are structural similarities among new programs in the four universities, orientations differ in complementary ways. The UPLB, for example, can be expected to achieve comparative strengths in the management of river basins and rural settlement systems, and in resource management technologies. The IPB is likely to have comparative strengths in coastal zone management and environmental systems analysis, the UPM in natural resource planning and environmental regulation, and Kasetsart in land and water resources management. Discussions about possible exchange programs among the universities have begun.

Education in Resource Planning and Policy Analysis

Programs of the national agricultural universities in Southeast Asia are giving primary attention to the professional manpower needs of resource management agencies. Others have been created with a perspective formed by interests in public policy and planning. They are imaginative, activist, and intellectually important, and are involved in developing scientific concepts to interpret and affect broad social and ecological relationships.

Environmental Education and Research Project, Mahidol University. Mahidol University, in Thailand, began its Environmental Education and Research Project in 1974. The project is an effort to consolidate environmentalists' political gains (e.g., environmental, industrial control, and urban planning laws, creation of an environmental agency and a public-interest coalition) by developing the people and knowledge required to make them effective and by advancing national thought about resource/environmental issues.

The formal purposes of the project are as follows:

1. To train professionals for work on resources and environmental issues in governmental agencies, educational institutions, and private enterprises;
2. To develop knowledge about these issues through a research program; and
3. To serve as a forum for the extension of ideas and techniques beyond the university through conferences, seminars, publications, courses, and organizational assistance.

The project is to become the Faculty of Environment and Resource Studies in 1978.

The focus of the project is its two-year Master of Science program in environmental management and technology. Fifteen entrants are selected each year on a highly competitive basis. Each is drawn from a different profession. Students have come from such diverse fields as agriculture, engineering, law, archeology, agriculture, education, economics, and health. They are also selected for a diversity of practical experience, university ties, ages, sex, and home locations. Unique to this project is the climate it sustains for intensive interaction and mutual teaching among students and staff, and for development of a strong sense of social responsibility.

The first year is devoted to a very intensive set of courses, taken together by all students, in ecology, economics, systems analysis, public policy, technology, planning techniques, and general concepts. It includes a month-long immersion in ecological field studies on an island in southern Thailand. There are also frequent field trips and lectures by government policymakers, as well as student publication of a journal for public distribution.

The second year is devoted to thesis research. Students are encouraged to do their thesis on topics related to their original disciplines, modified by dimensions added through their environmental studies. Some undertake the research in association with government agencies. Others work on a team basis within the project's framework for studies of urban-rural relationships and river basins. Research is generally oriented toward public policy and planning issues. The demand for graduates by such agencies as the National Environment Board and the National Energy Authority is much greater than can be satisfied and continues to rise.

Institute of Ecology, Pajajaran University. The Institute of Ecology at Pajajaran University in Bandung has the analogous role of intellectual

provocateur in Indonesia. It uses a research program on village ecology to train students and to expand concepts of development processes and policies on Java.

The institute's research program is addressed to understanding the structure, dynamics, and productivity of Javanese home gardens. These gardens are complex mixtures of trees, bushes, shrubs, herbs, fish, and livestock. They display levels of management, productivity, and soil quality superior to those in adjacent rice fields, and even more so to those on communal, then national, lands, which are often deteriorating. Although home gardens are important and relatively stable sources of rural well-being, and possible indicators of how densely settled Java can develop economically without current rates of environmental deterioration, they have not yet entered considerations of national development strategy.

The institute's research group includes scientists from the disciplines of ecology, anthropology, plant physiology, geography, and economics. It is studying why gardens are as they are, what they mean to home life and economy, how and why they vary over space and change over time, and what insights they may offer that would be of value to strategies of rural development. As the research progresses, the institute plans to expand its studies to the ecology of village systems (addressing, among other things, the relationship between management quality and tenurial arrangements for different kinds of village land) and to settled landscapes. The institute also has projects in environmental toxicology and aquatic ecology.

Asian Institute of Technology. The Asian Institute of Technology, an outstanding institution for graduate education in the region, is making important contributions to the training of resource and environmental planners. While it has no specific program for this purpose, it has numerous

courses and research projects which develop rigorous planning abilities. Most of these are taught by its divisions of systems, environmental, and water resources engineering. Faculty and students have led in developing planning applications of river basin and coastal systems modelling, water quality monitoring and regulation, regional and human settlement analysis, waste utilization, rural technology assessment, and energy studies. Short courses and collaborative projects, as in the Philippines' Bicol River Basin and the Thai coastal zone, and the movement of graduates into planning positions have helped make these advances available to governments.

Faculty of Tropical Medicine, Mahidol University. Mahidol University's Faculty of Tropical Medicine has been a leader in the assessment of impacts of development projects on human health, disease, and nutrition. A team from the faculty is participating in the Mekong Committee's study of north-eastern Thailand's Nam Pong Basin, a decade after its dam and reservoir system were completed. It is analyzing how and why health conditions have changed and how these changes are related to those in water regime for different kinds of settlements in the basin. It works in conjunction with teams from Kasetsart and Khon Kaen Universities, which are examining changes in land use, hydrology, agriculture, and socioeconomic conditions. It also works with agency groups studying fisheries and other environmental aspects of the basin. The Environmental Unit of the Mekong Committee, coordinator of the study, is developing means to integrate the ecological analyses into planning models. In its role, the Faculty of Tropical Medicine is expanding a kind of planning research it has pursued over some years and has used for educational purposes at the graduate level. As the hub of the SEAMEO Center for Tropical Medicine (TROPMED), its influence has been regionwide.

University of the Philippines at Diliman. The University of the Philippines' School of Economics at Diliman, the foremost economics faculty in Southeast Asia, trains many of the nation's economic planners. Staff and students have been involved in the perspective study, "Population, Resources, and Environment in the Philippine Future," and in a number of smaller studies, with the Population Institute, designed to link demographic and economic planning considerations. The university's Institute of Environmental Planning trains urban, physical, and regional planners and, in recent years, has increased the environmental content of its curricula. Staff members in the faculties of law, engineering, and education have become involved in particular aspects of environmental policy and planning. Although campus interests have not converged in common teaching programs, they have been influential through extensive government use of faculty and employment of graduates.

Development Academy of the Philippines. The Development Academy of the Philippines (DAP), created in 1973, is unique in Southeast Asia as an institution that brings academic expertise to bear on public policy and planning issues. Although not a university, it attracts academics to work part time on a range of planning studies, pilot projects, and training programs. Its basic function is to translate ideas and scattered information into effective actions. It has had some admirable successes in its short history. A perspective study of long-term relationships among population, resources, and strategies of economic and spatial planning, for example, resulted in the formation of the Human Settlements Commission as a complement to the economic planning agency. A pilot project in small-scale barrio irrigation development evolved into a national program for integrated barrio agricultural development, known as the Farm Systems

Development Corporation. The DAP also offers in-service training programs for government officials. Its tone of open professional interaction, problem-oriented intellectual commitment, and ecological perspectives of development has been influential in the universities.

Asian Development Institute. The Asian Development Institute of the United Nations, located in Bangkok, has been providing two-month environmental courses for development planners over the past three years. Its course is the only one in Southeast Asia addressed specifically to planners' requirements for environmental knowledge. For instructors, it draws from the large reservoir of national and international expertise available in Bangkok. Through the program, it has gained experience and prepared teaching materials that are of distinctive quality for training in operational aspects of the environmental issues facing government agencies. Future courses are expected to focus on the development of educational case studies, such as the Mekong Basin program, which are likely to have wide utility.

Education in Environmental Sciences

Multidisciplinary training in the natural sciences is becoming common at undergraduate and graduate levels, with ecology becoming a more prominent field of scientific inquiry and education. This is related to the trends toward problem-oriented team research among faculty and the kinds of teaching interests it promotes.

School of Biological Sciences, University of Malaya. The School of Biological Sciences at the University of Malaya offers Southeast Asia's foremost education in pure ecology. Its program is not new but has developed substantially over the past decade in association with major

ecological studies of tropical lakes and rainforest. Students can take options, honors programs, or graduate studies in ecology, with access to courses, supervision, and research projects of high quality. The faculty publishes a newsletter, "Wallaceana," several times yearly to inform scientists throughout the world of research, meetings, and publications in tropical ecology. Recently, ecologists, geographers, and anthropologists at the university have begun joint seminars and research projects, further extending opportunities for students.

Institute of Tropical Biology. Since its formation in 1968, the Institute of Tropical Biology (BIOTROP) in Bogor has provided nondegree training opportunities for thousands of biological scientists in Southeast Asia. BIOTROP draws upon expertise in the numerous scientific institutions of Bogor (e.g., National Institutes of Biology, Agriculture, Forestry, Fisheries, and the university) and from abroad for provision of particular courses lasting up to six months. Courses and symposia in pest, grassland, forest, and aquatic ecology have been particularly useful. BIOTROP publications are used to report research in tropical biology and to review the "state of the art" in various aspects of ecology.

University of the Philippines at Diliman. The University of the Philippines, Diliman, has established a doctoral program in environmental sciences, with various combinations of study possible among the biological and earth sciences. It is the first such program in the region.

School of Biological Sciences, Malaysian University of Science. The School of Biological Sciences, Malaysian University of Science, applies multidisciplinary approaches to the teaching of biology. Many courses are taught by teams of instructors from different specializations. The teaching materials are derived from research. Instructors are involved in team

research on, for example, the ecology of coastal and mangrove zones, fisheries, and the Muda irrigation system.

The Muda irrigation system is one of the most notable successes among agricultural development projects in Southeast Asia. Crop productivity and farm welfare have risen dramatically in a brief decade and have placed the Muda Agricultural Development Authority in a position to consider ecological and social consequences of agricultural intensification that had not previously seemed urgent. Of particular interest are the effects of changes in water regime on soil chemistry and structure, lush crop environments on pest dynamics and damage, agricultural chemicals on fisheries, and land tenure patterns on farmer incentives and practices. Natural scientists from the School of Biological Sciences are studying the ecological issues to find management tools and genetic stock that can increase the sustainable productivity of the irrigation system. Social scientists, through the university's Center for Policy Studies, are mapping land tenure patterns and correlating these with agricultural productivity and socioeconomic welfare. Both projects involve graduate students.

Institute of Environmental Research, Chulalongkorn University. The Institute of Environmental Research, Chulalongkorn University, in Thailand, has a role analogous to that of the Center for Policy Studies. It promotes interdisciplinary research that might otherwise be hindered by university structure and encourages research on problems of social importance. In one of its projects, for example, a large group of natural and social scientists is examining competition among land and water uses in the urban-rural fringe north of Bangkok. The group is studying social, economic, and ecological dynamics of resource use in the area, effects these have on the welfare of the different populations, and how they are influenced by market forces,

government agencies, public policies, and laws. Ultimately, it intends to develop a framework for integrated planning and regulation of land and water use. The immediate effect is felt in the content of university courses.

The Disciplines

Throughout the previous sections, I have suggested that the character of disciplinary education is changing with its content. Some disciplines deserve specific mention for the strength and value of their responses. These include geography, anthropology, demography, engineering, and agriculture.

Geography. Geography is becoming a forceful discipline in Southeast Asia, shifting from a descriptive emphasis toward an analytic one. Its strengths, and the relevance of its applications, are most apparent in the faculties of Chieng Mai University (Thailand), Gaja Mada University (Indonesia), and the University of Malaya. Chieng Mai geographers are moving effectively into problems of land and water use. Those at Gaja Mada have undertaken analyses of river basin systems that will make a difference in future planning concepts. University of Malaya geographers are contributing valuable analyses of environmental changes in land development areas and of shifts in population and settlement patterns.

Anthropology. Anthropology has been the first among the social sciences to attempt social analysis of contemporary resource and environmental issues. Anthropologists increasingly are applying their traditional "systems" perspectives to problems of development and, in the process, are providing a framework to which other disciplines can be attached. This has occurred most notably in the Institute of Philippine Culture, Ateneo de

Manila, which has undertaken studies of the Bicol River Basin development program and its impacts, effects of land tenure on agricultural productivity, the effectiveness of different modes of organization for water management, and others of contemporary significance.

Demography. Demography has become a field of some importance for development planning, which is gradually incorporating population/resource variables. Chulalongkorn University's Institute of Population Studies has built a solid base of research on migratory and population growth patterns in Thailand, and the University of the Philippines' Population Institute has been an essential contributor to progress in relating population variables to prospects for economic growth.

Engineering. Engineers have led in the development of new responses to resource and environmental management issues, and their expansion of disciplinary scope, beyond the technician stereotype, has been remarkably rapid. Academic centers of this transformation have been the Asian Institute of Technology, Chulalongkorn University, and Bandung Institute of Technology (Indonesia).

Agriculture. Agricultural scientists have moved rapidly from an emphasis on commodity production toward one on farming systems, and are expanding the range of cultivated lands with which they are concerned. The University of the Philippines at Los Banos, Chieng Mai University, and the Institute of Agriculture, Bogor, have led this movement.

Chieng Mai, Khon Kaen, and Central Luzon State Universities. In several universities, parallel developments of several or more of these disciplines have been converging on common problems and interests. This is particularly apparent in nonmetropolitan universities, which tend to be youthful and closely tied to their social and environmental settings, and

where young faculties are being built for disciplinary strengths suited to surrounding conditions.

At Chieng Mai University, for example, independent directions in anthropology, geography, and agriculture are now combining in research programs on highland, upland, and lowland agricultural systems management. Khon Kaen University's emerging strengths in agriculture and engineering are converging on common interests in upland farming systems, the management of irrigated agriculture, and water conservation. Central Luzon State University, by virtue of its progress in engineering and agriculture, has become a Philippine center for research and education in crop-water management. In each case, programs of unique national quality are being achieved. If future staff and program development occurs around them, as seems likely the universities will gain distinctive positions in resource management education.

III. SUMMARY

The growth of interest in natural resources and the environment is having an important impact on higher education in Southeast Asia. I have attempted to describe why such growth has occurred, how it has altered ideas about development, and what its specific impacts have been on higher education. I have noted the complementary progress of thought in governmental and academic communities, and the mutual support that is emerging as a result. And I have implied that patterns of change within each nation of Southeast Asia have distinctive qualities; the mutual benefits of comparative strengths in governmental and academic enterprise can eventually become available to the region as a whole.

At this stage, every educational program I have listed is exploratory. Faculty and students are pioneering in a very real sense, using the freedom of interdisciplinary endeavor to define a scholarship relevant to their situations. Guidelines are few; concepts and methods for the new "integration" remain elusive. What they will become, how students will translate their learning, and with what effects on national development are questions of some significance in this search for a structure of scholarship and education rooted in home soil.

Thus far, the path has been cut largely by the natural and technical scientists. I think this is because environmental issues have tended to be defined in terms of technical rather than social relations. With some notable exceptions, social scientists have not moved far from where they were in 1970. Presumably, this will change as needs for general policies, and their requisites of knowledge about social processes, organization, and effects, gain priority. In my view, consolidation of present trends in research and education requires a movement in the social sciences parallel to that occurring in the natural and technical science fields.

Exchange of ideas, experiences, techniques, and teaching materials among universities is bound to be creative and beneficial when it begins. Shortcuts might be easily learned from the hard-gained lessons of others, and common problems, subjected to collective scrutiny, might be more easily resolved. In education, exchanges seem to have particular promise among institutions within the categories I have used to classify programs: resource management, resource/environmental policy and planning, environmental sciences, and selected clusters of disciplines. In research, exchange among groups with common interests in river basins, area development, urban environments, farming systems, or population/resource/development

relationships would be valuable. Most programs have reached the stage where such exchanges can be productive.

It is not apparent where program innovations are leading, and what the shape of higher education will be when they arrive. But when we view them collectively, the trends seem powerful and bound toward outcomes as vital as the forces motivating them. Their uncertainties add to the adventure.

APPENDIX

The following people might be contacted for information about their programs:

University of the Philippines at Los Banos, College, Laguna, The Philippines

M.S. Basin Approach to Water Resources Management	Dr. Wilfredo David
Upland Hydroecology	Dr. Percy Sajise Dr. Romeo Raros
Agro-Forestry	Dr. Raphael Creencia
Farming Systems	Dr. Arturo Gomez
Environmental Science & Management	Dr. Ramon Nasol
Southeast Asian Regional Center for Agriculture (SEARCA)	Dr. Jose Drilon
Forestry	Dr. Romulo Castillo
Resource Economics	Dr. Remigio Torres

Institute for Agriculture, Bogor, Bogor, Indonesia

Center for National Resource Management & Environmental Studies	Dr. Soeratno Partoatmodjo
Coastlands	Dr. Koesoebiono, M.Sc.
Water Quality	Dr. Tjang M. Sucamihardja
Upland Management	Dr. Bedjo Soewardi
M.S. Resource & Environmental Management	Dr. Gunarwan Soeratmo
Farming Systems	Dr. Fred Rumawas
Natural Resource Policy & Administration	Dr. Herman Haeruman
Resource Economics	Dr. Affendi Anwar

Malaysian University of Agriculture, Serdang, Malaysia	
Environmental Sciences	Dr. Araffin D. Suhaimi
Resource Economics	Dr. Radzuan B. Abdul Rahman
Forestry	Dr. Manap B. Ahman
Kasetsart University, Bangkhen, Thailand	
M.S. Environmental Sciences	Dr. Kasem Chunkao
Chieng Mai University, Chieng Mai, Thailand	
Faculty of Agriculture Multiple Cropping Project Upland Farming Systems Project Highland Agronomy Project	Dr. Boonyawart Lumatopong
Irrigation Organization/Geography	Dr. Vanpen Surarerks
Upland Systems Modelling	Dr. Manu Seetisarn
Khon Kaen University, Khon Kaen, Thailand	
Water Resources	Dr. Chalong Kirdpitugsa
Upland Cropping Systems	Dr. Aran Patanothai Dr. Terd Charoenwatana
Mahidol University, Bangkok, Thailand	
M.S. Environmental Resource Management & Technology	Dr. Nart Tuntawiroon
Faculty of Tropical Medicine/Southeast Asian Center for Tropical Medicine (TROPMED)	Dr. Chalong Harinasutra
Pajajaran University, Bandung, Indonesia	
Institute of Ecology	Dr. Otto Soemarwoto
Asian Institute of Technology, Rangsit, Thailand	Dr. Robert Banks

University of the Philippines at Diliman, Quezon City, The Philippines	
School of Economics	Dr. Jose Encarnacion
Institute of Environmental Planning	Dr. Leonardo Viloria
Population Institute	Dr. Mercedes Concepcion
Population, Resources & Environment for the Philippine Future	Dr. Mahar Mangahas
Development Academy of the Philippines, Quezon City, The Philippines	Dr. O. D. Corpus
Asian Development Institute, Bangkok, Thailand	Dr. Vinyu Vichit-Vadakan
University of Malaya, Kuala Lumpur, Malaysia	
Ecology/Wallaceana	Dr. Jose Furtado
Geography	Tunku Shamsul Bahrin
Southeast Asian Center for Tropical Biology (BIOTROP), Bogor, Indonesia	Dr. Ishemat Soerianegara
Malaysian University of Sciences, Penang, Malaysia	
School of Biological Sciences	Dr. C. P. Ramachandran
Center for Policy Studies	Dr. Kemel Saleh
Chulalongkorn University, Bangkok, Thailand	
Institute of Environmental Research	Dr. Twesakdi Piyakarnchana
Institute of Population Studies	Dr. Visid Prachuabmoh
Ateneo de Manila, Quezon City, The Philippines	
Institute of Philippine Culture	Dr. Mary Hollsteiner
Bandung Institute of Technology, Bandung, Indonesia	Dr. Tisna Amidjaja
Environmental Impact Assessment	Dr. A'at Soeriatmadja

Gaja Mada University, Jogjakarta, Indonesia

Resource Economics/Forest and Watershed Planning	Dr. Achmad Sumitro
River Basins	Dr. Sugene Martopo Dr. Soetanto

Mekong Secretariat, Bangkok, Thailand

Environmental Unit	Dr. V. R. Pantulu

International Rice Research Institute, Los Banos, Laguna, The Philippines

Water Management	Dr. Thomas Wickham
Cropping Systems	Dr. Hubert Zandstra

In addition, the following might be contacted for national overview of educational and research activities in resource management:

National Research Council of Thailand, Bangkhen, Thailand	Dr. Sanya Sabharsi, Secretary-General
National Environment Board of Thailand, Bangkok, Thailand	Dr. Prom Panitchpakdi, Secretary-General
Inter-Agency Committee for Ecological Studies/Philippine UNESCO Man & Biosphere Comm., Manila, The Philippines	Dr. Estela Zamora, Chairman
Philippine Council for Agricultural and Resources Research, Los Banos, Laguna, The Philippines	Dr. Senen Miranda, Director, Division of Soil, Water & Farming Systems
Agricultural Development Council, Singapore	Dr. Ralph Retzlaff, Regional Representative
Ministry of State, Indonesia, Jakarta, Indonesia	Dr. Sumitro Djojohadikusomo, Minister
Malaysian UNESCO Man and Biosphere Comm., Kuala Lumpur, Malaysia	Dr. K. D. Menon, Chairman

Other Papers In This Series

Experiences in Rural Development: A Selected, Annotated Bibliography of Planning, Implementing, and Evaluating Rural Development in Africa, by Tekola Dejene and Scott E. Smith, August 1973. **OLC Paper No. 1.**

Education Sector Planning for Development of Nation-wide Learning Systems,* by Frederick H. Harbison, November 1973. **OLC Paper No. 2.

Reflections on the Comilla Rural Development Projects, by Akhter Hameed Kahn, March 1974. **OLC Paper No. 3.**

The Growth and Development of Nigerian Universities,* by A. Babatunde Fafunwa, April 1974. **OLC Paper No. 4.

The Reorganization of Higher Education in Zaire,* by William Rideout, March 1974. **OLC Paper No. 5.

Inter-Disciplinary Research on Rural Development: The Experience of the Rural Economy Research Unit in Northern Nigeria, by David W. Norman, April 1974. **OLC Paper 6.**

Visiting Scholars in the U.S. During the 1974/75 Academic Year (Africa, Asia, Latin America/Caribbean),* by OLC Staff, November 1974. **OLC Paper No. 7.

The Sahelian Drought and its Demographic Implications, by John C. Caldwell, December 1975. **OLC Paper No. 8.**

African Women in Agricultural Development: A Case Study in Sierra Leone, by Dunstan S.C. Spencer, June 1976. **OLC Paper No. 9.**

Economic Research on Women in Rural Development in Northern Nigeria, by Emmy B. Simmons, September 1976. **OLC Paper No. 10.**

Some Current Issues in American Higher Education: An Address Presented to the Conference of Commonwealth Vice-Chancellors, by Alan Pifer, November 1976. **OLC Paper No. 11.**

African Women in Rural Development: Research Trends and Priorities, by Achola O. Pala, December 1976. **OLC Paper No. 12.**

Rural Development Network Bulletin (Issued two to three times a year in English, French and Portuguese)

Single copies of these OLC papers and information about other OLC publications may be obtained without charge by writing to:

Overseas Liaison Committee
American Council on Education
Eleven Dupont Circle
Washington, D.C. 20036 U.S.A.

*Currently Out of Print