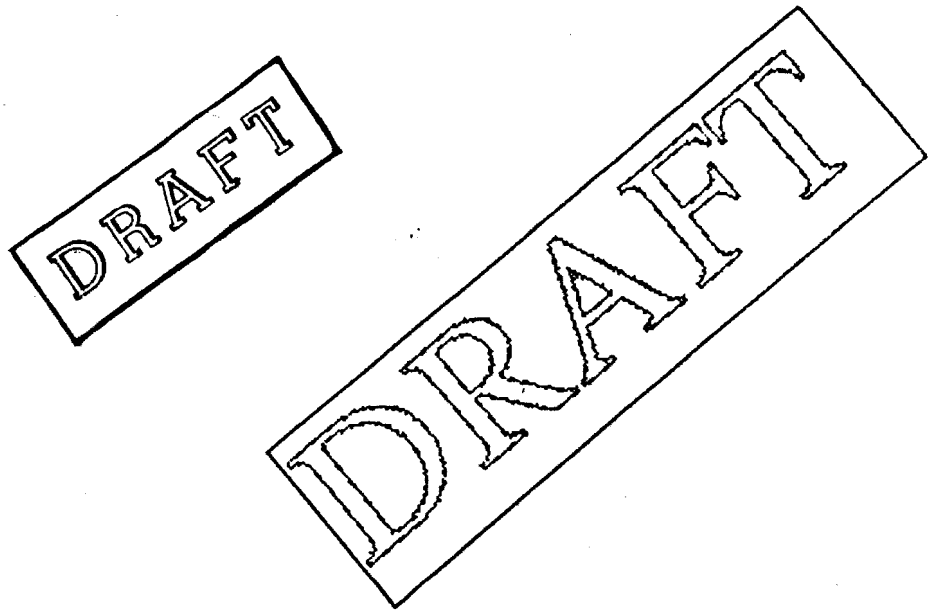
NAREPP
UNIVERSITY PROGRAMME

Assessment and Recommendations



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EXECUTIVE SUMMARY

The Natural Resources and Environmental Policy Project (NAREPP) was implemented by USAID and the Government of Sri Lanka to enhance Sri Lanka's ability to manage its environment and natural resources. The training and education component of NAREPP calls for strengthening four Sri Lankan universities -- The University of Colombo, The University of Moratuwa, The Open University of Sri Lanka, and The University of Peradeniya -- to enable them to develop a variety of programmes designed to meet immediate and ongoing environmental manpower needs. Major programmes at the four universities are environmental science at Colombo; environmental engineering at Moratuwa; environmental law and journalism and wildlife management at the Open University; and interdisciplinary environmental studies, natural resource management, and environmental economics at Peradeniya. An assessment of the NAREPP University Programme was carried out from March 21 to April 9, 1993 to determine the current status of programme activities at each university, identify strengths and weaknesses of each programme, provide recommendations for strengthening the Programme, and examine the roll that universities can play in achieving the short- and long-term goals of NAREPP, e.g EIA, pollution control, and incorporating environmental economics into decision making.

Role of Universities

Sri Lanka is facing serious and growing environmental and resource management problems and action is needed to develop environmental policies, formulate regulations to implement those policies, create agencies to carry out those regulations and manage resources and the environment, and provide technical and professional manpower for these agencies. These actions are important and necessary, *but they are not sufficient!* Environmental policies must reflect the environmental concerns and needs of the people of Sri Lanka and their leaders. This requires that Sri Lankans recognize that they have environmental problems and understand how these problems affect their lives. This requires environmental education and training at all levels. Further, environmental education must be based on an understanding of environmental problems, the ecological underpinnings of these problems, and how natural resource and environmental management can be carried out in Sri Lanka. This is a major task that will require new approaches to teacher education and the education of a new breed of environmental scientists, engineers, and managers. This role falls to the universities. Strengths of the universities include:

- **Training and Education**: Universities are uniquely qualified to carry out short-term training on environmental topics and techniques and are the only institutions equipped and qualified to provide the long-term education needed to prepare the environmental professionals of the future.
- **Multiplier Effect**: Investment in higher education has a multiplier effect. To maximize the impact of an educational program, *teach teachers.* Train six university lecturers in environmental impact assessment and they will teach the rest.
- **Stability**: University faculties are extremely stable. Investments in upgrading faculty are excellent long-term investments.
- **Learning and Research**: Universities go beyond imparting information. They are in the business of generating new knowledge and understanding. This is extremely important when dealing with complex problems such as environmental and natural resource degradation where we know little about the causes and less about the possible solutions.

- **Interdisciplinarity**: Sri Lanka needs people who recognize the complexity of environmental issues. Universities can provide leadership in this effort by developing new courses and curricula that cut across disciplinary lines and integrate information from various disciplines.

University Programs: Strengths, Weaknesses and Needs

Programmes at all four universities share similar or identical strengths, weaknesses and needs. All involve dedicated and capable faculty and are led by individuals with stature and vision. All enjoy support from their central administrations, and each has particular strengths associated with the type of programme and the university's facilities and setting, e.g. seven faculties on one campus at Peradeniya, the audio-visual facility at OUSL, etc.

Unfortunately, all four universities also share serious weaknesses common to most university programmes in developing countries. There are serious shortages of books and journals, laboratory and field analytical equipment, transportation capabilities, etc. Students don't read because text books are not available. Teaching is hampered by a dearth of Lanka-based audio-visual materials. Faculty are overworked and faculty development and the advancement of environmental science is limited by poor communications facilities; scientists are essentially cut off from each other and from colleagues in the rest of the world. Faculty and administrators are inexperienced in the art of grantsmanship and are, therefore, totally dependent on appropriated funds and the more or less regular contributions from international donor agencies. Finally, faculty are inexperienced in designing and carrying out interdisciplinary programmes, an essential ability in environmental studies.

Because of these shortcomings, faculty frustration, especially among young faculty, is high, as is the temptation to leave Sri Lanka for greener pastures in the West. Critical needs include: funds for enhancing library collections, improving fax and e-mail communications, and purchasing vital equipment and supplies; assistance in developing linkages with colleagues and programmes in the West; funds for developing Sri Lanka-based reading materials and audio-visuals for teaching; and assistance in learning how to pursue outside funding and how to carry out interdisciplinary research, teaching, and contract work. Steps in this latter direction have been initiated with the MARD project and with the European Community programme in the Mahaweli Authority.

Needs and Strategies are discussed in detail in the report and university strategies for correcting weaknesses are suggested.

Recommendations

1. **Curriculum Development:** NAREPP should give immediate and high priority to facilitating and supporting environmental and natural resources curriculum development at the four universities. This would include providing support for an interinstitutional curriculum planning process, the production of a series of written modules to be used as text materials for the curriculum, the production of a set of videos on topics related to the curricula, and efforts at the universities to get faculty approval for making environmental courses part of core curricula.

2. **Interdisciplinary Teaching:** NAREPP should assist faculty in their efforts to learn how to teach interdisciplinary courses by sponsoring workshops and study tours to expose teaching faculty to teaching strategies and techniques common in interdisciplinary, problem

focused environmental studies. This should include organizing workshop in Sri Lanka to train faculty in interdisciplinary course design, instructional strategies, use of field exercises and group projects, and evaluating group projects. Further, NAREPP should send a select group of instructors to the U.S. to spend one month at a university participating in interdisciplinary courses. This could be arranged at Ohio State University.

3. **Short-term Training:** NAREPP's long-term goal in short-term training should be to prepare the universities to assume responsibility for serving this need. NAREPP should organize a workshop to prepare university faculty and administrators for managing short-term (extension) training programmes, include university faculty in all NAREPP short courses as training exercises, and work with the universities to explore ways of coordinating and sharing opportunities and responsibilities for short-term training programmes to minimize wasteful competition and maximize the use of university expertise.

4. **Interdisciplinary Research:** NAREPP should place high priority on stimulating interdisciplinary research at the four universities on environmental and natural resource problems and on helping faculty and their universities identify opportunities and funding for interdisciplinary contract projects and research, organize themselves to be successful in competing for such grants and contracts, and manage the projects once they are awarded.

5. **University Reward Systems:** NAREPP should work with faculty developing interdisciplinary environmental and natural resource programmes to alter university reward systems and financial modalities that stifle interdisciplinary activity.

6. **Faculty Development:** NAREPP should support short-term upgrading of senior faculty at the four universities to familiarize them with critical new fields in environmental and natural resource science, engineering and management, including short courses, workshops, and study tours. NAREPP should also seek USAID support for doctoral training of select junior faculty to fill critical needs in the university system, e.g. Ecological Engineering, Integrated Resource Management, and Environmental Economics. NAREPP should also support study tours to expose faculty to ongoing projects and programmes in critical new fields.

7. **Linkages:** NAREPP should facilitate the establishment of linkage programmes between programmes at the four universities and similar programmes in the U.S. or elsewhere. NAREPP can immediately facilitate the establishment of a multifaceted linkage programme between the four universities and The Ohio State University. NAREPP could stimulate the development of linkages between Sri Lankan environmental programmes and those in other countries and provide much needed visibility for Sri Lankan problems and programmes by sponsoring an international conference in Sri Lanka that would focus on Education and Training for Sustainable Development in Developing Countries. The International Society for Environmental Education (ISEE) is willing to work with NAREPP and the universities to plan, organize, and run this conference.

8. **Communications:** NAREPP should assist universities in obtaining fax machines and establishing e-mail capabilities and in the preparation of a Directory of Environmental and Natural Resource Experts in Sri Lankan Universities.

9. **Library Collections:** NAREPP should increase its allocation for the purchase of books and journals.

INTRODUCTION

The Natural Resources and Environmental Policy Project (NAREPP) was implemented by USAID and the Government of Sri Lanka to enhance Sri Lanka's ability to manage its environment and natural resources. The training and education component of NAREPP called for a variety of educational and short-term training programs to meet the nation's environmental manpower needs at the technical and professional levels. Early plans provided for the education of eleven (11) Master's-level professionals at universities outside Sri Lanka, primarily in the United States. This plan was abandoned when it was decided that the funds needed for foreign education could be more productively invested in strengthening Sri Lankan universities, enabling them to develop a variety of programmes designed to meet immediate and ongoing environmental manpower needs. In 1992, four universities -- The University of Colombo, The University of Moratuwa, The Open University of Sri Lanka, and The University of Peradeniya -- were selected for strengthening in various environmental and natural resources management fields.

Major programmes at the four universities are environmental science at Colombo; environmental engineering at Moratuwa; environmental law and journalism and wildlife management at the Open University; and interdisciplinary environmental studies, natural resource management, and environmental economics at Peradeniya. Specific programme development objectives as stated by the four universities are:

University of Colombo - Enhance existing BSc and MSc degree programmes and initiate a new diploma course in Environmental Science; develop courses through SLIDA to train public service personnel in environmental planning and management and in sustainable development; and create an environmental consultancy unit at the university .

University of Moratuwa - Develop the Master's degree programme in environmental engineering; develop short-courses in environmental impact assessment (EIA); develop curricula for teaching EIA for BSc and MEng courses; establish a computer modelling unit in collaboration with the Central Environmental Authority; and pursue consultancy work on EIA.

Open University of Sri Lanka - Strengthen existing certificate course in wildlife management; develop an interdisciplinary post-graduate diploma course in natural resource management; produce and present certificate courses in environmental law and journalism; and enhance the engineering programme by introducing a certificate course in environmental engineering, strengthening present environmental and ecological components in the engineering degree, and developing short-courses on industrial environmental hazards.

University of Peradeniya - Develop an interdisciplinary Certificate Course in Environmental Awareness for undergraduates; implement new MSc programmes in environmental economics and natural resource management in the PGIA; develop a post-graduate diploma course in EIA; develop short courses in EIA and other areas for government officials and the private sector; and create a Centre for Environmental Studies.

An assessment of the NAREPP University Programme was carried out from March 21 to April

9, 1993 to determine the current status of programme activities at each university, identify strengths and weaknesses of each programme, provide recommendations for strengthening the Programme, and examine the roll that universities can play in achieving the short- and long-term goals of NAREPP, e.g EIA, pollution control, and incorporating environmental economics into decision making. The specific Scope of Work was:

1) Consult with M/EPA and representatives of key university faculties to establish basic requirements for multi-disciplinary education programmes using both individual meetings and inter-university workshops;

2) assist the faculty representatives in organizing multi-disciplinary teams as required to strengthen the quality of NAREPP-supported university programmes;

3) identify curriculum requirements specific to the multi-disciplinary process and to the individual needs of each NAREPP-supported faculty;

4) assist the multi-disciplinary teams in identifying and pursuing resources in addition to those provided by NAREPP (e.g., relationships with other U.S. universities, producing grant proposals for multi-disciplinary teaching and research consistent with NAREPP/NEAP (National Environmental Action Plan) priorities; and

5) produce an action plan which identifies progress in each of the preceding areas made during the consultancy and which provides specific direction for continuing the strengthening process.

ASSESSMENT PROCEDURES

Visits were made to each of the four universities where discussions were held with University, Faculty and Departmental administrators and with faculty members in relevant programs. Visits included tours of teaching facilities, laboratories, audio-visual and radio-TV facilities, computer facilities, and libraries. Discussions covered all aspects of interdisciplinary environmental program development, including curriculum development, teaching methodologies, textbooks and other support materials for courses, laboratory facilities, faculty work loads and the reward system, budgetary issues in programme development, attracting students to courses, developing useful short courses and marketing them, the need for interdisciplinary projects for faculty and students, specific programme needs, roles the universities could or should play in environmental education and training and why, institutional constraints that interfere with such activity, and how the university system might respond to problems facing Sri Lanka as a result of environmental degradation. Visits were also made to the Ministry of Environment, the Central Environmental Authority, NARESA, the University Grants Commission, and USAID. Written materials from each university and agency were collected and reviewed. Visits were also made to the Mahaweli Agriculture and Rural Development project in Pimburettewa and to the Commission of the European Community to discuss potential collaboration between U.S. and E.C. projects and Sri Lankan universities. A total of sixty nine (69) individuals were interviewed. A complete list is provided in APPENDIX A.

ROLE AND IMPORTANCE OF THE UNIVERSITIES

> **If you are planning for one year, plant rice.**
> **If you are planning for ten years, plant trees.**
> **If you are planning for one hundred years, educate the people.**
>
> ***Confucius***

Sri Lanka is facing serious and growing environmental and resource management problems not unlike those encountered in developing countries throughout the tropics. Immediate action is needed to develop policies on environmental quality and resource conservation, formulate regulations to implement those policies, create agencies charged with the responsibility for environmental protection and integrated natural resource management, and provide the technical and professional manpower needed to insure that these agencies can effectively execute their missions. NAREPP is working with the Government of Sri Lanka to accomplish or at least initiate these actions. These actions are important and necessary, *but they are not sufficient!*

National policies are expressions of the value system of the country, and their legitimacy and effectiveness are determined by this fact. Crash programmes to promulgate policies to address critical environmental and natural resource problems, policies patterned after those in the West, are necessary first steps that focus the attention of decision makers on these critical problems. Similarly, the transfer of environmental techniques such as those used in environmental impact assessment, environmental audits, and environmental economics are also appropriate and important first steps. But, these are short-term measures. In the long-term, the problem is not a lack of laws and techniques -- it is a lack of understanding and will -- social, economic and political will. Ultimately, natural resource and environmental policy in Sri Lanka will have to evolve from the Sri Lankan experience and reflect the values of Sri Lankan society. Environmental policies must reflect the environmental concerns and needs of the people of Sri Lanka and their leaders. This requires that Sri Lankans recognize that they have environmental problems and understand how these problems affect their lives and the lives of their children and grandchildren. Some of this heightening of environmental awareness and concern can be accomplished by short-term training and the use of radio and television. In the long-term, however, environmental education must be incorporated in curricula at all levels of the educational system - primary, secondary, higher, and extension education. Further, environmental education must be based on an understanding of the environmental problems facing Sri Lankan society, an understanding of the ecological underpinnings of these problems, and an understanding of how natural resource and environmental management can be carried out within the social, economic, and political milieu of modern Sri Lanka. This is a major task that will require new approaches to teacher education and the education of a new breed of environmental scientists, engineers, and managers. This role falls to the universities.

> **"People in the East don't know enough to be aware that they have environmental problems."**
> **G.K. Amaratunga, Chairman, CEA**

Training and Education

Sri Lankan resource and environmental agencies are hampered in carrying out their missions, because their staff members do not possess the technical skills needed for the job. One approach to this problem is short-term technical training for agency personnel. This is necessary, given the urgent need for technical capabilities in these agencies, but it is not sufficient. Ultimately, these agencies must be staffed by competent professional scientists and

managers who are broadly educated and knowledgeable in their fields. Techniques must be applied within a broader scientific and management context, a context provided only by competent professionals. Competent professionals will also be needed by other employers in Sri Lanka as the society becomes more aware of environmental problems and more demanding of its industrial and business sectors. The responsibility for producing these environmental and resource professionals falls to the universities. They will need assistance in developing new programs to satisfy this manpower need.

Multiplier Effect

To maximize the impact of an educational program, *teach teachers*. Investment in higher education has a multiplier effect. Train six university lecturers in environmental impact assessment and help them start an EIA course and they will be able to teach hundreds of agency, industry, and NGO staff in that technique. Further, they will reach hundred or even thousands of university students with this new information. By working through the universities we institutionalize educational programmes, both long-term education and short-term technical training. Universities should be encouraged to develop and teach more short courses for government, business, industry, and private citizens.

Stability

The impact of investment in technical environmental and resource training for agency staff members is often reduced as these staff members move within the Sri Lankan Administrative Service. University faculties, on the contrary, are extremely stable. Investments in upgrading faculty are rarely jeopardized by those faculty members leaving their fields or institutions, and are, therefore, excellent long-term investments.

Learning and Research

Universities go beyond imparting information. They are in the business of generating new knowledge and understanding. This is extremely important when dealing with complex problems such as environmental and natural resource degradation where we know little about the causes and less about the possible solutions. Universities can provide inputs in the form of data and information on environmental conditions; analysis and interpretation of such data and information; improvement of assessment, analytical, and decision-making techniques; case studies of specific problems and social processes, assessment of relative risks, recommendations for social and political action, and others.

Interdisciplinarity

Environmental and natural resource problems are extremely complex, involving ecological, physical, economic, political, and cultural aspects. These problems cannot be solved by individuals working in any single discipline. We must learn to bring experts from different disciplines together in an integrated effort to understand and solve these problems. This will require a new way of thinking and new types of professionals. We need people who recognize the complexity of these issues, their causes, and their solutions. Universities can provide leadership in this effort by developing new courses and curricula that cut across disciplinary lines and integrate information from various disciplines.

UNIVERSITY PROGRAMS
Strengths, Weaknesses, and Needs

UNIVERSITY OF COLOMBO

The MSc Programme in Environmental Science

> **"Our programme fills the need for environmental science in the country."**
>
> **Prof. K. D. Arudpragasam**
> **Dean of Science, U. Col.**

This is a well-establish programme, having graduated six batches of students since 1980. It is undoubtedly the premier environmental science programme in the country and should be strengthened before new environmental science programmes are started elsewhere. Strengths of the programme include its interdisciplinary base involving faculty from various departments in the Faculty of Science, its attention to scientific rigor, its dedicated and capable faculty, and the strong support that it presently enjoys from the Dean of Science and the central administration. There is an attempt to integrate information from various disciplines, especially in the "Man and the Environment" course taught by Dr. Kanthi Abeynayake. A major strength of this programme is the research component; students have to carry out a project, analyze their results and write theses. There is need for more of this in environmental and natural resource curricula in Sri Lanka. Major weaknesses of this programme are typical of science programmes in developing countries, e.g. lack of adequate laboratory and field equipment, inadequate library collections, and problems associated with requiring outside reading in the courses. Because library holdings in environmental science are inadequate and textbooks are too expensive, students depend almost entirely on lecture notes for learning. This would be a serious problem at any level, but it is especially troubling at the post-graduate level. Master's and doctoral students must have access to the literature in their fields and to textbook materials in their courses. Unless students can read, they cannot learn to learn on their own. Unless they are able to learn on their own, they will never be able to create new ideas, knowledge, and methods, and this is what society must be able to expect from those with post-graduate degrees.

> **"Our students don't read."**
>
> **Faculty Member**
> **Univ. of Colombo**

Biodiversity Unit

Noting that Sri Lanka is the southern-most land mass in South Asia and is extremely rich in biodiversity and endemism, Prof. K. D. Arudpragasam, Dean of Science at the University of Colombo, is supporting the establishment of a Biodiversity Unit at this university. This effort is at the conceptual stage at this time, but Prof. Arudpragasam is attempting to "formalize a process to bring the appropriate expertise together." Sri Lanka is indeed an ideal location for a significant, even international, programme on biodiversity. This effort should be strongly encouraged and supported by the Government of Sri Lanka through appropriate Ministries, the University Grants Commission, and NARESA. Outside support should also be sought from international agencies such as USAID and the World Bank.

It is very important that this effort at the University of Colombo be integrated with similar efforts at the Open University of Sri Lanka and the Sri Jayawardhanapura University. These two universities have joined forces and received clearance and support from the UGC to establish a National Centre for the Conservation of Biodiversity at a site near Bundala.

> **"I would like to be able to get together with other environmental toxicologists, but I don't know if there are any."**
>
> **Dr. Ajantha Perera**
> **University of Colombo**

Collegiality

Faculty members at Sri Lankan universities have little opportunity to get to know colleagues at other universities in the country or in other departments or faculties in their own universities. Measures should be taken to facilitate communication and exchange between scientists and scholars working in the same and similar fields. Measures should also be taken to

facilitate communication and interaction between faculty in different disciplines working on similar environmental and natural resource problems. This could include a directory of environmental and natural resources faculty members including indications of their research and teaching interests. Such a directory could also be expanded over time to include researchers in governmental agencies, industry, and business. Similarly, there could be a regular newsletter for communication among environmental and natural resource specialists. Workshops and seminars on selected topics could also be organized to bring together researchers and teachers with similar training and interests. These could be announced in the newsletter mentioned above. Optimally, those working in environmental and natural resources fields could create a professional society. All of these things require that someone of some institution assume responsibility for organizing and managing the efforts. This could be done by the UGC, NARESA, or one or more universities. International donors such as USAID/NAREPP can assist with logistical support in getting these efforts started, but they should not assume long-term responsibility for them. Collegiality measures are best left to the participants -- the collegians.

Short-Term Training

The University of Colombo is hoping to develop a series of workshops and short courses designed to reach higher-level government officials, possibly through SLIDA. Because of its location in the national capital, it is in a good position to do this. Its capabilities for this task are also enhance by the broad spectrum of faculty expertise at this comprehensive university. There is no doubt that higher officials require concise, well packaged information. Seminars and short (half-day) workshops could have a significant impact on how higher officials see and interpret environmental and natural resource issues. Longer programmes might focus on senior staff members for these officials; staff often do most of the background work in policy drafting anyway. One problem with focusing too closely on higher officials is that they shift in their positions and therefore their responsibilities on a relatively short-term basis. Attention must also be given to training at lower levels, especially at the Divisional level.

> **"Currently, environment has no major part to play in policy making. We must reach Sri Lankan policy and decision makers."**
>
> **K. D. Arudpragasam**

Short-term training through workshops and seminars is a public service activity that universities are uniquely suited to do. University programme organizers must realize, however, that this type of activity is "demand driven." For this reason, universities wanting to get into this type of education must develop market survey and advertising capabilities to identify needs and let potential clients know what you are offering. Extension or outreach programming must be run like a business, and in business "demand" determines success. It does not matter how good a workshop you organize, if nobody comes or those who come don't get what they need or what they perceive that they need. The key is "find a need and fill it - and market what you are doing."

Consultancy

The University of Colombo is planning to develop a Consultancy Unit to facilitate faculty involvement in real-world problem solving. Similar efforts are being undertaken at Moratuwa and Peradeniya -- and at most universities in Sri Lanka. Consulting is an established and accepted activity at Sri Lankan Universities and is most successful where faculty members possess critical technical skills. Consulting is important in universities, because it brings the real world into the university and ultimately into its curricula. Faculty engaged in consulting can add a practical dimension to their teaching that those without such experience cannot. This

adds relevance to courses and maintains students' interest. Therefore, consulting should be encouraged as long as it does not interfere with the research and teaching missions of the university.

Consultancy groups at the University of Colombo and other universities have an opportunity to institutionalize consulting into the university structure and programme. Protocols should be developed to allow consultancy income to flow through and be managed by the university. The universities can exact a fee or charge for this service and for the use of university facilities and staff. Faculty remuneration for consulting can fall into three categories:

1) faculty can be allowed to consult a certain percent of their time and receive supplemental income directly from their client. In this case, the university does not enter into the arrangement as long as the percent of time is not exceeded.

2) faculty may be released from university responsibilities for a specified percent of their time to allow them to participate in a consultancy contract for the university. In this case, the faculty member continues to receive his or her university salary but has a temporary change in job duties, e.g. released from teaching one course to allow time for the consultancy work. The contract would be through the university. The benefits to the faculty in this case are the opportunities to work on interesting and challenging projects and have some variety in their jobs. Further, with the university serving as the contractor, the faculty member does not have to expend time and energy finding consulting opportunities.

3) faculty may receive supplemental income from consultancies run through the university if their participation in those consultancies does not interfere with their carrying out their other responsibilities in the university. For instance, they could consult during holidays or they could use some of their consulting time noted in item (1) to participate in a university consultancy contract. Benefits to the faculty from this approach are supplemental income and no effort needed to find and compete for the consultancy.

In terms of university programme development, a combination of the second and third strategies should be encouraged and facilitated. To do this, universities must develop budgetary and financial modalities to accommodate these activities AND they must develop modalities to allow for some of the university profit to be fed back to the faculty members' departments, centres, and programmes. Faculty are driven by more than personnel income enhancement. They could easily make more money elsewhere in the economy. Faculty are also driven by desires to build their own programmes within the university and to have some control over funding for such efforts.

There is a distinct probability of competition between universities in the areas of consulting and workshop offerings. This could be a good thing, encouraging each university to develop the best offerings or products. But it could also be draining of limited resources and time and very inefficient. Consideration should be given to combining efforts to coordinate workshop and consultancy unit efforts. This could be done through the UGC, by establishing an interinstitutional coordinating council, or by establishing an interinstitutional office in Colombo to coordinate and manage efforts in these areas. A major benefit of coordination is that this would enable the universities to draw from all of the institutions for programme participants, thereby insuring that the best teams available are assigned to the tasks. In preparing proposals for contracts, this ability to "field the best possible team" could mean the difference between success and failure in competing for the contract.

Faculty Strengthening

The University of Colombo is seeking to strengthen faculty in interdisciplinary areas such as

biodiversity. Dr. Arudpragasam noted the need to identify national needs and develop programmes to serve those needs. He indicated that the University can serve many of these needs now but does not have capabilities in others areas of need. To fill these "lacunae," it will have to "produce faculty" in critical new areas. This can be accomplished by a combination of short-term training (2-3 months) for senior faculty and Ph.D. programmes for junior faculty. These doctoral programmes should be split-linkage programmes where the student takes courses at an institution in the U.S. or elsewhere but does his or her dissertation research in Sri Lanka. Care must be taken to insure that these junior faculty are released from teaching duties while in this type of programme so they can concentrate fully on their research.

UNIVERSITY OF MORATUWA

Environmental Engineering and Management Programme

The Environmental Engineering and Management Programme (EEMP) was started in 1982 and has graduated ten batches of students. Graduates are not having trouble finding jobs and it is anticipated that demand for environmental engineering expertise will grow in coming years in Sri Lanka. Strengths of this programme are its engineering rigor, its focus on solving environmental problems, and the leadership being provided by Professor L. L. Ratnayake. The University of Moratuwa is a premier engineering school and is the logical location for the development of environmentally oriented engineering programmes. The most commonly expressed need in this programme and in the air pollution programme in chemical engineering is for field and laboratory analytical equipment. While there is certainly a real need for certain pieces of equipment, I suspect that there is a surprising amount of equipment sitting unused or underused in labs and closets. An inventory of equipment would reveal what is available, increase user time on that equipment, and reduce the need to acquire new equipment. There is a need for more and better computers and software, especially computer models that can be used in environmental engineering teaching and research. Teaching would also be enhancedby improved audio-visual equipment and some good films or videos on environmental issues.

The major weakness of this programme is that it is almost entirely an engineering programme. Exposure of students to the fundamentals of ecological systems and environmental management is minimal. Of these two deficiencies, the former is by far the more significant. Environmental management could be viewed as a "back-end skill" that shows the engineers how their knowledge can contribute to better decision making. It is not fundamental to becoming a competent environmental engineer. Ecology, however, is a "front-end skill" that should be taught early in the curriculum and form a foundation and *raison d'etre* for the engineering skills taught through the rest of the programme. This deficiency is serious and should be corrected. The University of Moratuwa needs an ecologist on its faculty, an ecologist with an engineering background. Sri Lanka needs *ecological* engineers and *ecological* engineers are different from environmental engineers. The latter are offshoots of the fields of sanitary or water quality engineering, fields that focus primarily on engineering design to solve problems, e.g. structures. The new field of ecological engineering applies engineering skills to the restoration or replication (as best we can do it) of natural ecological systems. For instance, constructing natural wetlands for sewage treatment or focusing on correcting forestry problems that are causing flooding at lower levels in the watershed instead of building dikes and dams to contain water. This is still engineering, but it is engineering that starts out with a new set of design and end-product criteria. Senior faculty could be exposed to short courses on ecology and ecological engineering and they could participate in study tours of sites where ecological engineering is being carried out. But, the University needs to have a *bona fide* ecologist on its faculty. This will require doctoral training in ecology and ecological engineering in the U.S. for a person with appropriate credentials and interests. An ecologist would be able to offer courses in ecological engineering AND would be able to offer courses in "ecology for engineers" for students in other programmes at the University.

Air Pollution Programme in Chemical Engineering

The air pollution faculty in the department of chemical engineering are struggling to build research and teaching programmes. This is a young and dynamic group of faculty, but they do not have very many resources. Their major needs are field analytical equipment and computer models.

Short Courses and Consultancies

Plans are being developed in the EEMP to run a series of short courses for industry. The department of chemical engineering has similar plans. There is certainly a need for such courses and there also seems to be a demand. As noted earlier, short course operations must be run like businesses with demand determining what you offer. Of course, universities should do all they can to generate demand in areas where they believe it is needed by society.

Consulting is a strong and successful tradition in engineering schools throughout the world and Moratuwa is no exception. The University should explore ways to build consulting into the university programme and encourage faculty to run their consultancies through the university. See page 7 for a discussion on this topic.

Linkage Programmes and Study Tours

Several faculty members have links with universities in the United States, Canada, and Europe, and there is interest in expanding these. This might be especially valuable if the University decides to embark on new programmes such as ecological engineering. There is also considerable interest in study tours as a means to enhance faculty skills and understanding of new fields. Study tours could be arranged and they could be structure to provide opportunities for participants to explore potential collaboration with colleagues in the U.S. and linkages between their programmes.

OPEN UNIVERSITY OF SRI LANKA

The Open University of Sri Lanka (OUSL) fills an important niche in Sri Lankan higher education in that it is designed to provide higher educational opportunities to persons who cannot be in residence in university full time. Without the Open University, people scattered in remote areas would have no opportunity to obtain university or post-graduate training. This service is an important equalizer, enabling all Sri Lankans to obtain the education they want and need to be competitive in the job market. This capability should be enhanced in areas related to environmental and natural resource science, engineering, and management. Because these programmes serve a clientele that is different from those served by other universities in Sri Lanka, programme overlap will be unavoidable and even desirable. Indeed, this overlap offers some intriguing possibilities for collaboration among universities in such areas a curriculum development, textbook preparation, and the production of audio-visuals for teaching.

> **"We want linkages with universities in the U.S."**
>
> **Prof. G.T.F. Silva, Head**
> **Chem. Engineering, Moratuwa**

The major strength of the Open University lies in its unique mission, the ways it is organized to meet this mission, and the dedication of its faculty to their unique roles in this mission. Ongoing environmental programmes include a certificate course in wildlife management under the able leadership of Dr. S. W. Kotagama and expanding programmes in environmental law

and journalism.. New programs being developed include a post-graduate diploma in natural resource management involving the faculties of natural science, engineering technology, and social science; a programme in industrial chemistry; a certificate course in environmental engineering; and a Bachelor of Philosophy programme that would be flexible enough to allow emphases in environmental areas. The Open University is also involved in establishing a major new programme in biodiversity, joining with the Sri Jayawardhanapura University to establish and operate a Centre for the Conservation of Biodiversity near Bundala (see page 5). These are all important programmes worthy of support. Because of the special mission of the Open University, needed support falls into three related areas: faculty time, course development, and audio-visual development. The last two of these relate directly to needs at the other universities, suggesting that a coordinated effort in curriculum development, including course preparation, preparation of reading materials, and the production of audio-visuals for teaching would be beneficial to all.

"Finding money for equipment or for short-term faculty is relatively easy. Long-term commitment to staff is more difficult. An endowment of $60,000 would support a permanent Senior Lecturer position. "

Prof. A. deZoysa, Head
Computer Studies, OUSL

Faculty Time and Course Reading Material Production

Faculty at all universities are fully occupied with ongoing programme responsibilities and have difficulty finding time to initiate new programmes. This problem is especially acute at the Open University. Because courses at OUSL are taught largely by correspondence, all course materials must be prepared in written form before the course begins. This is tantamount to writing a textbook for every course taught. It is a tremendous writing task that is rarely encountered at traditional residential universities.

The University Grants Commission has approved the establishment of a Centre for the Conservation of Biodiversity to be operated jointly by The Sri Jayawardhanapura and Open Universities. The Centre will be initially located near Budala in South Sri Lanka near Yala National Park. The success of this effort will be enhanced if all universities developing biodiversity programmes could become affiliated with this Centre.

The OUSL faculty needs help with this situation, either by finding funding for additional faculty, getting assistance elsewhere with course materials preparation, or a combination of the two. While it is beyond the mission of NAREPP to provide endowments for faculty positions, course development falls directly into NAREPP's mission. NAREPP could coordinate curriculum planning among the universities receiving NAREPP assistance and provide funds to pay honoraria to specialists who would prepare written modules on topics selected for inclusion in the planned curricula. These materials could then be adapted by the OUSL for use in their courses. This would free OUSL faculty from some of their writing responsibilities,

"We need grants to cover course development costs, so this doesn't have to be put on the students."

Prof. J. N. O. Fernando
Dean of Sciences, OUSL

subsidize the production of the written lessons at OUSL, allow Sri Lankan faculty from all participating universities to prepare course reading materials specifically oriented to Sri Lankan problems, and produce a set of modules that could be drawn from to package sets of readings for various courses at the four universities and other universities in Sri Lanka. It is even possible that these modules could be marketed to a major textbook publisher and made available in other countries. If the latter could be done, the production would be self supporting or even profit making.

Video Production Facilities

The Open University has just taken ownership of a 2,000 sq. meter, state-of-the-art audio-visual studio built and equipped by the Japanese. Video production facilities include a video studio; control room; three editing rooms; NTSC, PAL, and SECAM converters; copying capabilities in all formats; an audio dubbing studio, a make-up room, a stage setting store, and a maintenance shop. This is the best video production studio in the country. The studio also has an audio studio, control room and a post-production studio. The OUSL is able to offer these production facilities for curriculum oriented programme production in collaboration with other universities.

The OUSL A-V Studio is capable and willing to undertake productions of videos for course use in all areas of environmental and natural resources science, engineering, and management. These productions could include field filming throughout Sri Lanka and the South Asia region. Costs would have to be born by sponsors but are reasonable. A significant advantage of this studio is that its mission is entirely educational. It is potentially a tremendous resource for those developing environmental curricula at the universities -- if it is used. Video production could complement curriculum and course development and provide Sri Lanka-based examples of environmental and natural resources systems, problems, and issues. As with the readings, videos might also be marketable in the West.

The Director of Educational Technology, Dr. Buddhi Weerasinghe, is looking for linkages with video programmes at U.S. universities, and we are exploring that with the Department of Information and Applied Communications at Ohio State University. Linkage activities might include training of OUSL technicians in modern video technologies, collaboration on productions, and linkage broadcasts between Ohio and Sri Lanka.

Short Courses, Workshops, and Video Broadcasting

As with all of the universities in the NAREPP program, the OUSL is planning to implement a series of short courses and workshops aimed at government officials. OUSL is targeting local officials in Municipal Councils, Urban Councils, and Pradeshiya Sabha. It also has the capability to broadcast video throughout the country and is interested in collaborating with other universities in developing such offerings. Costs for broadcasting range from Rs 6,000/hour from 5:30-7:00 pm to Rs 11,000/hour between 7:00 and 9:00 pm. These costs would have to be born by sponsors.

Books, Equipment, and Faculty Training

The OUSL suffers from the same library and equipment problems encountered at the other universities. There is one special need at OUSL associated with the video studio, and that is their need for a modern mobile unit. This would greatly enhance filming on environmental and natural resource topics.

Faculty training needs are also the same as at other institutions. Senior faculty need exposure to new areas of environmental science, engineering, and management and younger faculty need more extensive training in the form of doctoral programmes. Faculty would benefit from study

tours of relevant programmes in the U.S. Linkage programmes with U.S. universities should be explored for all four universities to increase opportunities for faculty to interact with colleagues in the U.S.

THE UNIVERSITY OF PERADENIYA

Faculty at the University of Peradeniya are engaged in an effort to establish an integrated, interdisciplinary programme in environmental studies and are proceeding deliberately in this effort through traditional academic pathways. The University Senate has established a Sub Committee on Environmental Studies with members from each of the seven Faculties. That subcommittee has designed a multi-faceted programme plan that includes the development of a Certificate Course in Environmental Awareness that would be open to all undergraduates in the University but would not immediately be required in any curriculum[1]; support for strengthening existing post-graduate courses on environmental topics, especially the proposed Natural Resource Management MSc Programme in the Post-Graduate Institute of Agriculture (PGIA); development of a post-graduate diploma course on environmental impact assessment (EIA); and the creation of a series of one- to three-week short courses for government and the private sector. The ultimate goal is the establishment of a Centre for Environmental Studies. All of these proposals are going through traditional approval processes in the University.

> **"I would like for my students to understand the things being taught in this course before they come into my courses. I may end up requiring it as a prerequisite."**
>
> **faculty member**
> **Faculty of Engineering**

The process being followed is tedious and time consuming, but the University and faculty want to create strong programmes that will become integral parts of the university mission and programme. Faculty and administrators at Peradeniya are consciously attempting to avoid creating programmes precipitously in response to faddish social concerns or temporary funding opportunities. This is wise. Programmes developed quickly to take advantage of funding or address immediate social concerns rarely survive in the university system. They are established on the margin of the academic programme and are easily lopped off when outside funds disappear or the fickle tides of social concern change direction. So, while it takes more effort and time to follow traditional programme development processes, this is the only way that programme development can truly change the structure of the university and insure that the new programmes become integrated into the University's teaching and research mission. The faculty at Peradeniya should be encouraged and supported in their efforts.

Strengths of the programmes at the University of Peradeniya include the deliberateness with which the faculty are developing their programmes, the dedicated and wise leadership being provided by senior faculty and the administration, the insight and commitment of the Vice Chancellor to the programmes, and the presence of an established interdisciplinary programme in the form of the Post-Graduate Institute of Agriculture. There is a tradition at Peradeniya for interdisciplinary activity. Weaknesses are the same as are found at the other institutions: needs for equipment, computers, software, books, journals, etc..

Certificate Course in Environmental Awareness

This course is scheduled to be offered for the first time during the summer of 1993. It is hoped that approximately 250 students will enroll although this may be ambitious for a first offering.

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[1]This course may evolve over time to being required in some curricula.

Two meetings were held during this consultancy to allow me to advise on the content and structure of the course.

The course is designed to be sixty hours long and could be offered either over three terms (full-year), twenty hours per term or concentrated into a sixty-hour summer offering. The full-year offering would involve evening or week-end classes so students could enroll without conflicts with required classes in their disciplines. Advantages of the full-year offering would be extra time available to students for reading, field studies, and writing. It would also mean that the course would be offered when most students are on campus. The main advantage of the concentrated summer offering is that the students and faculty could devote full time to this one activity. Both options will probably be tested in the first few years the course is offered.

Discussions on the course content and structure included the following:

1) The course should expose students to the ecological factors underlying environmental and natural resources issues; introduce them to the various types of problems, e.g. water pollution, air pollution, human population, global warming, deforestation, land degradation, environmental health, etc.; discuss some options for solving these problems, e.g. tactics for sustainable development, environmental economics, methods for resolving environmental and resource conflicts, etc.; and examine how the government of Sri Lanka functions in environmental matters.

2) There must be a strong field component such as case studies on some current problems or issues that the students could examine, analyze, and make recommendations for solutions. This should be a group exercise, with students divided into teams of five to eight individuals and each team assigned to a case study. Teams should be structured to be interdisciplinary to give students experience in working with persons from other disciplines. Students would be required to submit a written report at the end of the project and make a formal presentation of their assessments and recommendations before the full class and possibly other interested individuals from the university and the community. Both papers and presentations would be group efforts with one document and presentation from each group. This will teach students that they have to find productive and effective ways of working together toward a common end. After all, this is what they will have to do when they get out in the real world.

   Grading of the field exercise could be traditional, but this would be difficult and very time consuming. Plus, it is very difficult to use traditional grades in exercises involving group products; how do you determine what contribution each team member made to the product? There was much discussion about strategies for grading. The most sensible strategy would be to NOT grade the exercise at all. Instead, simply make the successful completion of the exercise a requirement for passing the course and require student groups to redo their reports and presentations until they are acceptable. Again, this is what happens in the real world.

3) The percentage of coverage should be:

Ecology	20-25 %
Problems and Issues	30-35 %
Tactics for Solutions	25-30 %
Government Operations	
Field Exercise	10-25 %

4) The course should be taught in English, at least initially, because only students who speak English will have time to take it. Other students are too tied up with their

English language lessons.

5) Integration of information MUST be built into the course. There is a tendency in these types of courses to make them catenas of lecturers, each speaking about his or her specialty. This cannot be allowed to happen. *One or two professors must be in charge of the course and present at all lectures.* Their role is to integrate for the students what is being taught on the various topics covered. Indeed, the best course would be entirely taught by one or two professors who understand the various aspects of the course content and can integrate as they go along. This is a huge demand on faculty preparation, but it is essential. You cannot expect students to be able to integrate on their own.

6) Students will have to have access to textbooks and to other literature. Faculty will need videos and overhead transparencies to illustrate their lectures.

Much will be learned about the how this course ought to be structured, how best to offer the content, and how to structure and grade the field exercises as it is taught the first few times. This is a normal process; all problems will not be solved up front, indeed many will not even be identified.

Post-Graduate Programmes and the PGIA

The Senate Sub Committee on Environmental Studies does not plan to develop any post-graduate degree programmes, preferring to support programmes that already exist or are being developed in other units of the University. One such programme is the new MSc degree in Natural Resource Management organized by the PGIA. Another PGIA effort, a new MSc degree in Environmental Economics deserves similar support and encouragement.

The MSc in Natural Resources will be an integrated programme patterned on similar programmes at universities in the U.S. A faculty member has been identified to receive doctoral training in integrated natural resource development abroad and return to Peradeniya as leader of this programme. An integrated natural resource management program at Peradeniya will be a major force in reorienting the way natural resource management is carried out in Sri

The Post-Graduate Institute of Agriculture is a true interdisciplinary centre in that it has no faculty of its own and draws faculty from the established Faculties to work together on projects and programmes. It has a long tradition of working across disciplinary lines and has been successful in attracting outside funding in the form of grants and contracts. It is a model that should be replicated at this and other universities.

Lanka. Graduates will have a broad understanding of resource and environmental systems and the ways in which components interact with each other and with the Sri Lankan economy. They will also be familiar with management strategies that are based on this integrated approach.

Environmental economics is desperately needed in Sri Lankan environmental and natural resources decision making. The case must be made that this field is distinct from neo-classical economics and even agricultural economics in that its theory base includes the constraints that ecological systems place on economic activity. This basic foundation requirement is what makes it difficult for other economists to move easily into this new field. Sri Lanka needs to be able to turn out its own environmental economists. The new MSc programme will fill this role. At the present time Dr. Abeygunawerdene is the only doctoral level environmental economist on faculty appointment in Sri Lanka. There is a need for at least one additional person to assist Dr. Abeygunawerdene in handling the educational needs in this area.

"I cannot handle the demand. We must have another PhD Environmental Economist."

Dr. P. Abeygunawerdene
PGIA, Univ. Peradeniya

Post-Graduate Diploma Course in Environmental Impact Assessment

Plans are being developed to assume leadership for the Environmental Impact Assessment short course being offered currently by NAREPP. Professor C. M. M. Bandara and Drs. P. Abeygunawerdene and S. K. Hannayake are offering lectures in the June offering of this short course and Drs. Bandara and Hannayake will also be assuming partial responsibility for running the field case studies. Faculty from the other three universities will also be involved in the case studies. The objective is to turn the teaching of this course completely over to Sri Lankan faculty by September, 1993 with U.S. consultants serving only as advisers.

Considerable planning and preparation will be needed on the parts of Sri Lankan faculty be able to meet these deadlines. Faculty must be prepared to determine what should be taught in lectures and they must expend the time to prepare those lectures. NAREPP and its consultants can assist with advice and help with the preparation of teaching materials. NAREPP could also help with logistical arrangements for the first couple of offerings, but this will ultimately become the responsibility of the sponsoring university or universities. Finally, all four universities are planning some form of EIA workshops. Communication is essential if there is to be a cooperative effort in planning and running these courses.

Short Courses and Workshops

The University is anxious to develop a series of short courses and workshops that they can market to the government, industry, and the community. Again, this is also a goal of the other universities. Communication among the universities is essential. Also again -- it must be understood that this type of short-term training is largely demand driven; universities must learn to do market surveys, advertising, and promotion.

Consultancy

The University of Peradeniya is also anxious to expand its involvement in environmental and natural resources consulting. Refer to page 7 for suggestions and precautions.

Interdisciplinary Research

As was mentioned above, the University of Peradeniya has a long and successful tradition in interdisciplinary research and contract work, primarily through its Post-Graduate Institute of Agriculture. It has now demonstrated its willingness to adopt a similar, even larger interdisciplinary effort to address the complexities of environmental problems by establishing the new Centre for Environmental Studies (se below) which will include participants from all seven Faculties at the University. Further, the physical proximity of the various Faculties at this university facilitates interaction and collaboration among faculty members with similar interests and skills. Finally, there is a growing realization at this university that interaction across Faculties must be predicated on faculty members working together across disciplines on joint projects. In an effort to initiate this type of interaction, Professor C. M. Madduma Bandara has taken the lead in working with the Mahaweli Agricultural and Rural Development Project (MARD) to design a programme for reforestation of the Kuda Oya in System B of the Mahaweli Project. In this effort, specialists are being drafted from relevant specialties at the University and elsewhere. The University will later submit a proposal to MARD and USAID to actually carry out this project (See pages 18 and 19).

Centre for Environmental Studies

Under the leadership of the Sub Committee on Environmental Studies of the Faculty Senate, The University has established a Centre for Environmental Studies at the University. This Centre will function as a traditional interdisciplinary centre, drawing upon the entire university for participants in interdisciplinary research, contracts, consultancies, and teaching programmes. The teaching and research efforts listed above, incuding those in the PGIA, will be managed through the new Centre. This effort should be strongly encouraged and support should be provided to facilitate the initiation of this Centre. Other universities should be encouraged to use the Peradeniya Centre for Environmental Studies as a model.

Centres are excellent structures to accommodate interdisciplinary activities in educational institutions with otherwise high walls between disciplines, departments, faculties, or colleges. They can serve as institutional focal points around which faculty with similar interests can congregate without disturbing unnecessarily the traditional organization of the University. There are many positive benefits from such efforts. There are, however, cautions that must be heeded if such centres are to be sustained in the university structure over time. These include making sure that there is a funding source from the University that does not put the Centre into direct competition with Departments and Faculties for funds and that faculty get rewarded for their activities with the Centre, including salary and promotion recognition (See APPENDIX B). Centres are vulnerable because they are at the periphery of the university organization, but Centres can also grow into Departments or even Colleges or Faculties. Faculty spending time on interdisciplinary projects and programmes are also vulnerable, because this takes time away from more traditional and accepted disciplinary activity.

> **"A Center is a hub, a focus, a point of convergence around which activity revolves, a source of action and influence. It is a gathering place for those with common interests and goals. In academia, it is an area where faculty with diverse professional backgrounds come together to examine complex problems, issues, and challenges. It is a home for interdisciplinary research, scholarship, and education."**
>
> **Craig B. Davis**
> ***The Interdisciplinary Challenge***
> **Ohio State University, 1988**

Budget and Financial Modalities

Discussions were held with the Vice Chancellor (Prof. J. M. Gunadasa) and the Bursar on the subject of flow of money in interdisciplinary programmes. Centres depend heavily on contracts and grants to support their activities. Direct costs on such grants and contracts support the project activities, but indirect costs accrue to the University. Modalities must be developed to allow the Centre Director and project leaders to manage direct project funds without unnecessary and time consuming purchasing procedures. Modalities must also be established to allow adequate flow of indirect funds back to the Centre to support its operations and programmes. The Vice Chancellor and Bursar were both quite aware of the need for these things and assured us that they could be arranged. The new Centre will be able to expect strong support from this Vice Chancellor and cooperation and assistance from this Bursar.

AGENCIES

MINISTRY OF ENVIRONMENT

There is one statement that is commonly heard when talking with senior members of the SLAS -- "We have a general lack of trained personnel." Both short- and long-term training and education are needed to provide for manpower needs in all environmental and natural resources agencies. The most critical need is for strong undergraduate and post-graduate degree programmes in environmental science and natural resources management at the universities to begin training professional that are needed to carry out the missions of environmental and resource agencies. Certificate courses, short courses, and workshops can be used to upgrade the technical skills of existing agency staff, but this will not produce the level of understanding and rigor that is needed -- the latter will require degree training. Special attention should be payed to Division-level officers, the Divisional Secretaries, Assistant Divisional Secretaries, and Planners. These are the SLAS officers closest to the villages. It is especially important to provide training for the Planners, because these individual can have direct and significant impact on the types of development activities that occur at this level. Further they tend to remain at the Divisional level longer than Secretaries do.

While there are some tangible benefits that might accrue to SLAS officers who obtain in-service training, e.g. increased self esteem, strengthening one's position for advancement, strengthening one's chances for obtaining leave, etc.; the Government of Sri Lanka should explore the possibility of offering more direct motivation, such as bonuses, salary increases, etc.

CENTRAL ENVIRONMENTAL AUTHORITY

CEA Chairman G. K. Amaratunga is very supportive of NAREPP's efforts to provide training

in EIA and environmental awareness. He expressed his concern that many Sri Lankans were unaware of the seriousness of the environmental problems facing them. He also expressed concern about inadequate professional expertise to handle complex environmental problems, echoing what I have heard about inadequate levels of professional and technical expertise in agencies charged with managing natural resources and the environment. He also expressed concern about what he sees as narrow approaches to environmental problems, noting that "we have good engineers, but most are unable to handle environmental problems, because they are unable to go beyond their technology."

UNIVERSITY GRANTS COMMISSION

The UGC is supportive of programmes being developed under the NAREPP-supported programme, but universities cannot look to the UGC as a source of new funds to support these programmes. The UGC gives its funding to the universities; little remains at the Commission for discretionary use. Universities will need to prune in order to do new things OR they will have to generate funds from outside the university system, e.g. through grants, contracts, short courses, etc. Further the UGC is essentially a reactive body leaving the leadership for programme initiation to the universities. They can help, but they prefer not to lead. They might, however, be willing and able to assist with coordination of interuniversity efforts in such areas as curriculum planning and development, seeking out funding, etc. There are pluses and minuses in having this function taken up by the UGC, but it is one option.

NARESA

NAREPP planned close links to NARESA when the latter wasone of the key agencies dealing with environmental matters for the government. Significant personnel and policy changes, however, caused this relationship has suffer! NARESA is anxious to renew its link with NAREPP. One possibility would be for NARESA to provide an office and staff for a Sri Lankan University Consortium for Environmental Research. This office would be directed by the universities but housed at NARESA. NARESA would provide a direct link to the government and its research needs. As with using the UGC for this type of activity, there are pluses and minuses. It is another option.

IDR OPPORTUNITIES -- MARD AND THE E.C.

Items 2 and 4 of the Scope of Work for this assessment called for assisting faculty representatives in organizing multi-disciplinary teams and assisting the multi-disciplinary teams identify and pursue resources in addition to those provided by NAREPP. These skills are best learned by doing. Therefore, discussions were initiated with the Chief of Party (Mr. Bruce Spake)for the Mahaweli Agriculture and Rural Development Project (MARD) to examine the possibility of having MARD contract with a consortium of universities to carry out a reforestation project along the Kuda Oya in System B of the Mahaweli. After discussions and field visits to the site over a two day period, the drafting of a preliminary terms of reference for such a project, and subsequent discussions with Mr. Gary Alex at USAID, it was decided that MARD would contract with a faculty team at the University of Peradeniya to prepare a Scope of Work that could be used in soliciting offers from Sri Lankan universities to carry out the project. At a joint university workshop held in Colombo on April 8, four universities (Colombo, Moratuwa, Open and Peradeniya) agreed that the University of Peradeniya should take the lead in bidding on the final contract once it is announced by USAID.

The preparation of the Scope of Work for MARD on this project and the yet-to-come preparation of a proposal for the full project will be a learning experience for those involved. Preparers will have to learn how to recognize and respond to a client's needs; help the client understand aspects of the project that he might have overlooked and omitted from the terms of reference; assess what types of expertise are needed to carry out the scope of work; line up the

needed expertise; construct a reasonable budget; prepare a written proposal and possibly present it orally. If the contract is won, project managers will have to be able to manage in interdisciplinary team, coordinate the various aspects of the study and work, coordinate inputs of data and information, compile and edit that information, prepare and submit timely reports, and manage the project budget. Guidance will continue to be given by this consultant throughout this process.

If this effort is successful, other opportunities for interdisciplinary project support could come from MARD. The current project covers only about one half of the reforestation projects planned for the next three years. There might also be a project dealing with wetlands.

Discussions were also opened with Mr. Daniel Crickx, Liaison Officer with the Mahaweli Authority of Sri Lanka from the Commission of the European Community. The EC is funding a major resource development project in the Mahaweli, partly in System B. This project includes an aspect involving the creation of fuel wood plantations. There is a possibility that funding could be available to the universities to undertake projects associated with this effort. More meetings with Mr. Crickx will be held in June.

This demonstrates that opportunities do exist for university participation in interdisciplinary projects. Further exploration should focus on such agencies as the World Bank, the Asian Development Bank, the World-Wide Fund for Wildlife, IUCN, the various agencies of the United Nations, etc. There is no lack of funding opportunities, if the universities will get organized to compete successfully for them.

SUMMARY OF NEEDS AND STRATEGIES

CURRICULUM DEVELOPMENT

The process of developing curricula for environmental and natural resource programmes at the four universities, if carried out deliberately, can provide answers to many questions and clarify how the universities can best meet the educational needs of the country in these areas and what resources they need to accomplish that end. The curriculum development process should start with the question "what must students *understand* about the environment, natural resources, and the management of both?" The focus should be on "understanding" rather than "knowing." One can learn a lot of facts and know a lot without understanding how all of it fits together. What must our students understand?

The second question is "what are the best ways to teach students the things they need to understand or provide them with the experiences from which they can develop their own understanding -- What methods are needed? As we identify what our students must be able to understand and what methods we want to use to provide for this, we will begin to identify those "lacunae" about which Prof. Arudpragasam spoke so eloquently. Where are we lacking in expertise, equipment, library and other reading materials, visuals for teaching, abilities to carry out field work, abilities to provide students with practical experience.

Programme development at the universities is hampered today by shortages of equipment, lack of adequate reading materials, limited library journal and reference collections, and lack of appropriate and Sri Lanka-based audio-visual materials. Further, traditional curricula in Sri Lanka are disciplinary and largely theory based. Faculty need to develop programmes that are interdisciplinary and problem focused. They need to create opportunities for students to do projects and internships, to learn by reading and doing on their own. All of this would be best accomplished through a cooperative effort among the universities, sharing their perspectives and ideas, contributing their expertise and facilities, and collaborating on materials development, teaching, and directing student projects.

Strategy: Create an interuniversity curriculum committee that will meet regularly to discuss curricular matters and coordinate cooperation and collaboration in the development of curricula, courses, field programmes, and reading materials and videos for courses. Specific tasks that this committee should undertake include:

1) Write an "Educational Philosophy for Environmental and Natural Resources Studies at the undergraduate and post-graduate levels in Sri Lanka (see APPENDIX C for example). This should address the question about what students need to understand and how that might best be taught. This philosophy statement will form a theoretic foundation for curriculum development.

2) Identify national and international environmental problems that must be addressed in curricula.

3) Examine faculty and institutional capabilities, identify the "lacunae" that need to be filled, and explore ways universities might collaborate on filling these needs.

4) Organize and coordinate a programme to develop a set of written modules on various topics that would be included in courses on environmental and natural resources topics. Contract with specialists in Sri Lanka to write the modules, work with editors to put them in final publishable form, and implement mechanisms for printing the modules and making them available to faculty throughout Sri Lanka for use as reading materials in their classes,

5) Organize and coordinate a programme to develop a set of videos on topics that will be covered in courses. Faculty at the various universities can be contracted to prepare scripts, appear in the videos, and help proof the final products. Production can be carried out at the Video facility at the Open University.

6) Support faculty at the universities who are trying to get new courses and curricula approved by their academic senates and administrations.

7) Organize a programme to seek outside funding to support curricular development and innovation in the area of environment and natural resources studies.

Strategy: Universities should implement field exercises and projects in their courses. Undergraduates could be given credit for serving in internships with environmental and natural resource agencies, consulting firms, industrial divisions, etc.

Universities could also create non-thesis Master's degrees in which students are instead required to complete and extensive internship in an appropriate industry or agency or carry out some practical project and write about it.

INTERDISCIPLINARY RESEARCH

It is essential for Sri Lanka that the universities assume leadership for developing new educational and training programmes to address national needs in the area of environmental protection and natural resources management. Programmes must be developed to carry out research on complex environmental and natural resource problems and educate a new breed of environmental professional to satisfy manpower needs in these critical areas. Faculty and their institutions will be unsuccessful in doing these things unless ways can be found to get faculty from different disciplines working together on projects. Until faculty start collaborating across disciplinary lines on research projects, they will not interact effectively on interdisciplinary curricular projects. Therefore, it is mandatory that universities create mechanisms to identify opportunities and needs for interdisciplinary research and the financial means to carry them out. There is no lack of need and there is no lack of funding, if the universities get organized to get the job done.

Universities must organize to identify funding opportunities for interdisciplinary research (IDR) and assist faculty in the preparation of proposals, building and managing IDR teams, designing and managing budgets, and preparing timely reports. All of these things are essential in problem-focused IDR. Each university could go about this effort in its own way, but consideration should be given to collaboration.

IDR is best learned by doing it. Therefore, it is important that some projects be identified and started soon to provide faculty with opportunities to learn and perfect their skills in IDR management.

Strategy: **Establish a Research Development Committee that will be charged with identifying (1) opportunities for problem-focus contract research such as that being organized through the MARD project and (2) sources of funds that could be used to seed interdisciplinary research projects initiated by faculty at the participating institutions. The former provides opportunities for faculty to organize and manage interdisciplinary teams for contract projects and studies. The latter provides opportunities for faculty to accomplish the same thing, but do it by focusing on projects of their own creation and design. The committee should work with administration at each university to develop budgetary and financial procedures that reward faculty for IDR participation and funnel indirect funds into faculty programmes.**

Strategy: **Create interdisciplinary environmental research and post-graduate education centres at each university to coordinate environmental and/or natural resources programmes at the university. The Post-Graduate Institute of Agriculture and the Centre for Environmental Studies at the University of Peradeniya. could serve as models.**

Collaborate on the establishment of national centres to address major environmental and natural resource problems of concern and interest in Sri Lanka. The first of these might be the

Centre for the Conservation of Biodiversity being organized by the Open and Sri Jayawardhanapura Universities.

INFRASTRUCTURE

Interdisciplinary activities, whether teaching or research oriented, do not fall within the traditional mission and structure of the university. There is a danger that interdisciplinary activity will be carried out as an overload performed in addition to the regular duties assigned. There is also a danger that faculty will not be given appropriate credit for interdisciplinary activities, because such activities may be viewed as superficial and detracting from time that would be better spent working on "rigorous" disciplinary topics or projects. And finally there is a danger that financial support will be difficult to get and keep; funds generally flow through traditional faculties and departments and interdisciplinary programmes are peripheral to this flow.

Strategy: **Faculty developing interdisciplinary programmes should work with their administrators, especially the Vice Chancellors, to develop mechanism to provide reasonably secure access to funds to support their programmes over time. Faculty should also work with colleagues and administrators to insure that interdisciplinary activity will be counted when work loads are calculated, salaries are increased, and promotions are given out.**

WORKSHOPS AND SHORT COURSES

Faculty at all four universities are planning to develop short courses and workshops for government officials at various levels, industrial managers, and others. This is a traditional part of the university mission and should be encouraged and supported. There is certainly great need for such offerings and the demand should increase in the years to come. Further, short courses and workshops are excellent ways for universities to generate some modest income for their programmes. In a market as small as Sri Lanka, universities might benefit from some form of coordination or even collaboration on short course and workshop offerings.

Strategy: **Universities should work together to identify critical needs for workshop and short-course training, e.g. critical environmental issues and problems, critical techniques, etc. This could be done as part of the curriculum planning process noted on pages 20 and recommended on page 25. Then they should develop a plan for developing appropriate workshops and short courses and marketing them to government, industry, and the public.**

Universities should establish a clearinghouse operation to keep everyone informed about short course and workshop planning so as to reduce unnecessary redundancy and overlap.

Universities should also explore ways to cooperate on workshop and short course development, including cooperation in identifying demand, designing programmes, staffing, marketing, and advertising.

LINKAGE PROGRAMMES

All of the universities would benefit from linkage programmes with universities in the U.S. and elsewhere. The academic community in Sri Lanka is isolated from larger academic communities in North America, Europe, and even India. Linkages between similar programmes would open the academic world for Sri Lankan faculty; expand their circle of colleagues; and offer opportunities for visits abroad through faculty exchanges, project planning grants, study tours, and visiting lectureships. They would also bring foreign scholars and researchers to Sri Lanka where they would enhance Sri Lankan programmes. Linkage programmes can be structured to provide training or even degree and post-doctoral programmes for Sri Lankan faculty. Linkage programmes may also include student exchanges or agreements for sending foreign students to Sri Lanka for special courses and field work, e.g. biodiversity studies. Ideally, Sri Lankan and foreign faculty would collaborate on generating funding to support the linkage, on developing and carrying out joint research projects, and on publication of scientific and scholarly papers.

Strategy: **Universities, singly or as a consortium, should explore linkage programme opportunities. This can be done by working through embassies, bilateral development agencies, or international organizations such as SACEP; by pursuing relationships established by individual faculty with faculty elsewhere; or through conference attendance. Personal connections between faculty are the best vehicles. Contacts can be stimulated by sending faculty to international meetings or by hosting an international meeting in Sri Lanka. The latter should be explored with funding agencies.**

FACULTY TRAINING AND DEVELOPMENT

As the universities move into new areas of teaching and research associated with environmental and natural resource studies, deficiencies in expertise will be encountered. These are showing up already. Universities should explore ways of exposing mid-level and senior faculty to new ideas, concepts, theories, and techniques and to enable selected junior faculty to pursue doctoral degrees or post-doctoral training in the U.S. or elsewhere. The former can be done through short courses, seminars, workshops, visiting scholars, exchange programs, study tours, and linkage programmes with universities in other countries. The latter should be approached through linkage programmes that provide opportunities for split doctoral programmes where the student takes courses at a foreign institution but does his or her research in Sri Lanka.

Strategy: **Explore possibilities for study tours to India, Europe, or the U.S. This could grow out of linkage programmes or be arranged as parts of development projects funded by the U.S. or other donors.**

Take advantage of short courses and workshops sponsored by international agencies and donors. Pursue funding for this type of training through various donor agencies.

Work with linkage partners to establish these opportunities.

Strategy: **Aggressively pursue funding to send junior faculty to the U.S. or elsewhere for doctoral training through a split/linkage arrangement. Seek support from donor agencies, international agencies, and the Government of Sri Lanka.**

COMMUNICATIONS

Faculty need to be able to communicate easily with colleagues in their field in Sri Lanka and abroad. Priority should be placed on establishing or enhancing fax and e-mail capabilities at each university. Further, universities should consider developing a directory of environmental and natural resource professionals within the university system or even in the entire country. The academic community ought to consider the possibility of forming a new professional society for environmental and natural resources scientists, engineers, and scholars. This society could hold an annual conference and produce a regular journal or newsletter.

Strategy: **Seek assistance from the UGC and donor agencies to underwrite the costs of fax machines, e-mail capabilities, and improved phone line quality.**

Strategy: **Seek assistance from the UGC and donor agencies to organize a national conference on environmental research and education in Sri Lanka and use this conference to initiate a professional society. The society could be supported on dues from faculty members and institutional members.**

IMPROVEMENT OF LIBRARY COLLECTIONS

Universities should place a high priority on upgrading their journal and reference book collections in areas of environment and natural resources. Without access to the current literature, researchers and scholars cannot function at the cutting edges of their fields and domestic science and scholarship become second class. When this happens, the decline of the educational system is inevitable.

Strategy: **Seek funding from any and every source to purchase journals and reference books. Develop a functional computer inventory and search system with access from all university libraries and provide an efficient interlibrary exchange programme. Look into computerized bibliographic services.**

* * * RECOMMENDATIONS * * *

A Programme for NAREPP Support of University Programmes in Environment and Natural Resources

1.0 CURRICULUM DEVELOPMENT

NAREPP should give immediate and high priority to facilitating and supporting environmental and natural resources curriculum development at the four universities (see pages 19 and 20).

1.1 Provide leadership in helping the universities organize an INTERUNIVERSITY CURRICULUM COORDINATING COMMITTEE (IC^3) and assist the committee in its operations by providing meeting facilities at NAREPP or elsewhere, travel and per diem costs for travel to and participation in committee meetings, clerical support, and a budget for supplies, copying, etc. This committee should meet twice a month for the first year and monthly thereafter. Ed Scott and Ari Hewege should meet with them each time and a consultant in interdisciplinary environmental programme development should be contracted to provide periodic advice and guidance.

1.2 Support the development of a collaborative project to produce thirty (30) to forty (40) modules on topics included in interdisciplinary environmental and natural resource curricula developed by the universities. Selection of the modules to be developed should be done by the IC³. Funds should be made available to hire specialists to write the modules and provide illustrations, hire artists to refine or add illustrations and editors to organize the modules into a commonly agreed upon style and format, and cover printing and distribution costs. Funds will also be needed to cover the cost of getting the module manuscripts peer reviewed by specialist in the U.S. These modules will be designed to serve as reading materials for interdisciplinary courses; instructors will be able to select the modules they want for their courses. The modules will also be made available to editors at OUSL who will modify them for their special needs in long-distance education.

NAREPP can also provide assistance in marketing the modules to textbook publishers in the U.S. who might be interested in locally prepared text materials.

1.3 NAREPP should provide funds for the development of a set of videos on topics related to the curricula being developed at the universities. Topics could be selected by the IC³ or by NAREPP. Production should be contracted to the OUSL A-V Studio, an education facility with experience in the production of teaching videos.

1.4 NAREPP should provide support for having universities make "environmental studies" a foundation course for all students. The UGC would like to see the universities move in this direction, but it will not take the lead. The initiative will have to come from the universities. The challenge is on the campuses; colleagues will have to be convinced that such curricular changes are desirable. NAREPP could help faculty prepare documentation and presentations for Faculty Senates and Departments. This activity should also be coordinated by the IC³.

2.0 TEACHING INTERDISCIPLINARY ENVIRONMENTAL COURSES

NAREPP should support workshops and study tours to expose teaching faculty to various teaching strategies and techniques common in interdisciplinary, problem focused environmental studies, e.g teaching broad, interdisciplinary introductory courses; helping students integrate knowledge from several disciplines; teaching field courses; using team projects in classes; team teaching, etc.

2.1 NAREPP should organize a three-week workshop in Sri Lanka that will be led by two or three specialists in organizing and teaching various types of interdisciplinary courses. Sri Lankan faculty would learn how to design interdisciplinary environmental courses, select instructional strategies, use field exercises and group projects, evaluate group projects. They would actually produce one or more course plans during the workshop. Consultants could spend some time after the workshop working with the Sri Lankan faculty members on detailed course planning on their campuses.

2.2 NAREPP should send a select group of instructors to the U.S. to spend one month at a university participating in interdisciplinary courses, field studies, group projects, etc. This could be arranged at Ohio State University or any other NAREPP might choose. Participants should be individuals who will

actually be responsible for teaching, managing, or administrating such courses.

3.0 SHORT-TERM TRAINING

NAREPP's long-term goal in short-term training should be to prepare the universities to assume responsibility for serving this need. University faculty should be involved in all short courses and workshops run by NAREPP over the next three years, and they should by trained and prepared during this process to assume full responsibility for the courses or workshops and to build them into their university offerings.

3.1 Appropriate Sri Lankan faculty should be recruited to work along side and assist consultants in the planning, teaching, and evaluation of all short courses and workshops. Consultants should be expected to devote adequate time to preparing the Sri Lankan faculty to assume full responsibility for the offerings.

3.2 NAREPP should organize a workshop (2-3 weeks) to prepare university faculty and administrators for managing short-term (extension) training programmes. Topics should include needs assessment, targeting audiences, marketing of courses, organizing teaching teams, handling course or workshop logistics, evaluation, etc. Extension specialists from the U.S. would be good consultants in this area.

3.3 NAREPP should work with the four universities to explore ways of coordinating and sharing opportunities and responsibilities for short-term training programmes to minimize wasteful competition and maximize the use of university expertise.

4.0 INTERDISCIPLINARY RESEARCH AND CONTRACT PROJECTS

NAREPP should place high priority on stimulating interdisciplinary research at the four universities on environmental and natural resource problems and on helping faculty and their universities identify opportunities and funding for interdisciplinary contract projects and research, organize themselves to be successful in competing for such grants and contracts, and manage the projects once they are awarded.

> **"We will not have true interdisciplinary programmes at this university until faculty from different disciplines begin working with each other on research projects."**
>
> **Prof. J. M. Gunadasa**
> **Vice Chancellor, Univ. Peradeniya**

4.1 NAREPP should organize and fund an Interdisciplinary Environmental Research Competition to encourage faculty to begin thinking about and planning projects that address complex environmental issues and problems in Sri Lanka. Proposals should be solicited from all universities in Sri Lanka and should require that at least three widely different disciplines be included on the project, e.g. ecology/engineering/economics or economics/political science/engineering. A panel of consultants and Sri Lankan experts should select the winners. Two or three significant grants should be awarded in each year.

4.2 NAREPP should hire a consultant to work with the universities and interested faculty to explore potential funding sources for interdisciplinary contracts and grants within Sri Lanka and internationally and advise on preparing proposals, organizing and managing interdisciplinary teams, preparing and managing budgets, and preparing appropriate and timely reports.

This type of activity will contribute to all aspects of environmental and natural resources problem solving in Sri Lanka and could generate income that could be used to support other aspects of the environmental and natural resources programmes, especially teaching.

5.0 INTERDISCIPLINARY STUDIES AND UNIVERSITY INFRASTRUCTURE

NAREPP should work with faculty developing interdisciplinary environmental and natural resource programmes to alter reward systems and financial modalities that stifle interdisciplinary activity. The focus should be on establishing budgetary structures and financial modalities to insure a base level of support for interdisciplinary programmes and a flow of funds generated by interdisciplinary activities back into the programme for its support. A consultant with experience both in interdisciplinary environmental and/or natural resource programme development and in administration of academic units that include interdisciplinary programmes, e.g. Faculties, Colleges or even Universities, should be hired to guide this effort.

6.0 EXPERTISE LACUNAE AND FACULTY DEVELOPMENT

NAREPP should support short-term upgrading of senior faculty at the four universities to familiarize them with critical new fields in environmental and natural resource science, engineering and management, including short courses, workshops, and study tours. NAREPP should also support doctoral training of select junior faculty to fill critical needs in the university system.

6.1 NAREPP should work with USAID to fund split doctoral programmes to provide faculty expertise in the following new programmes areas of critical need.[2] In a split programme the student takes courses in the U.S. and does his or her dissertation research in Sri Lanka. Their universities would be expected to guarantee positions of responsibility upon their return.

6.1.1 **Ecological Engineering** - PhD in ecology for a junior faculty member in the Department of Civil Engineering at the University of Moratuwa.

6.1.2 **Integrated Resource Management** - PhD in natural resources for a junior faculty member at the University of Peradeniya.

6.1.3 **Environmental Economics** - PhD in resource or environmental economics for a junior faculty member at the University of Peradeniya.

6.2 NAREPP should develop study tours and short courses in the U.S. to expose faculty to ongoing projects and programmes in critical new fields. Suggested short courses/tours include:

a) Short Course and tour of wetlands projects and programmes to learn how wetlands can be used for pollution control, flood control, storm protection, water purification, etc. This would include training in wetland ecology and ecological engineering of wetlands. (4 weeks)

b) Short course on and practical exposure to environmental decision making and environmental dispute resolution. Case studies. (4 weeks)

c) Short course on interdisciplinary programme and IDR management including a tour of successful educational and research programmes. (4 weeks)

6.3 NAREPP should bring in consultants to teach short courses, present seminars, and work with faculty on topics identified by the IC[3].

7.0 LINKAGE PROGRAMMES

NAREPP should facilitate the establishment of linkage programmes between programmes at the four universities and similar programmes in the U.S. or elsewhere. This could be done by providing opportunities for faculty at Sri Lankan institutions to meet with faculty from institutions outside Sri Lanka. Emphasis should be placed on

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[2] In order of priority.

linkages with U.S. institutions, but linkages should also be fostered with institutions in India. Linkage programmes would connect Sri Lankan universities and faculty to colleagues in large academic communities in North America, India, and/or Europe

7.1 NAREPP could facilitate contacts by providing travel support for selected faculty to travel to international conferences when it can be demonstrated that exploration of linkage programmes would likely occur at the meetings or during pre- and post-conference visits and discussions with colleagues in the U.S., India, or elsewhere. Costs should be shared with the faculty member's university. Several interdisciplinary conferences are scheduled for the coming months, e.g. the Indian Environmental Society is sponsoring a major follow up to the Rio Conference in late September, and the North American Association for Environmental Education holds a major conference every October.

7.2 NAREPP could organize, through consultants, tours of centres of excellence in the U.S. and India to pursue discussion and planning of linkage programmes, planning collaborative projects, and drafting grant proposals. Such visits should be made only after a period of planning and communication has occurred between faculty at Sri Lankan institutions and faculty at the U.S. and Indian institutions to maximize the chances for success.

7.3 NAREPP can immediately facilitate the establishment of a multifaceted linkage programme between the four universities and The Ohio State University. Preliminary discussions have been held at Ohio State and there is strong interest in pursuing such a collaborative programme. NAREPP could sponsor a visit to Ohio State by a team of appropriate faculty and administrators to establish the protocols for linkage, plan collaborative projects, and initiate funding proposals. NAREPP could explore additional funding possibilities through USAID to initiate this programme. Areas of potential collaboration include ecology and ecological engineering, environmental economics, integrated natural resource management, conservation of biodiversity, ecotourism, sustainable resource development, tropical renewable resources, wetland ecology and management, environmental education and communications, geographic information systems and remote sensing, and environmental law and policy -- all active programmes at Ohio State University.

7.4 NAREPP could sponsor an international conference in Sri Lanka that would focus on Education and Training for Sustainable Development in Developing Countries (or some similar topic). Foreign participants would be invited, but the meeting would be open to all Sri Lankan academics. Foreign and Sri Lankan experts would be selected to cover areas of concern and need in environmental and natural resource education and training in Sri Lanka, would prepare papers for their presentations, and would spend time after the conference visiting the four universities and discussing opportunities for collaborative projects and institutional linkage programmes. The papers would be published in book form.

The International Society for Environmental Education (ISEE) is willing to work with NAREPP and the universities to plan, organize, and run this conference. ISEE would also assist in the preparation of the book at the end of the conference.

8.0 COMMUNICATIONS

NAREPP should work with the universities to foster better communications and

interaction between specialists and programmes.

8.1 Fax machines should be provided to as many programmes as possible and funds should be made available to connect these to the phone system.

8.2 Equipment and software should be provided to get all programmes on e-mail. There are problems with phone lines that are beyond university or NAREPP control, but every effort should be made to insure that e-mail capability is available where phone lines are adequate to support it. Access to e-mail would provide access to on-line data systems such as OCLC (computerized library biographical services).

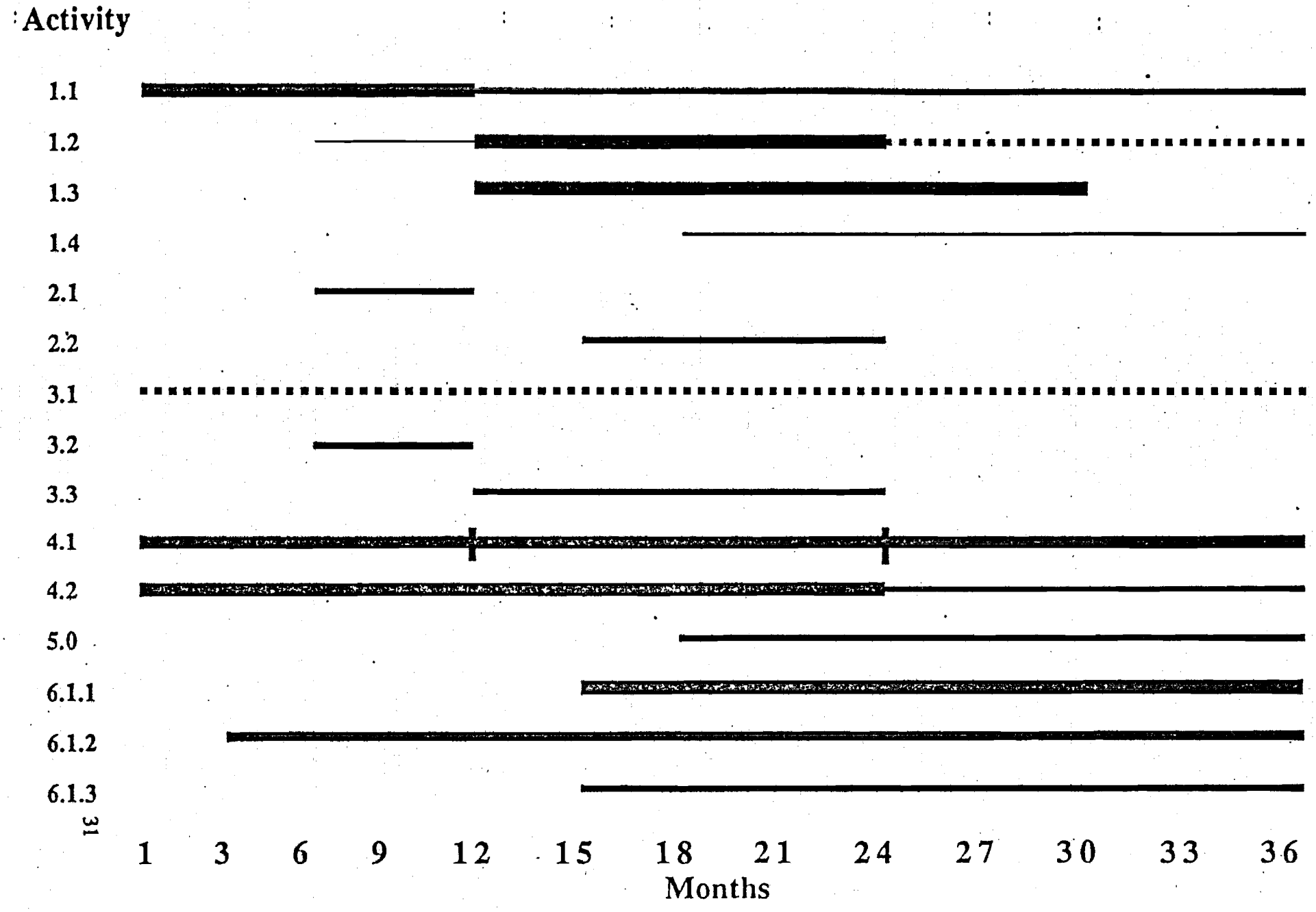
8.3 NAREPP should provide funds and clerical support for the preparation of a Directory of Environmental and Natural Resource Experts in Sri Lankan Universities. The work to gather and organize the information for the directory should be carried out by the university faculty[3].

9.0 LIBRARY COLLECTIONS AND LITERATURE

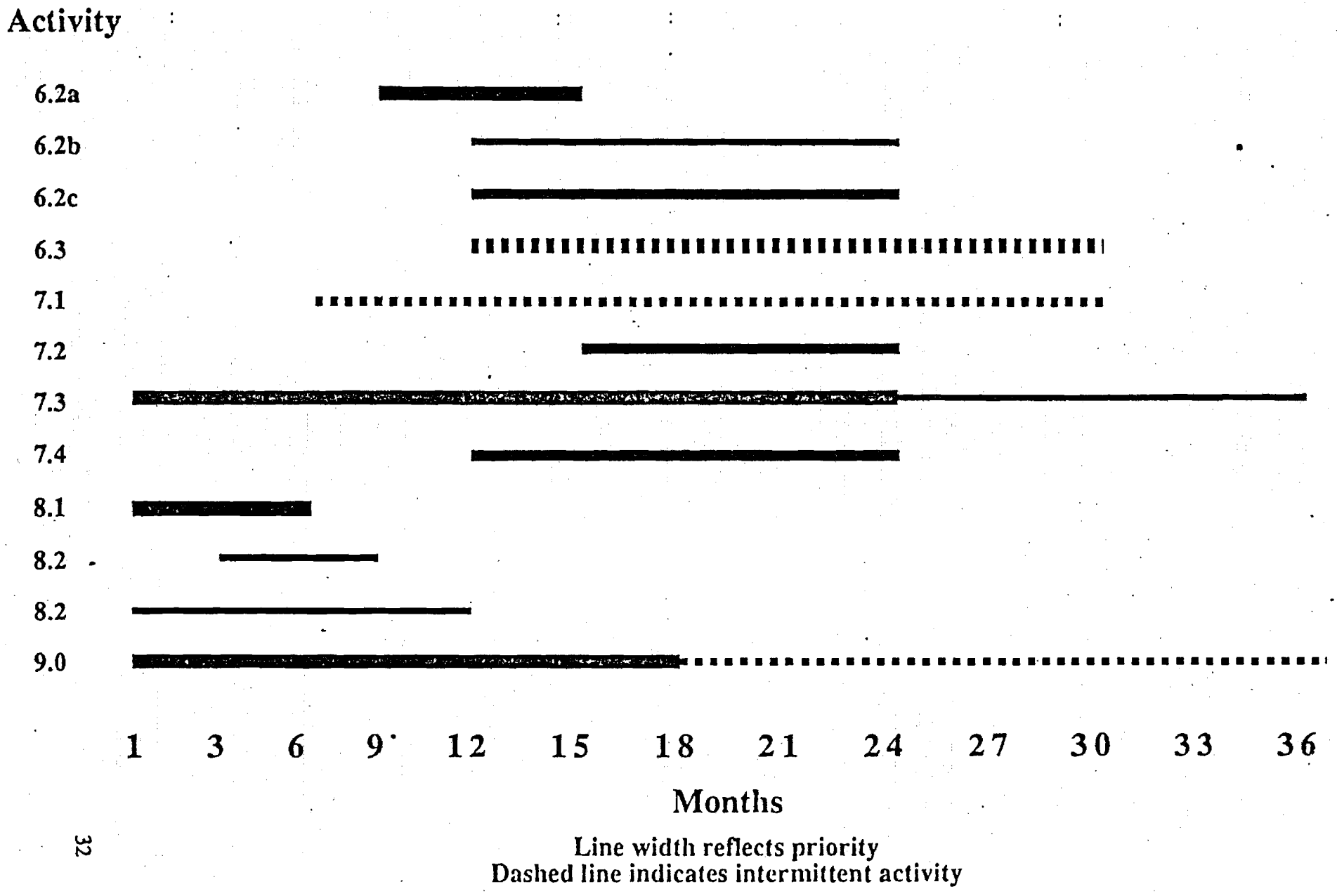
NAREPP should increase its allocation for the purchase of books and journals. Without this type of information, Sri Lankan faculty will face a constant struggle to maintain cutting edge research and teaching programmes. Outstanding young faculty will continue to leave Sri Lanka for positions in the West where they *do* have access to the current literature and *can* develop research and teaching programmes that are on the cutting edges of their fields.

[3]The CEA produced a directory of expertise some time ago. This might serve as a starting point for this effort.

SEQUENCING OF ACTIVITIES



SEQUENCING OF ACTIVITIES



Line width reflects priority
Dashed line indicates intermittent activity

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APPENDIX A

PERSONS INTERVIEWED

Dr. Kanthi Abeynayake. Senior Lecturer. Department of Botany, University of Colombo. Colombo. Botanist.

Dr. Piyasena Abeygunawerdene. Department of Agricultural Economics & Extension, Faculty of Agriculture, PGIA[4], University of Peradeniya. Peradeniya. Environmental Economics.

Mr. Gary Alex. Agricultural Project Officer. U.S. Agency for International Development. Colombo.

Dr. A. A. P. de Alwis. Department of Chemical Engineering, Faculty of Engineering, University of Moratuwa. Moratuwa. Conservation and Fuel Efficiency Engineering.

G. K. Amaratunga. Chairman, Central Environmental Authority, Government of Sri Lanka, Colombo.

Prof./Dean K. D. Arudpragasam. Dean, Faculty of Science, University of Colombo, Colombo. Environmental Science, Biodiversity, Aquatic Ecology, Coastal Ecosystems Management.

Dr. K. F. Abeynayake. Department of Botany, University of Colombo, Colombo. Micorrhiza, Water pollution control using aquatic macrophytes, Environmental Studies.

Dr. P. Amarasinghe. Department of Chemical Engineering, Faculty of Engineering, University of Moratuwa. Moratuwa.

Prof. I. Balasuriya. Vice Chairman, University Grants Commission, Colombo.

Prof. S. Balasuriya. Faculty of Medicine, University of Peradeniya, Peradeniya. Community Medicine.

Shiranee Balasuriya. Senior Lecturer. Landscape Architecture, Faculty of Architecture, University of Moratuwa. Moratuwa. Landscape Architect

Prof. C. M. Madduma Bandara. Head, Department of Geography, University of Peradeniya. Peradeniya. Environmental Geography.

Prof. J. M.R.S. Bandara. Department of Plant Pathology, Faculty of Agriculture, PGIA[1], University of Peradeniya. Peradeniya. Biology.

Nilanthi Bandara. Senior Lecturer. Faculty of Engineering Technology, The Open University of Sri Lanka. Nugegoda. Environmental Chemistry.

Dr. S. Bhuvendralingam. Senior Lecturer. Department of Civil Engineering, Faculty of Engineering, University of Moratuwa. Moratuwa. Water Qualiy Engineering.

Mr. E. J. H. Corea. Department of Civil Engineering, Faculty of Engineering,

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[4]Post-Graduate Institute of Agriculture

University of Peradeniya. Peradeniya. Environmental Engineering, water and waste water treatment.

Dr. Daniel Crickx. Liaison Officer with the Mahaweli Authority of Sri Lanka. Commission of the European Communities. MASL Building, 500, T. B. Jaya Mawatha, (9th Floor), Colombo - 10. Telephone: 687232, Fax: 687240.

Prof. J. N. O. Fernando. Dean. Faculty of Sciences, The Open University of Sri Lanka. Nugegoda. Chemistry.

V. S. Fernando. Department of Computer Science, Faculty of Engineering, University of Moratuwa. Moratuwa.

Dr. K. G. A. Goonesekera. Department of Agricultural Engineering, Faculty of Agriculture, PGIA[1], University of Peradeniya. Peradeniya. Engineering.

Prof. J. M. Gunadasa. Vice Chancellor, University of Peradeniya. Peradeniya. Agricultural Geography.

Prof. H. P. M. Gunasena, Dean, Faculty of Agriculture, University of Peradeniya. Peradeniya.

Mr. Herath Gunatillake. Department of Agricultural Economics & Extension, Faculty of Agriculture, PGIA[1], University of Peradeniya. Peradeniya. Agricultural Economics.

Prof. H.D. Gunawardhana. Department of Chemistry, University of Colombo, Colombo. Analytical Chemistry.

Camena Guneratne. Lecturer. Law Division, Faculty of Humanities and Social Sciences, The Open University of Sri Lanka. Nugegoda. Environmental Law.

Prof. S. Gunesekera. Dean. Faculty of Humanities and Social Sciences, The Open University of Sri Lanka, Nugegoda.

Dr. Shantha K. Hennayake. Department of Geography, University of Peradeniya. Peradeniya. Political Geography.

Prof. W. Herath. Department of Agricultural Biology, Faculty of Agriculture, PGIA[1], University of Peradeniya. Peradeniya. Biology.

Mr. Ariyaratne Hewage. Deputy Director, Management and Training. NAREPP/IRG. Colombo.

Dr. A. A. Jayasekera. Department of Agricultural Engineering, Faculty of Agriculture, PGIA[1], University of Peradeniya. Peradeniya. Agricultural Resource Management.

Dr. S. Jayasekara. Veterinary Physiology and Toxicology, University of Peradeniya, Peradeniya. Environmental Toxicology.

Mr. Avanthi Jayatillika. Project Officer (NAREPP), U.S. AID, Colombo.

Prof. W. Jayatillaka. Department of Agricultural Economics & Extension, Faculty of Agriculture, PGIA[1], University of Peradeniya. Peradeniya. Agricultural Sociology.

Dr. Y. N. A. Jayatunga. Department of Zoology, University of Colombo, Colombo. Aquatic Ecology.

Prof. T. Jogaratnam. Department of Agricultural Economics & Extension, Faculty of Agriculture, PGIA[1], University of Peradeniya. Peradeniya. Agricultural Economics.

Prof. H. H. J. Keerthisena. Department of Civil Engineering, Faculty of Engineering, University of Peradeniya. Peradeniya. Civil Engineering.

Dr. S. W. Kotagama. Zoology Department, The Open University of Sri Lanka, Nugegoda. Wildlife Management, Biodiversity, Wetlands Conversion.

Prof. S. A. Kulasooriya. Department of Botany, Faculty of Science, University of Peradeniya. Peradeniya. Microbiology.

M. Mendis. Journalism Division, Faculty of Humanities and Social Sciences, The Open University of Sri Lanka. Nugegoda. Environmental Journalism.

Vidura Sri Nammuni. Department of Architecture, Faculty of Architecture, University of Moratuwa. Moratuwa.

Dr. Anura Nanayakkara. Senior Lecturer. Department of Civil Engineering, Faculty of Engineering, University of Moratuwa. Moratuwa.

Mr. V. K. Nanayakkara. Secretary of Environment, Ministry of Environment, Government of Sri Lanka, Colombo.

Dr. Devanesan Nesiah. Cabinet Secretary, Environment and Parliamentary Affairs, Government of Sri Lanka, Colombo.

Prof. K. A. Nandasena. Head, Department of Soil Science, Faculty of Agriculture, PGIA[1], University of Peradeniya. Soil Science.

S. Pathinather. Senior Lecturer. Department of Civil Engineering, Faculty of Engineering, University of Moratuwa. Moratuwa.

Dr. Asoka Perera. Senior Lecturer. Department of Civil Engineering, Faculty of Engineering, University of Moratuwa.

Dr. Ajantha Perera. Zoology Department, University of Colombo, Colombo. Environmental Toxicology.

S. A. S. Perera. Department of Chemical Engineering, Faculty of Engineering, University of Moratuwa. Moratuwa. Engineering Economics and Reactor Engineering.

Dr. S. Premaratne. Department of Animal Science, Faculty of Agriculture, PGIA[1], University of Peradeniya. Peradeniya. Forage Management.

Kumudu Rajapkshe. Assistant Lecturer. Zoology Department, Faculty of Science, The Open University of Sri Lanka. Nugegoda. Marine Biology.

Dr. Malik Ranasinghe. Senior Lecturer. Department of Civil Engineering, Faculty of Engineering, University of Moratuwa. Moratuwa.

Prof. L. L. Rantayake. Environmental Engineering and Management Program, Department of Civil Engineering, Faculty of Engineering, University of Moratuwa. Moratuwa.

N. Ratnayake. Environmental Engineering and Management Program, Department of Civil Engineering, Faculty of Engineering, University of Moratuwa. Moratuwa.

Prof. N. B. Ratnasiri. Head. Division of Zoology and Former Dean, Faculty of Natural Sciences, The Open University of Sri Lanka. Nugegoda.

Prof. D. C. H. Senarath. Dean. Faculty of Engineering, University of Moratuwa. Moratuwa.

Prof. H. D. J. Silva. Head. Department of Chemical Engineering, Faculty of Engineering, University of Moratuwa. Moratuwa.

Prof. G. T. F. de Silva. Vice Chancellor. University of Moratuwa. Moratuwa.

Dr. C. Sivayoganathan. Head, Department of Agricultural Economics & Extension, Faculty of Agriculture, PGIA[1], University of Peradeniya. Peradeniya. Extension.

Mr. M. Sinnathamby. Department of Economics, Faculty of Arts, University of Peradeniya. Peradeniya. Economics.

Prof. Priyani Soysa. Director-General, NARESA, Government of Sri Lanka, Colombo.

Dr. Bruce Spake. Chief of Party. Mahaweli Agricultural and Rural Development Project (MARD), Development Alternatives, Inc.. Pimburettewa. Telephone: 027-2174; Fax: 027-2174, 698315; Telex: 21979 SALAKA CE. Colombo Telephone: 699357.

Prof. H. Sriyananda. Dean. Faculty of Engineering Technology, The Open University of Sri Lanka. Nugegoda.

Prof. R. O. Thattil. Head, Crop Science, Faculty of Agriculture, PGIA[1], University of Peradeniya. Peradeniya.

Mr. Clavore Wilson. Department of Economics, Faculty of Arts, University of Peradeniya. Peradeniya. Environmental Economics.

Dr. Nilmini Wanigasooriya. Faculty of Dental Sciences, University of Peradeniya. Peradeniya. Orthodontics.

Dr. Buddhi Weerasinghe. Director, Educational Technology Division, The Open University of Sri Lanka. Nugegoda.

Dr. Cyril Wijesundera. Curator of the National Herbarium. Royal Botanical Garden. Peradeniya. Ecologist, Botanist.

Prof. Dayantha S. Wijeyesekera. Vice Chancellor. The Open University of Sri Lanka, Nugegoda.

Prof. Arjuna de Zoysa. Head. Computer Studies Division, Faculty of Engineering Technology, The Open University of Sri Lanka. Nugegoda.

APPENDIX B

The Interdisciplinary Challenge[5]

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The Ohio State University
Columbus, OH 43210
March, 1989

Interdisciplinary activity is becoming increasingly important on university campuses as researchers, scholars, and educators grapple with complex questions and problems that cannot be addressed effectively within any of the traditional disciplines. This trend is most obvious in the professional schools where research and education have focused for some time on complex issues facing our society. But today, many of the most exciting and challenging questions in the fundamental natural and social sciences and the arts and humanities also require expertise from several disciplines. Further, funding agencies such as the National Science Foundation, other governmental agencies, and many foundations are encouraging an integrated approach to research and teaching, stipulating that proposals in certain programs must be interdisciplinary and that the university must demonstrate that such activity is supported and rewarded. For instance, in its proposal solicitation for the new National Center for Geographic Information and Analysis (NCGIA), NSF asked for "information on cross-disciplinary research and instruction," an excellent indication of the institution's commitment to interdisciplinary work. A structured system of Centers, complementing and building on the existing disciplinary structure of colleges and departments, can provide support and rewards for faculty engaged in interdisciplinary work.

A Center is a hub, a focus, a point of convergence around which activity revolves, a source of action and influence. It is a gathering place for those with common interests and goals. In academia, it is an area where faculty with diverse professional backgrounds come together to examine complex problems, issues, and challenges. It is a home for interdisciplinary research, scholarship, and education.

Academic Centers are characterized by horizontal specialization, highly trained faculty, flexible organizational structures, and organic rather than mechanistic relationships. Mintzberg[6] calls such organizations *adhocracies* and notes that planning and coordination in an adhocracy is achieved mainly through constant informal communication among the "operating core" of professionals. In academic Centers, this operating core is the faculty.

Universities have not had great success in mobilizing their resources in a timely and effective

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[5]Excerpted from a white paper addressing interdisciplinary issues at The Ohio State University, Columbus, Ohio

[6]Mintzberg, H., 1979. *The Structuring of Organizations*, Prentis-Hall, Engelwood Cliffs, New Jersey.

way to address complex interdisciplinary problems. Epton *et al*[7] attribute this to barriers in the university that "inhibit the workings of the adhocracy." Universities are organized into departments and faculty members are trained to be disciplinarians. The reward structure of the University fosters and promotes rigid adherence to disciplinary norms and standards. The flow of resources and the cult of the discipline keep faculty members focused on the department and discipline. Venturing beyond is discouraged. As a result, research and teaching programs become increasingly narrow in scope and linear in direction. The time that faculty devote to planning and coordination becomes vanishingly small compared to the time they spend pursuing their own research and teaching their own courses. Specialization becomes increasingly vertical, horizons narrow as relationships become predictable and mechanistic, and the organizational structure becomes increasingly inflexible. Further, the overall quality of departmental-disciplinary faculty will rarely remain consistently high over an extended period of time. It is a rare department that does not have a cadre of faculty members who have failed to remain current in their fields. Thus, all of the qualities of the adhocracy are lost, life becomes predictable and comfortable, and all of this is justified on the basis of disciplinary tradition.

Effective interdisciplinary research, scholarship, and education requires flexibility, innovation, and the ability to respond rapidly and appropriately to ideas, opportunities, and challenges. These are integrative processes that require continuous communication and accommodation among participating faculty. The most successful Centers will be those that function as adhocracies, developing flexible organizational structures that can change to meet new challenges, attracting a broad spectrum of highly qualified and dedicated faculty from specializations relevant to the mission of the Center, and facilitating the constant informal communication that is the primary mode of decision making in productive adhocracies. Faculty members should flow in and out of Centers as their interests and the needs of the Centers evolve. This organic faculty will be the creative force of the Centers, their operating cores, generating the ideas, exploring new territory, setting directions, and developing programs.

Centers at universities rarely have faculty of their own. Thus, these centers have no tenured operating core. Faculty that do participate usually do so as a overload without the encouragement and support of their department chairs and colleagues and with little or no expectation of reward from the system. Dedicated faculty members might participate in this way for long periods of time, sustained only by the intrinsic rewards of interdisciplinary collegiality and collaboration. But, more often, faculty initially enthusiastic about the interdisciplinary work burn out and withdraw to the comfort and security of the disciplines. Participation in interdisciplinary programs declines to attendance at formal meetings and the adhocracy disappears. The Center ceases to function as a "Center."

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[7]Epton, S. R., R. L. Payne, and A. W. Pearson, (Eds.). 1983. *Managing Interdisciplinary Research*. John Wiley & Sons, New york.

APPENDIX C

Philosophy For Undergraduate Education in Natural Resources

School of Natural Resources
The Ohio State University
November, 1987

Introduction

This statement of educational philosophy was developed by the School of Natural Resources Academic Affairs Committee to provide a focus for the redesign of the undergraduate programs of the School of Natural Resources.

General

A need for definition of the term "natural resources" was identified by faculty members during their discussion of needs for curricular change. The following definition is offered:

> Natural resources are those resources used for human benefit, though not created through human effort. They comprise the biosphere, together with the soil, water, and atmospheric and electromagnetic resources supporting it. The study of natural resources necessarily involves both the natural sciences, as the sources of information concerning the resources themselves, and the humanities and social sciences, as they provide insights into human use and need aspects.

By its nature, natural resources is both a multidisciplinary and an interdisciplinary field. Therefore, students in undergraduate programs in the School of Natural Resources need to develop thorough understandings of basic concepts in the humanities and in the social and natural sciences, focusing on how they interact with one another. Learning how to integrate knowledge from many disciplines to address issues concerning natural resources effectively is the primary objective of all undergraduate programs in the School of Natural Resources.

A distinction is drawn between training and education for natural resources undergraduate students. All SNR programs must include the training necessary for B.S. graduates to gain and hold entry level employment in their areas of concentration, and must also prepare them for broader opportunities for professional advancement, for further study, for citizenship in a pluralistic society. All SNR programs will stress scientific methods of learning.

A balance between professional training and general education must be sought and achieved, so that Bachelor of Science graduates of the School of Natural Resources are capable of understanding and developing their personal and professional options after graduation.

A major hurdle which must be surmounted in the development and implementation of the SNR curriculum model is created by the delicate problem of depth versus breadth, with respect to the academic and professional needs of undergraduate students in the several programmatic areas within the School. It remains the intention of the School of Natural Resources to offer exemplary baccalaureate programs in each of its several major areas within four-year time frames, with due attention to the specific professional needs of each major. Developing four-year programs which will meet both general education and professional education goals in each major area will call for creativity in selection of appropriate offerings

from the university community, along with the careful development of appropriate offerings at both the School and individual major levels.

Problem Solving and Decision-Making

Natural resource scientists and managers deal with problems of quality, scarcity, and allocation. In this context, students of natural resources must become intimately familiar with the role of the resource professional in seeking solutions to problems associated with natural resources, making decisions, and resolving conflicts that result from competing demands and from biological and other scientific constraints. Resource managers and scientists are called upon to deal with issues concerning equity and justice not only in terms of human needs, but also increasingly in terms of the needs of endangered species, biological diversity, endemic habitats, and ecological systems. The political realities of decision-making and problem-solving dictate that all concerned be given the opportunity to voice their opinions, or to band together to exert political pressure to secure preferred managerial responses to issues of concern, including issues related to the preservation, conservation, management, or exploitation of natural resources.

In this context, the role of the natural resources professional is one of information integrator, provider, and interpreter. Resource managers and other scientists must be sensitive to an increasingly complex array of messages from other managers and scientists, technical specialists, legal and political entities, organized interest groups, and concerned citizens. The research scientist seeks to extend the boundaries of knowledge and to communicate new information to client groups; the manager works to build meaningful, purposeful, realistic consensus in the process of decision-making. Controversial decisions must often be made in the short term, but the long-term goal should be to seek a balance among competing demands of people, organizations, resources, and technologies, at the same time protecting the integrity of the resource base.

Undergraduate education in natural resources at The Ohio State University builds on a basic foundation of technological, socio/cultural/economic, and natural science competencies that lead to educational experiences in which students must deal with decision-making situations involving considerations such as equity, short-term vs. long-term costs and benefits, and technological and environmental risks, all within the context of sound scientific knowledge and understanding.

The process of educating the undergraduate student is a cooperative university-wide effort involving the quantitative, social, and natural sciences, the humanities, and the communication offerings of the general University curriculum. In their natural resources specialization studies, students will build on solid bases in the aforementioned General Education areas, and will have opportunity to increase their competencies in these areas by emphasizing their integration within the context of natural resources. They must also develop specializations in natural resources science and/or management areas that complements this breadth with academic depth.

The Natural Resources core and specialization curricula will emphasize the applications of the technological, socio-economic, and natural sciences, first building a knowledge base relative to the field of natural resources, then integrating each of the areas while at the same time increasing students' understanding of both process and content. A spiral approach will continue throughout the undergraduate program, emphasizing increasing sophistication of content and integration, with the ultimate product being graduates who can provide leadership in their professions.

Professional Education And Technical Training

It is necessary to reduce the divergence between gaining the technical expertise required to accomplish a task and developing an understanding of why the task is being done; students have a need to understand which goes beyond their need to know for the purposes of employability. The SNR mandate includes teaching students how to draw data-based conclusions and act on those conclusions to make decisions -- that is, to be conceptual thinkers.

The decision-making process is likely to be faulty if students have not developed sufficient background to understand the context of their natural resource management decisions. The SNR philosophy is to provide a general education during students' undergraduate tenure in the School, at the same time providing them with appropriate technical skills.

CURRICULUM AREAS

Professional Background

Early in their studies, students in natural resources will be presented with an overview of what the field of natural resources is, what its basic parameters are, what natural resources professionals do and why, the recurring problems of natural resources management, and how decisions related to the use and management of natural resources impact human societypast, present, and future. A central component of this effort is a consideration of ethical perspectives, including how management decisions are made and identification and selection of methods for keeping options open in the future, both short-term and long-term.

Natural Sciences

An understanding of the physical dimensions of natural resources is essential to the understanding of natural resources science and management. Management and production must be viewed from a number of different perspectives, including: renewable and non-renewable natural resources, range management, timber management, fisheries management, wildlife management, parks and recreation administration, water resources management, environmental education, and environmental science. This is closely linked to the development of systematic approaches (i.e., a "systems approach") to resource science and management. The biotic and abiotic systems provide the resource base upon which society depends.

Basic principles of energy, light and matter form the foundation for the understanding of more complex systems. These principles govern the interactions of atoms, the relationships between light and biomass, air and water movement, plant and animal distribution, and social geography.

Understanding the organization of the basic levels of structure into complex living systems is essential. Evolutionary concepts of animal and plant development involve anatomical design and physiological communication between cells. Transfer of genetic information is part of the basic concept of communications. Understanding of the value of that information is paramount in seeking decisions regarding preservation of biologic diversity.

Studies of soils, hydrology, and geology are unifying areas which are relevant for all students of natural resources, who must have an understanding of the complex animal and plant communities in soils, the influence of soils and geology on terrestrial communities, and the impact of hydrologic factors on water quality. These are essential to an ecosystem approach to resource science and management.

In order to approach living things logically, SNR students must be familiar with basic taxonomic systems, both plant and animal. Students must gain ability to use dichotomous keys

in all major taxonomic areas. How plants and animals respond to one another and their environments, both inter- and intra-specifically, is the culminating science; it must become clear in at least an elementary fashion to all SNR undergraduate students. Understanding how physical and biological factors interact, including human impacts, is the final step in integrating the natural sciences, preparing students to overlay them with social science concepts in the development of personal and professional world views.

Quantitative Sciences

In order to understand and describe the concepts involved in both the social and the natural sciences, mathematical skills are necessary. In order to develop constructs concerning changes in our world, SNR students need to be able to evaluate and use statistical procedures. Also, students need to be able to use computers for managing, processing, and evaluating both numeric and written information. Thus, it is necessary that proper attention be accorded the quantitative sciences in the development of all undergraduate programs in SNR.

Social Sciences

An understanding of the human dimension in natural resources valuation and use is required by the concept of a natural resource. Use and valuation should be viewed in a number of different contexts, each of which contributes different concepts and methods to building an understanding of the human social condition. The historical context provides the basis for understanding how past ideas concerning resource use and valuation have affected trends of social development resulting in the present mix of preferences for resource development, use, or preservation. This is closely linked to the development of philosophical positions and ethical concepts related to man's relationship with the natural world.

An understanding of the philosophical and ethical contexts within which decisions are made concerning non-renewable resource use, short-term depletion of renewable resources, or sustainable use of renewable resources constitutes an historical/philosophical/ethical component of basic natural resources education. Politics and economics provide a context for understanding how power and money are organized in a society and how the distribution of power and money affects resource use and valuation. Concepts of law, education, political organization, political institutions, and the political/decision-making process are important to understanding how conflicts over differences in resource use preferences and valuations are resolved. To understand valuation from a market or social welfare perspective requires the use of economic concepts and theories. These ideas are further elaborated to develop concepts of resources as raw materials and commodities that are traded and valued based on their supply and users demands. How societies are organized, and the processes that determine how cultural and social values are expressed, must be understood. How natural resources are defined, their appropriate development and use, and their distribution within a society must be addressed. The norms and roles that define appropriate behavior for managers, developers and users of natural resources, and the processes of socialization through which norms and roles are learned, are of particular importance. Understanding how individuals perceive resources and how natural resources can meet individual needs will be developed, perhaps through a diverse set of problems designed to develop understandings of such things as the location of cities vis-a-vis raw materials and transportation networks, perceptions of and reactions to natural forces as hazards, technological and environmental risks, and cognitive mapping and perceptions of spaces.

Undergraduate students majoring in programs in the School of Natural Resources will develop a thorough understanding of the human dimension in natural resources through the University, School and major requirements. University requirements will provide a broad perspective on the history of civilization and the evolution of thought and human value constructs. Students should be exposed to theories and concepts of human development and

organization from cultural, social and personal perspectives. In addition, students should develop a basic understanding of economic and political institutions and the processes that affect resource valuation and decision-making. The School requirements will focus on developing a basic understanding of the history and literature of conservation and the philosophical and ethical issues related to resource development, use, and preservation. All students should understand the institutional arrangements for managing natural resources and the social, political, and economic issues that generate conflict over resource management. Each major will provide students with an in-depth review of the history of its discipline, and the moral and ethical questions that professionals must confront.

Communications Skills

Among the essential attributes of the educated person is the ability to communicate with others. Most professional persons realize the necessity of communicating with other professionals in their own fields, but many are deficient in the basic skills involved in doing so effectively. Even more, professional persons need to develop skills necessary to communicate with professionals in other fields, or with various client groups, including the general public.

On the skill level, professional communicators segment their field into four areas reading, writing, speaking, and listening. Sequencing them in this fashion also arranges them in a hierarchy from that area which receives most attention to that which receives least in educational programs. Students majoring in natural resources need to develop these skills, for both general education and professional education purposes. Though primary attention is focussed on skill development, it is expected that students will have ample opportunity in their studies to develop a supporting conceptual base related to communications, including understandings of communications theory and information technologies.

On the university-wide general education level, educational opportunities for developing basic composition and speaking skills and concepts are expected to be available and should be included in each student's program. More advanced skills in the communications areas are needed by each student, including training in the selection, procurement, and understanding of reference materials, and in technical writing for both professional and lay audiences, including the preparation of professional papers, technical reports, impact statements, management plans, etc. Skills in developing presentations, including the selection and preparation of ancillary materials needed for making them effective, need to be emphasized in all program areas, for all students enrolled in the undergraduate programs of the School of Natural Resources.

It is simplistic to suggest that students can develop their listening skills solely by paying attention to lectures and taking notes. Group activities, opportunities to learn orally from other students, etc. are meaningful learning experiences in this area.

In addition to general education course work in the communications area, natural resource courses should incorporate communications skill development activities as appropriate to the content of each major, within its specific courses. Also, natural resources undergraduate students will benefit from course work designed specifically for communications concerns common to the natural resource management fields.

International/Foreign Language

Graduates of the School of Natural Resources must have understandings of other societies. They must be able to relate to different developed and developing countries and to the cultures and people of those countries. To recognize, appreciate, and understand different cultures is an attribute of an educated person.

Each graduate should have a minimum competence in at least one foreign language with emphasis being placed on the following languages: Spanish, French, Russian, Arabic, Chinese, Japanese, German, and Italian. In addition, all undergraduates should develop international perspectives through their other course work. International perspectives should be incorporated in natural resources courses as appropriate. Students will be encouraged to seek additional international perspectives by participating in international educational experiences outside of the United States and its territories.

Data Acquisition and Interpretation Skills

Natural resource decisions are based on social, biological, political, and economic data collected in field situations. SNR graduates should be familiar with the important aspects of planning, executing, and evaluating primary data-gathering activities. To accomplish this, all undergraduate students in the School of Natural Resources will have direct involvement in the planning and execution of primary data-gathering activities in the general areas of the natural sciences and the social sciences. These experiences should include general skills needed by all students, such as project planning, sampling strategy, sampling bias analysis, and data management. An important area of emphasis will be the absolute importance of ethical data collection and reporting, addressing the strategies necessary to ensure quality control.

All School of Natural Resources students will participate in field experiences. One field experience, or set of field experiences, should be a shared and structured experience for all SNR students which provides some contact with all varieties of field sampling techniques and data acquisition. A second field experience, or set of field experiences, should be specific to each major's area of concentration. This specific experience may be in the form of short, intensive activities, internships, or formal field courses. In this way, students will have a general view of all types of natural resource data acquisition strategies, while also gaining the specific technical knowledge necessary for them to enter natural resources professions or graduate education.

Every SNR student should know how to access effectively the literature in natural resource fields in general and in their major field in particular. The skills of finding and evaluating data from both traditional sources and the "fugitive literature" is of critical importance in natural resource decision-making processes. However, the primary data acquisition ("field") activities described above are different from these bibliographic skills which are best integrated in other course work.

Capstone Experiences

An important component of the undergraduate curriculum will involve capstone experiences, which will take integrative, inter-disciplinary approaches to natural resource problem-solving and decision-making. There will be a common capstone experience for all SNR students, and capstone experiences in each program area. In addition, integrative experiences will occur throughout the undergraduate curriculum as they may fit within specific courses. The central tenet of the SNR capstone experience is that natural resource management is done by people as well as for people and, as such, requires that value judgements be made. The objective is to provide students with a firm foundation for decision-making, policy implementation, ex-post and ex-ante evaluation, and conflict resolution.

The School-wide capstone experience will draw on ecological, political, economic, and sociological data and models. Analysis will be undertaken from a variety of perspectives so that students come to understand the nature of dissent when conflict exists not only over the ends, but also the means by which decisions are made. A focus on the processes society uses to make decisions, even when consensus is not reached, is essential. Specific analytical constructs may include environmental impact analysis, benefit-cost analysis, benefit-risk

assessment, income distribution analysis, multiple objective planning, and dispute resolution. A variety of approaches to the analysis of management alternatives may be used to facilitate application of these constructs, including: problem definition, theories of public choice, risk perceptions of experts and lay public, financial investment criteria, alternative scenarios and alternative paradigms, application of communication strategies for target groups, political and/or community action planning, and short-and long-term planning. Implementing the School-wide capstone experience will require that all natural resource students have a "hands-on" experience in the development and use of one or more of the constructs listed above. Ideally this should be as a member of a multidisciplinary team made up of students from all of the SNR major programs, perhaps also including qualified students from related fields across the campus.