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**PROPOSAL FOR SUPPORT UNDER  
THE AGENCY FOR INTERNATIONAL DEVELOPMENT  
INSTITUTIONAL GRANTS PROGRAM**

488

APPLICANT: The University of Arizona

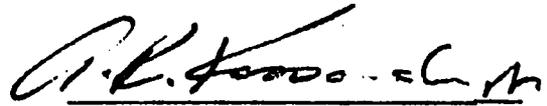
DATE: May, 1974

GRANT TITLE: Integrated Natural Resources Planning  
and Management of Arid and Semi-Arid  
Lands

AMOUNT OF GRANT: \$1,045,000 (for period FY 74-FY 79)

AID SPONSORING OFFICE: Office of Science and Technology, Bureau  
for Technical Assistance

  
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Grant Director

  
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## I. DEVELOPMENT PROBLEM

### A. University's Perception of Problem

Concern over the availability and management of natural resources has become a worldwide theme during recent years. Both politicians and resource specialists throughout the world, including those of the developing nations, have begun to recognize that the natural resource base is both finite and limited, and, in the absence of proper stewardship, susceptible to rapid depletion. Concurrently, a new "environmental awareness" has focused global attention on many examples where narrowly conceived development projects (e.g., livestock production, water development, road construction, forestry) have wasted and exhausted the resource, preempted better use of the land, and created serious secondary environmental problems, the costs of which may diminish or actually outweigh anticipated benefits over the long term.

However, this newly perceived requirement to do a better job of protecting and managing the resource base to meet long-term goals comes at the very time when rapidly growing populations are intensifying the immediate demand for more arable land, water, minerals, fuel, and forest products. This is creating a particular dilemma for developing countries (LDCs) since many feel that the development of their indigenous natural resources, given the rapidly growing worldwide demand, offers the fastest way to disengage their economic well-being from reliance on subsistence agriculture. Consequently, while such nations are interested in protecting and sustaining the resource base over the long-term, implementation of a new philosophical and operational approach to natural resource management must be based, in the first instance, on a recognition that resource development will intensify and, secondly, on gaining access to and applying improved skills and techniques for identifying and evaluating various resource management options.

When viewed from a global perspective, nowhere is the need and challenge greater than in the semi-arid and arid lands that lie within the tropical and sub-tropical zone bounded approximately by the 30 degree latitude lines. This zone contains most of the world's least developed countries--countries plagued by soaring population rates; vast areas of traditionally dry, marginal land; and now critical new problems of loss of land productivity, soil erosion, and desert encroachment triggered by what appears to be a combination of natural drought and poor or non-existent resource management practices. In developing countries of Latin America (Bolivia, Peru, Chile), Africa (Chad, Mali, Niger, Ghana, Mauritania, Upper Volta, Senegal, Sudan, Kenya, Ethiopia, Tanzania) and Asia (Afghanistan, India, Bangladesh, Pakistan, Jordan, Syria) countless hundreds of millions of inhabitants find their lives jeopardized by the inability of the land to even sustain past levels of productivity, let alone

keep pace with requirements being levied by growing numbers of humans and livestock.

The traditional economic base in these areas has been a subsistence pastoralism with limited development of irrigated agriculture. The destruction of vegetation and soil and the advance of barren deserts, exacerbated by inadequate control over the numbers and movements of livestock, is a continuing process. Efforts to improve carrying capacity for livestock through water development are often defeated by failure to provide control over livestock concentrations. The choice among alternative uses of limited water resources, particularly in relation to irrigation, is seldom made on a rational basis; one which involves balancing short-term cost and benefits against long-term economic returns, conservation of water and soils, and proper social and health adjustments. Collectively, the urgency to exploit economically valuable resources for domestic and export purposes, and the absence of capabilities for managing the land and waters, are combining to severely mortgage the future welfare of coming generations in many developing countries.

The importance and magnitude of this set of problems have received international recognition within the past 1-2 years. Both the new U.N. Environment Programme and UNESCO's Man-and-the-Biosphere Programme have assigned top priority to addressing resource management problems of the arid and semi-arid regions. The challenge facing the international development community is to equip the LDCs to bring to resource management a new perspective and capability, one which first establishes the nature and value of the resource base on a broad regional scale; and then which can plan and implement development with an improved appreciation of the management alternatives and associated benefit-cost trade-offs, and particularly of decisions which could limit or foreclose future options.

This will require, among others, the examination of existing technologies for dry-land resource management, as well as continual evaluation of the emerging technological state-of-the-art to identify and apply the most suitable and effective methods and tools. In addition, efforts by outside institutions must recognize the extreme sensitivity of the developing countries to possible infringement by foreign interests on their sovereignty over indigenous natural resources and, as a result, the strong LDC desires to develop their own capabilities for resource assessment and management. Consequently, development assistance must focus on equipping the LDC to carry out these tasks through training, education, and strengthening institutional capabilities. In addition, building developing country skills to tackle their own complex problems of resource management is the only viable alternative to what must otherwise be continual, long term financial assistance by development agencies.

## B. University Interest and Current Involvement

The University of Arizona has, since the early 1900's, been recognized as a leading U. S. institution in arid and semi-arid lands research and management. By virtue of its geographical location in the Southwest, this land-grant institution has been continually involved both academically and operationally with resource management problems and opportunities of arid and semi-arid ecosystems. The University's curriculum, research activities, involvement with other U. S. and international organizations, and overall philosophy and approach to natural resources clearly reflect an interest in, and commitment to, an improved understanding of principles and techniques for sound arid land management.

An excellent example of the University's perspective and interest is the establishment in 1958 of the Office of Arid Lands Studies to provide for centralized, inter-departmental coordination of arid lands oriented natural resource activities, with particular emphasis on the interdisciplinary aspects. From a modest beginning, the OALS has evolved into a stable State-supported unit of international acclaim which has, among others, effectively mobilized the scattered University resources to carry out arid land projects and studies in support of state, regional and local needs.

As described in Section II, relevant university academic programs span the spectrum of natural resource disciplines. There are, for example, some 47 major water resource-oriented research projects, 28 in minerals, 35 in forest/range & wildlife, 14 in energy, 8 in recreation, 21 in remote sensing, and 27 others focused on environmental protection and analysis, and information systems--all related to the arid lands. Of particular note is the work done on the Indian reservations in the State which present many of the social, cultural, economic and physical problems associated with developing countries.

In terms of international interest, the University of Arizona's overseas activities are extensive and growing steadily. Currently, 272 faculty report recent international experience in related areas of research and education. Some have been associated with development and demonstration of the first year-round, power-water-food facility located in Abu Dhabi which is designed to assure a plentiful supply of high quality produce while consuming limited water resources. Others have, for example, participated in projects carried out by the Department of Anthropology in Mexico and with the Laboratory of Tree-Ring Research which involves, respectively, sociological and climatological aspects of arid land management.

University faculty are currently serving as principal consultants to a large AID-financed study at MIT of alternative strategies to rehabilitate the drought-stricken Sahel-Sudan area of Sub-Sahara Africa; and the Director of the Office of Arid Lands Studies spent two months visiting eight African and Middle Eastern countries during February and March 1974 to assess

international resource management problems, institutional capabilities, and opportunities for new University linkages. At the request of the U. S. mission, he visited Ghana to provide guidance on the type of program required to assist that country predict and evaluate the impact of intensified drought and attendant desertification.

Finally, under an existing AID 211(d) grant, the Department of Watershed Management has been carrying out an integrated resource management program, with concomittant international involvement and implications, entitled "Optimum Utilization of Water Resources for Agriculture, with Special Emphasis on Systems Analysis of Watershed Management under Conditions Characteristic of Less Developed Countries."

Many other relevant domestic and international interest and activities can be cited. The above, however, were selected as being illustrative of the breadth of the University's interest; its focus on integrated, multiple-use planning and management considerations; and the importance it attaches to the international dimension of arid lands resource management.

#### C. Match Between AID and University Objectives

The AID approach to LDC resource management was well-stated at a Science and Technology Workshop held in 1971: "An integrated, multi-disciplinary approach to natural resource management should be pursued within the LDCs which recognize both the country's desire for short-term economic pay-off and the reality that long term benefits are maximized only through a program based on sound research, management and conservation." Further, "The use of 211(d) grants...could be useful in areas such as resource development and planning and environmental assessment. Application to regional land use planning should be considered. Strengthening United States capabilities in these areas also would be responsive to the growing requirement to relate development to a nation's overall social/cultural goals."

It is recognized that current AID emphasis on the least developed countries and the rural poor, coupled with the recent appearances of drought and famine in broad areas of the developing world, have promoted arid land resource management in AID's list of priority development problems. The AID perspective and role appears to be to mobilize and bring to bear on the problems the best of U. S. science and technology and to emphasize the strengthening of LDC manpower and institutional capabilities throughout. As reflected in AID documentation on the African Sahel problems, development assistance requirements include more effective adaptation and application of existing and emerging technologies, more broadly based planning to avoid offsetting secondary impacts of traditional single purpose development, improved information transfer, and expanded education and training programs. It further indicates that the U. S. should, and can, assume a leadership role in terms of making significant contributions in each of these areas, both bilaterally and through improved U. S.

### Inputs into international activities.

The University of Arizona has, since its inception, been oriented to the development of a better understanding of the problems encountered in the arid and semi-arid environments. A major portion of this work has been agriculture, where a very high level of competence, both locally and internationally, has been obtained. In recent years this competency level has been extended to such general areas as desert ecology, and water resource management, while attempts to establish an equal level of competence and international involvement in all resource areas have been hampered by the lack of adequate funding.

President Schaefer's trips to Israel, Africa and South America, the establishment of formal and informal ties in Afghanistan, Brazil, Mexico, Iran, Turkey, Saudi Arabia, and the current involvement with MIT (Sahelian Project) are all indicative of the University's continually growing interest in natural resource problems of the arid and semi-arid lands of the world.

Since the University of Arizona is a land-grant institution, the solution of practical problems has always been a major goal, and this is becoming increasingly important with the concern being generated in relation to the finiteness of our world's supply of natural resources. Any knowledge obtained in learning how to manage these natural resources better will be of benefit to LDCs, the United States, and the State of Arizona.

As an educational institution, the University strongly believes that its students must perceive problems and their possible solutions within an international context. This is particularly true of natural resources which certainly have international implications (both in terms of commonality of the ecosystem problems and global economic/environmental impacts), and which can hardly be dealt with on a national or sub-regional level. In recognition of this, the University has attempted to address arid lands resource management from a global perspective which accounts for the present level of its international involvement and its commitment to strengthen this dimension through, among others, this grant.

From the above, it is evident that there is a match between AID's objectives and those of the University of Arizona. Our desire is to increase knowledge of the causes of resource management problems and solutions; to pursue multi-disciplinary approaches to problem solving; to work with individuals and institutions from other countries in this enterprise; to upgrade and increase the flow of information on arid lands; and to build additional internationally-oriented education and training activities into existing University problems. All these should be directly supportive of AID's concern for enhancing the quality of life of the inhabitants of the marginal arid lands in developing countries since they represent the essential components of a U. S. response capability which recognizes the need for new solutions to old [albeit growing] problems; requires improved single source access to information; emphasizes long term

sustaining U. S.-LDC linkages; and respects the fact that national sovereignty concerns and the complexity of the problems necessitates major attention to building LDC capabilities to carry out the management functions as opposed to continual reliance on outside institutions and AID donors.

## II. DESCRIPTION OF GRANTEE

### A. Existing Competence and Interest

The University of Arizona can bring to bear on the development problem addressed by this grant a solid nucleus of academic courses, capabilities and experiences across the spectrum of natural resources disciplines, as well as a number of significant and effective linkages with U. S., international and developing country institutions. Some of these were touched on in Section I.B; the institutional linkages are described in Section IV; and Appendix A contains a description of major university resource-oriented programs. The following identifies those aspects of the broad-based University program which most closely relates to the specific objectives of the Grant.

An analysis of the curriculum, faculty competence, research investigations, and non-academic programs indicates that the University of Arizona has strong capabilities in virtually all aspects of natural resources management as applied in arid lands--water resources, forestry, minerals, energy, wildlife management, recreation, and agriculture.

At present, the University has approximately 60 academic and non-academic departments actively involved in teaching or research related to some aspect of the planning and management of natural resources. A variety of interdisciplinary degree programs are offered such as those in Arid Lands Resource Sciences, Geosciences, Genetics, Latin American Studies, Linguistics, Oriental Studies, Urban Planning, Watershed Management, Wildlife and Recreation, and Water Resources. It is noteworthy that a new Dean of the College of Agriculture (which has an institute of renewable resources) has been hired by the University, an individual with an excellent reputation, broad international experience, and an expressed desire to expand the institution's international role and its multidisciplinary approach.

Major emphasis within the University is already placed on the interrelationships among the disciplines as well as on the application of new resource management tools (e.g., legal instruments, remote sensing, modelling). Also, the University has done major innovative work in new approaches to using natural resources (e.g., hydroponics, solar energy). Individual faculty members are applying resource management theories and techniques to resource development in Arizona and have extensive practical experience on U. S. Indian reservations and in the LDCs. In addition, the University is currently actively involved in carrying out resource inventories, environmental impact analyses, and land use planning studies for the State of Arizona, and in cooperation with several Federal agencies. It is the focal point for a major international program on desert ecosystems; it serves as the operating agent for a Department of the Interior-NASA remote sensing program which involves ecological studies in SW Arizona; it is

carrying out a major arid lands research and information dissemination program; and several of its departments are engaged in developing and testing new physical and computer modelling approaches to resource management.

Facilities at the University include a library of more than one million volumes, the Triga Nuclear Reactor, and the Computer Center; several research units including the Institute of Atmospheric Physics, the Water Resources Research Center, the Institute of Government Research, the Division of Business and Economic Research, the Steward Observatory, the lunar and Planetary Laboratory, the Engineering Experiment Station, the Laboratory of Tree-Ring Research, the Office of Arid Lands Studies, and the Bureau of Ethnic Research. Also capable of contributing to the subject program are the Agricultural Experiment Station and associated Land Grant College programs, the Arizona Cooperative Fishery Unit, the Arizona Cooperative Wildlife Research Unit, the Arizona Bureau of Mines, and several museums including the Arizona State Museum.

The University, through the Office of Arid Lands Studies, has been designated as the Arizona Regional Ecological Test Site and, as such, is conducting a program of ecological studies in SW Arizona based on remote sensor data from high altitude aircraft and satellites.

Another major University program of particular relevance to resource management in the LDCs involves closed-system food production in greenhouses to minimize water requirements. One such system is being operated in Aba Dubai and a second experimental unit is located in Mexico.

Particularly noteworthy is the fact that University staff are currently involved in a large number of co-operative projects with Federal and State agencies which include the U. S. Forest Service, Bureau of Land Management, Bureau of Indian Affairs, Corps of Engineers, Arizona Co-operative Fishery Unit, the Arizona Department of Mineral Resources, and the Arizona Center for Water Resources Research. The on-campus location of units of most of these agencies offers significant advantages to the program in terms of access to expertise and participation in addressing practical resource management problems.

The University's international involvement is extensive and has been growing significantly during recent years. Two aspects of this are particularly significant for purposes of this Grant: (1) the University has stressed institutional linkages (rather than individual scientist exchanges); and (2) it is now increasingly being looked to by other countries and assistance agencies for natural resource expertise outside of the area of arid land studies (e.g., tropical forests studies in Latin America; water resource planning in the Philippines). The University of

Arizona has 272 scientists with international experience in research & education relating to natural resources inventorying, planning, management development, marketing, and to the social and environmental aspects related to resource activities.

Present international involvement by the University of Arizona is summarized in Appendix B prepared by the Office of International Programs. Specific attention should be focused on University of Arizona association with Brazil's University of Ceara to stimulate and improve rural life and agriculture; joint work with the Arid Lands Research Center, Abu Dhabi, to develop a power-water-food facility; the Office of Arid Lands Studies computerized arid lands information system in cooperation with Israel, Mexico, and Australia; and joint University of Arizona - M.I.T. cooperation in the Sahel-Sudan area of Africa.

In November 1973, the Office of Arid Lands Studies (OALS) sponsored its Fourth International Remote Sensing Conference devoted specifically to arid lands problems and solutions.

Finally, the University has experience with the AID 211(d) concept. The Department of Watershed Management is currently carrying out a program under a 211(d) grant entitled "Optimum Utilization of Water Resources for Agriculture, with Special Emphasis on Systems Analysis of Watershed Management under Conditions Characteristic of Less Developed Countries."

The courses, research, recent travel abroad, and experience fostered by the ongoing 211(d) Grant will enhance and complement the proposed new 211(d) program in natural resources management and planning. It should be noted that the focus of the existing grant to Arizona is on systems approaches to watershed management, and that the orientation of the proposed extension of that grant will be on agricultural use of water on small watersheds. This is distinctly different from the cross-discipline, multi-resource nature of the proposed grant, which also deals with land areas of a larger dimension -- generally regional in scope. Appropriate institutional and organizational arrangements have been made to assure coordination between the two programs which could be mutually reinforcing at certain points. Consideration was given to combining the new and old grants since water resources, the principal focus of the ongoing 211(d), is obviously one of the key resources which must be dealt with in any integrated natural resources program. After careful study of the alternatives, AID and University representatives agreed that the two programs should be funded and administered as separate grants for the following reasons: (1) a synthesis would be disruptive of the present 211(d) which is now running smoothly; (2) no savings on overhead or management costs would result from a combination; (3) a close integration of key personnel and relevant activities associated with the ongoing water management 211(d) is designed into the new project; and (4) the future emphasis of the ongoing grant on small watersheds will cause much of the effort to be outside the scope of the proposed integrated natural resources grant.

**B. University Contribution and Other Anticipated Funding**

The proposed grant program is designed to build and expand on a solid base of existing University expertise, programs and facilities. Consequently, by providing and sustaining the nucleus, the University brings to this partnership an uncalculable contribution which, however, is far in excess of the magnitude of this particular grant. For example, a remote sensing center of expertise, research and education now exists at the University. This center enjoys financial support from State funds and is currently self-supporting, thus requiring minimal outlay for remote sensing programs. Continuation of the activity and the facility is, of course, assured. Further, the seminars and other specialized, new programs will build upon existing interests and talents which, in effect, will amount to a University contribution.

The arid lands information system is another case in point. Thousands of documents and several international linkages currently exist and, in effect, the information system will be operational immediately upon program initiation, with expansion resulting from the AID input to the program. The contribution by the Office of Arid Lands Studies in support of the information system, plus the activities by the Policy and Review Board, Management Committee, and Task Forces, has been conservatively estimated at \$27,000 the first year and to increase annually (see budget, Section III .E.). This contribution will almost certainly be much higher, but keeping accurate records on the amount of time Deans, Directors, Department Heads, and Vice Presidents put into this program may be difficult. Records will be maintained to indicate actual time involved in Board, Committee, and Task Force meetings.

We wish to emphasize that funds provided by this Grant will not replace existing funding for any programs. All new activities financed under the Grant will be additive to existing programs at the University. In specific support of this Grant the University will provide:

- (a) Necessary space for faculty members and students.
- (b) Use of necessary equipment, supplies, library and other required facilities.
- (c) Normal administrative and technical supervision by department heads, deans, and administrators.
- (d) All overhead during life of grant.

While it is impossible to state that the University of Arizona will convert salaried personnel from AID support to State Funds upon program completion, the President has initiated a policy of having all positions revert to his office upon death or retirement. These positions are then sought by all operations with personnel needs, thusly permitting the University to expand and strengthen some operations while phasing out or down the less responsive or outdated operations. The President's awareness of the critical importance of natural resource activities

is in full evidence by his continued and increasing support of the Office of Arid Lands Studies, support of the remote sensing center, support of the recent African trip to initiate contacts for this program, and in his support of many other natural resource-oriented activities on the campus. His awareness of and interest in this program is further indication of the likelihood of continued support for many of the activities, especially those of faculty efforts integrated into the mainstream of campus activity. This will, of course, greatly depend upon student demand for the educational programs developed.

It must be emphasized, however, that certain program aspects have little or no likelihood of receiving state support by the conclusion of this program. This is particularly true regarding the international newsletter, the information publication and dissemination system, international travel, student stipends, research support, and international seminars. Funds for these and other such activities will be sought from other sources, including AID.

Further, the University has waived the 46% overhead, which on the estimate of \$675,000 of salaries and wages amounts to a cash contribution of \$310,000. The Office of Arid Lands Studies and the Office of the Vice President for Research have jointly contributed several thousand dollars in travel, reproduction, office expense, and other logistics associated with the preparation of this proposal which has evolved to its present state over an 18-month period of time.

Since the proposed grant came under discussion, the University has carried out a number of preparatory activities which demonstrates its commitment and capability with respect to development of an integrated resource management program targeted on developing countries -- and also represents a significant University contribution. The Management Committee, which has been at work defining the proper scope of the 211(d) program and the requisite inter-departmental framework and relationships, has also been used successfully by the University administration for preparing multi-disciplinary inputs into several new University, State and international natural resource programs. The latter has included preparation of a proposal for a state-wide Energy Resource Information System for the Arizona State Commission for High Education; evaluation of a multi-institutional Rocky Mountain Planning Project; an Energy Task Force has been at work; and a review of remote sensing programs at the University with a view toward formulating new course work and research program proposals. The work of the Management Committee is, and will be, carried out by an inter-departmental group of University faculty administrators who will contribute significant amounts of their time. In addition, the University has recently made an assessment of the remote sensing capabilities of other U. S. universities, and published an inventory of arid lands research institutions throughout the world.

The previously discussed two month trip in Africa to initiate linkages in that continent enjoyed University of Arizona funding and is a clear indication of the University commitment to this proposed program. Further, one of the objectives of the trip was to seek new funding sources for support of concurrent activities and

to establish rapport with potential funding agencies. The agencies contacted so far include the United Nations (FAO, UNEP, UNDP, UNECA, UNESCO, and SSO), Ford and Rockefeller foundations, and some of the government agencies within the LDC's. One of the Program Director's duties will be to keep the potential funding agencies' awareness of and interest in the program at a high enough level to obtain some aspects of funding during the program and more importantly after the phase out of the AID 211(d) support.

Throughout the lifetime of the proposed grant program, the University will seek additional outside funding to sustain the evolving capacity beyond the termination date. As indicated in the Financial Plan and related narrative (Section III, E.) it is anticipated that supplemental funding from "Other sources" (e.g., Ford & Rockefeller Foundation, and international agencies) will increase substantially throughout the five year period.

### C. Policy and Management

Below are charters delineating the administrative organization and responsibilities of the Policy and Review Board and its chairman, the Management Committee, the Program Director, and the Task Forces. The Board and Management Committee are created for the express purpose of establishing policy and operating guidelines; they have specific responsibility and authority, and are not to be considered advisory. The Policy and Review Board and/or the President of the University has the responsibility and obligation to initiate and implement any and all changes required to assure success of Program objectives.

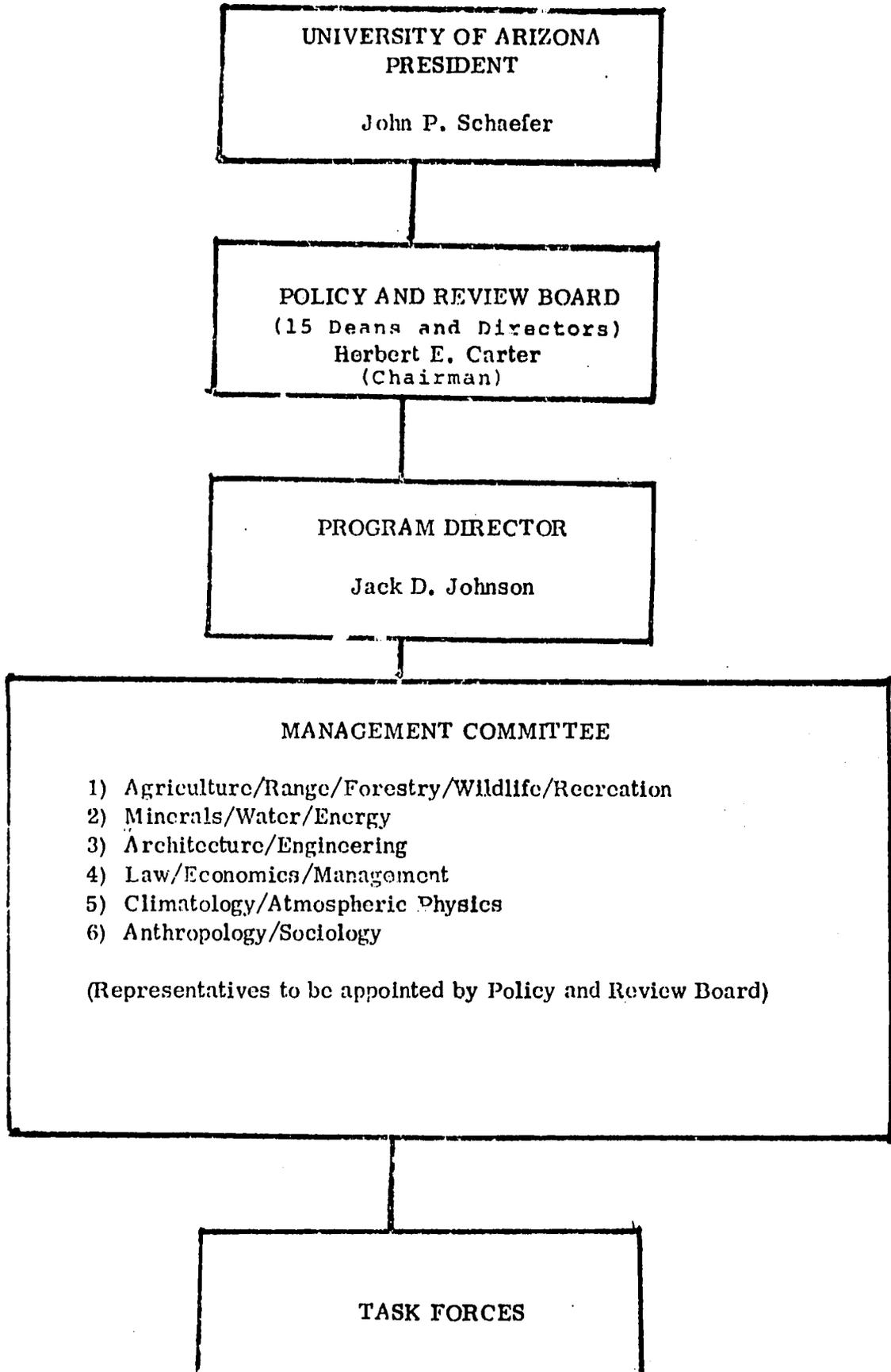
AID will serve, ex-officio, on the Policy and Review Board and the Management Committee. While AID may not choose to attend many of these meetings, their designated representative will automatically receive meeting notices, agenda, and minutes.

#### 1. Policy and Review Board

The Policy and Review Board (PRB) will serve as the policy-establishing and progress review board for all University of Arizona activities related to this 211(d) Institutional Grant.

The PRB is specifically charged with:

- (a) Assuring that general operating, educational and research policies are consistent with the goals and requirements of the grant, and the University of Arizona.
- (b) Reviewing and reacting as necessary to quarterly progress and fiscal reports.



(c) Appointing and/or approving members and chairmen of the Committee.

(d) Approval of budgets, personnel hiring procedures, and the hiring of all senior personnel.

Members of the PRB currently include 9 College Deans, 2 research unit Directors, the Vice President for Research, a Department Head representing the College of Federal Arts, a Professor representing the College of Law, and the Coordinator of Interdisciplinary Programs.

2. Chairman, Policy and Review Board

The Chairman of the PRB is appointed by, and serves at the pleasure of, the President of the University. Fiscal and technical management will be assigned to the Office of Interdisciplinary Programs and the Coordinator of Interdisciplinary Programs, Dr. Herbert Carter, has been assigned the responsibility of PRB Chairman. As Chairman he will establish agenda, convene, and preside over PRB meetings. He will bring to the President's attention any action or decision required by the President.

3. Program Director

The Program Director reports administratively to the Chairman of the Policy Committee and is responsible for day-to-day program management and implementation of activities required to meet the grant objectives as delineated in Section III of the proposal. The Program Director serves and implements the policies and decisions of the PRB and its duly appointed subcommittees. He serves ex-officio on the PRB and the Management Committee.

4. Management Committee

The PRB's Management Committee (MC) shall be responsible for all actions delegated to it by the PRB and in general for assuring program implementation within the established policy and guidelines. It is currently charged with organization and supervision of task force work groups, including preparation of work group charters, new course and research proposals, the annual budget, status reports, and other items that must be submitted to the PRB for review or approval. Members of the MC shall form and/or chair task force work groups as required to implement the Program. The current MC structure includes department head and research unit directors, but the composition, chairman, and responsibilities of the MC will be reviewed by the PRB upon program implementation.

5. Task Force Working Groups

These groups will essentially be the operational backbone of the program and will, in general, include faculty specialist rather than department heads. It is currently envisaged that such groups (small but interdisciplinary) will formulate comprehensive research programs, review courses, help decide areas requiring financial support, and make recommendations regarding new faculty needs, geographical areas where linkages should be strengthened, etc.

To the extent feasible, the Program Director will serve ex-officio on these working groups and will assist them with travel, secretarial, and other logistic needs within constraints established by the MC.

### III. PURPOSE, OBJECTIVES AND ACTIVITIES

#### A. Grant Purpose

This grant is designed to assist the University of Arizona establish an institutional response capability in the area of multiple-use planning and management of natural resources in arid and semi-arid regions of developing countries. The program will focus on concepts and technologies for inventorying, assessing, and managing the resource base in a manner that optimizes overall benefits over the long term. Special importance will be attached to the socio/economic, institutional, legal and public policy aspects of resource management.

The long range goal toward which this program will contribute is the upgrading of LDC capabilities for assessing and implementing the best use of natural resources--including broader application of more effective techniques for identifying and appraising resources; improved planning and management strategies and procedures based on concepts of integrated, multiple-purpose resource use; and environmental protection. Such a goal is dictated by the growing worldwide awareness of the finite nature of the land and natural resource base and of the heretofore neglected social and environmental costs associated with many traditional single-purpose resource development activities. This awareness now extends into the developing world--and includes countries which are in the process of opening new regions for development and are confronted by decisions which may preempt future uses of the land; other countries which are beginning to consider the overall regional impacts of new roads, dams and irrigation systems; and especially the currently drought stricken countries of Africa, Asia and Latin America where single-purpose development projects (e.g., boreholes, livestock production), are now perceived to have actually exacerbated the problems. The grant is also directly supportive of AID's emphasis on helping the poorest people of the least developed countries since, in large measure, it concerns the improved management and utilization of fragile, marginally productive lands upon which millions of people throughout the world have traditionally relied (e.g., semi-arid desert interface) as well as of previously underdeveloped virgin areas that are being turned to as population pressures increase.

Completion of the proposed program should result in the creation of a center of U. S. competence in this subject field consisting of an expanded nucleus of trained and experienced educators and advisors, a new education and training capacity, and a body of new information on LDC resource management problems and U. S. and international response capabilities. The University thus will be in a much improved position to fill a current gap in U. S. ability to contribute effectively to development assistance efforts in this field--both within the framework of the U. S. bilateral aid program and within multinational programs in which the U. S. is looked to for leadership (e.g., Man-and-the-Biosphere, UNEP).

B. Major Objectives/Outputs

The thrust of the program will be to strengthen and provide a greatly expanded international dimension to the University's capabilities in the following three areas:

Multiple-use management of natural resources--land, water, wildlife, forest, minerals, energy: This involves strategies and techniques for management of natural resources within a specified land area in a manner that optimizes the sustained yield of renewable resources, conserves all resources and provides appropriate environmental safeguards. Emphasis will be placed on establishing analytical bases for determining the short and long term impact of development strategies, evaluating development approaches in geographic specific cases, and, ultimately, managing the complex of resources. Such analytical studies may include land use modelling methodologies, techniques for resource inventories and surveys, and the economic and social implications of responses such as the creation of new regulatory institutions or settling nomadic tribes.

Assessment and mitigation of undesirable secondary environmental effects associated with natural resources development projects: This will require, among others: (1) an evaluation of the types and magnitude of problems associated with secondary impacts of, for example, slash-and-burn agriculture, livestock production, water development, and mining; (2) the development of knowledge and techniques for predicting secondary effects (e.g., ecological research, predictive models, environmental guidelines); and (3) analysis of alternative scientific, social, and legal-administrative measures which might be adopted to mitigate the impacts.

Application of new technologies to problems of resource surveys, assessment, and monitoring: This will include research, analysis, development and demonstration of various aircraft and satellite-borne remote sensors, computerized techniques for mapping and land classification and systems analysis and modelling methodologies.

The University of Arizona will create a comprehensive program around these three areas of concentration. In terms of an environmental focus, emphasis will be placed on management of the land, water, plant, animal and mineral resources of semi-arid and arid lands--environments in which the University is now uniquely qualified and in which AID and the international development community has a current major interest. Throughout this program the social/human aspects will receive major consideration.

Five specific outputs of the Grant are envisioned, all supportive of the three areas of program emphasis just described. The outputs are: (1) a centralized information system for natural resources management; (2) an improved education and training capacity; (3) increased knowledge of principles and techniques for assessing and addressing resource management problems

and alternative remedial actions; (4) a competent and available advisory capability; and (5) a network of worldwide institutional linkages.

The University envisions that these five outputs will, in combination, lead to an achievement of the grant purpose. There is an intimate relationship among all five of the outputs and, although they are discussed separately below, each will have measurable observable products, the quality of which is quite dependent upon the others. For example, the centralized information system will provide inputs to education, training, research and the worldwide institutional linkages; similarly, the latter activities will feed information back into the information system. There is a likewise obvious relationship which exists between the education and training activities and the acquisition of new knowledge through research.

The University of Arizona has long supported the premise that excellence in education and training is directly related to excellence in research achievements. And, for these activities to function properly within the less developed countries, it is essential that a network of institutional linkages be established. Whereas the capability for education, training, and research within the State of Arizona is primarily dependent upon our on-campus capability and our linkages with other state institutions, the broader, international context of this program requires that linkages be established with other institutions in the U. S. as well as institutions within the developing countries. It will be through these linkages that much of the information contained within the centralized information system will be obtained and disseminated. They are viewed as basic and essential to broadening our education and training activities as well as to create the requisite adaptive research and advisory capabilities.

#### 1. Centralized Information System

One of the highest priority needs in terms of mounting and implementing effective development assistance activities in the area of natural resources management is improved access to comprehensive and timely information and data about the nature of the problems, the availability of new techniques, and the location of expertise to apply to the problems. Under the grant, the University will inventory, evaluate, and disseminate these types of information, building upon its existing information programs. In carrying out this function, the University will not attempt to duplicate information files which exist in other institutions; it will identify, describe, and catalog these, and thereby serve as a switchboard for identifying points of contact in the U. S. which can either provide required information directly, or through referrals.

Specific activities will include: upgrading the bibliographic information service currently operated by the Office of Arid Lands Studies to provide an increased international dimension and to expand its coverage of semi-arid land resource information; establishment and maintenance

of a "talent bank" of U. S. and international capabilities, both of individuals and institutions; collection, synthesis, and appraisal of information on the technological state-of-the-art; and distribution of a new international newsletter on natural resources management, research, and related activities.

Following is a brief description of specific components of the information system portion of the program:

Bibliographic Information System. The project director for the University's current arid lands bibliographic information system will manage this expanded program. Current dissemination systems will be upgraded in Year 1 to increase international exchanges, and this will be a continuing process. It is anticipated that the bibliographic and information services of the Office of Arid Lands Studies will be expanded during Years 1 and 2 to enhance international coverage, and that they will be periodically updated thereafter.

Program Publications. In order to maintain a state of awareness and involvement by participants, a newsletter will be disseminated periodically (beginning in Year 2) to AID personnel, interested faculty members at the University of Arizona, other U. S. scientists involved in the natural resource programs of developing nations, and the developing nations and institutions therein. Since this type of activity can consume large quantities of financial resources, it will be considered a level-of-effort activity with the level dictated by the funds allocated for such purpose by the Policy Committee.

In addition to the newsletter, a series of state-of-the-art reports will be issued on new techniques and methodologies for problem analysis or problem solving which emerge from the University's research projects or information collection and evaluation activities.

Developing Nation Analysis. Information files will be maintained on resource problems in areas of particular interest to AID and/or the LDCs linked to this program. This will be continuing effort, with the initial goal a first level-of-effort, producing at a minimum a file of the physical resources and attendant problems in the selected developing nations in which ties will be established. The files will contain information relating to its natural and human resources, existing policy and management agencies, on-going research/educational programs (whether AID sponsored or otherwise), planning and development activities on all levels; and a directory of counterpart individuals who are actual and potential contacts.

Talent Bank. An integral part of the information system will be the

development and maintenance of a file of personnel and institutions within the U. S. and other countries which have general or specialized expertise in the program area. This should meet one of the principal problems the University perceives to exist in the U. S.--namely, rapid access by AID and other development agencies to specialized expertise and experience. The University's existing inventory of sources of individual and institutional talent within the U. S. and abroad will be updated and expanded immediately with a comprehensive file completed by Year 2 followed by an annual update.

## 2. New Training and Education Capability

Grant activities will be designed to make the University's existing graduate degree program more responsive to LDC resource management concerns, and to develop the capability and techniques to provide special training opportunities for LDC resource experts and development assistance practitioners. The adaptation and integration of existing courses and the development of new ones is central to achieving the desired output. During the first year, on-going courses will be evaluated to determine how they can be modified to include greater emphasis on LDC problems and requirements, and how interdisciplinary aspects can be expanded and strengthened. The second year will see the establishment of any new courses necessary to fill obvious gaps. A major effort will be made to make the course work relevant to the resource requirements and socio-cultural features of the developing nations. This will necessitate, in the first instance, a concurrent assessment of LDC problems and needs; and secondly, a course content which places strong emphasis on the economic, socio-political and administrative aspects of resource management.

The University has some expertise and experience in virtually all of the natural resource categories. Consequently, existing capabilities must be identified and assessed in preparation for upgrading the University's program. The general approach will be to identify and define training and research needs required by developing nations, utilizing several approaches including but not limited to literature surveys, special reports, consultation with development officials, study groups, and on-site visits. Secondly, analyses of the University of Arizona's existing capabilities will be programmed with special reference to the developing nation analysts; gaps between needs and current organized capability will be identified; and then the means of overcoming the gaps will be designed, including new requirements for faculty, courses, and research programs.

It is currently our plan to address the education programs in terms of three distinct categories. They are:

Formal Degree Work. Formal degree work which involves research

within the less developed countries will normally be pursued only at the Ph. D. level. It is quite possible, however, that selected masters degree programs might include dissertations having been accomplished within the developing countries (if such research was an integral part of a large-scale multidisciplinary project involving both Ph. D. and masters level dissertation work.)

Short-Term Training Programs. Short courses, seminars, workshops and other formalized techniques (requiring only several weeks of instruction) to train resource managers both within the United States and abroad will be designed and tested. They will be a mixture of specialized instruction for resource managers and technicians as well as more generalized, overview courses for policy and decision makers. A minimum of one overseas workshop or seminar will be presented in years 2 through 5.

Long-Term Non-Degree Work. Capacity for long-term, non-degree work will also be developed, including post-doctoral, training, faculty exchange, or simply the training of senior personnel who are not seeking a formal degree. This latter category may involve a period of specialized training at the University of Arizona plus some specific on-the-job training by placement in an industry or government institution.

### 3. Increased Knowledge and Expanded Research Capability

As a result of research activities to be carried out under this grant, the University of Arizona will gain an increased understanding and capability to develop and/or adapt new resource management methodological and technological tools for application in the LDCs. Such research will be undertaken in the United States and also abroad in cooperation with LDC institutions, and will address topics which may include: concepts and techniques for resource inventory and assessment; physical and mathematical modelling of land use patterns and management alternatives; methodologies for predicting the ecological impact of specialized development projects; effectiveness of alternative governmental structures, public policies and regulations; constraints and opportunities with respect to interdisciplinary management techniques; and the inter-relationship among natural resource development, industrialization and urban and rural development. A minimum of two research projects per year will be initiated after Year 1, at least one of which will be carried out cooperatively with an LDC institution. Important results will be presented as a part of the state-of-the-art report series (see Output No. 1 on Information) or in the form of papers delivered at scientific meetings.

### 4. Expanded Advisory Capability

One of the major objectives of this program will be to produce

faculty members and graduate students competent to provide consulting and advisory services to AID, other donors, and LDC institutions in support of resource management programs. The evolution of this capability will be gradual pending the emergence of a body of knowledge and a critical mass of staff members experienced and knowledgeable in this development sector. Included in the budget is a small "prepaid" advisory service available to AID. Actual capability will, of course, greatly exceed this amount and will be available to the development community on a negotiated basis under separate funding arrangements and subject, of course, to scheduling considerations.

#### 5. Institutional Linkages

Creation of a series of linkages between the University of Arizona and other natural resources-oriented institutions is perceived to be a key output of the grant program, since it affords a practical mechanism for sustaining interest in, and utilization of, the other outputs of the grant during and beyond the funding period. In addition, it provides a vehicle for concentrating program resources on selected, important problems with enough critical mass to have a positive impact, and can lead to relationships that will facilitate LDC resource management objectives long after 211(d) funding is terminated. Finally, the linkage experience and interactions during the period of the grant will be vital to the University's efficient upgrading of its information base, knowledge, and LDC contacts and experience.

Three distinct types of institutional linkages will be pursued: domestic, international, and developing country.

Domestic: A principal linkage that must be developed and cultivated is with AID, since it is essential to the correct identification of priority problems and needs, the proper evaluation of opportunities for studies and contacts, and for ease of access to key people and information within the development community. The University will work closely with AID's Office of Science and Technology to build this linkage, and also with the AID Missions in cooperating countries.

A second type of domestic linkage will involve the University with State, Federal, private, industrial and academic institutions which have on-going resource management programs and interests with respect to arid land resources. Most of these will be limited in scope--with emphasis on information exchange and "talent banking". However, several will be selected for more broadly-based programs which could involve exchange of personnel and cooperative research and training programs. Leading candidate institutions for major linkages include the Bureau of Land Management, NASA, USDA Georgia Tech, MIT, and Cornell

University. The latter three academic institutions are AID 211(d) grantees working on various aspects of science and technology (i.e., small rural industry, industrial and public works technology, and science policy, respectively) which are related to natural resource management policies and decision making. In addition, MIT is currently conducting a large study of land and resource management in the African Sahel for AID.

The University of Arizona will continue, and seek to strengthen, its contacts and ties with other U. S. universities which are working on narrower aspects of natural resources management in the LDCs, such as the consortia on soils, water and livestock which AID currently supports.

International: Cooperative relationships will be pursued with international agencies and also multinational industrial firms involved in resource development activities in developing countries, as well as with major arid land centers in other developed nations such as the Commonwealth Scientific and Industrial Research Organization in Australia and the University of the Negev, Israel. Particular emphasis will be placed on developing effective mechanisms for information exchange, cooperative program activities, and joint program and project design and implementation with the following key multinational institutions: UN Environment Programme, FAO, OAS, UNESCO, and the U.N. Resources and Transport Division.

Developing Countries: It should be emphasized that while linkages with developing country institutions are fundamental to the operation of the grant, it is entirely possible to expend all of the limited financial resources in pursuing this objective. While informal linkages involving primarily information exchange can and will be accomplished through the mails, linkages which involve faculty exchange, collaborative education programs, joint research projects and similar quasi-formal arrangements will require substantial face-to-face meetings. Further, each could constitute a continuing drain on the limited financial resources since the University will most certainly attempt to establish broad-scale regional research programs within some of the LDCs where formal linkages exist. It is quite evident then that, prior to the determination of specific institutions with which the University will establish major linkages, we will need to assess the potential for payoff in terms of the country's existing institutional capability, the nature of its problems, and the possibility of obtaining outside funding for some of the collaborative activities. One of the initial program tasks therefore, will be the compilation of the information necessary to determine which countries are the best candidates for the pursuit of major linkages, and which we should confine to more limited (e.g., information exchange) relationships.

Based on a recent preliminary University assessment of LDC institutions, as well as our past overseas experience, the following are leading candidates for major, broad-based linkages under this grant:

(1) Centre for Arid Zone Research and Development, Pakistan; (2) Council for Scientific and Industrial Research, Ghana; (3) Arab Center for Studies of Arid Zones and Dry Lands, Syria; (4) National Water Development Board, Kenya; and (5) Instituto de Investigaciones Cientificas, Chile.

### C. Program Scope and Activities

The scope of the program will necessarily encompass the full spectrum of natural resources of the arid and semi-arid regions--land, soil, water, minerals, wildlife, energy, forests--since their mutual relationships and interactions are of principal concern. Emphasis will be placed on arid and semi-arid lands where a particular strength of the University matches the priority currently assigned to this type of eco-system by the UN Environment Programme, UNESCO (within its "Man and the Biosphere Programme"), and by AID in terms of its relevance to the African Sahel and other drought-prone, agricultural-oriented regions of the developing world. Although the principal concern of this program is with arid and semi-arid lands, we anticipate some programmatic involvement with adjacent, more humid savannah regions which are often directly affected by the conditions and/or actions taken within the arid area. A case in point is Ghana, where their government has sought AID assistance to analyze options with respect to the southerly advance of the Sahara Desert, the influx of refugees from the drought stricken north, and possibilities for restructuring principal livestock and agricultural land use patterns involving both regions.

It is intended that the University of Arizona will create the desired new capability within the framework of its existing interdisciplinary program on multiple purpose management of natural resources. This currently involves the effective integration of a spectrum of natural resource disciplines; a large number of faculty experienced in resource management in foreign countries; participation of the University in operational resource management projects at the State, regional and Federal levels; major program activities in arid lands information dissemination and application of new technologies; and close working relationships with U. S. Federal and State resource agencies. In effect, the grant will add an international, LDC-oriented dimension to the University's on-going natural resources program.

A number of selected inter-related program components will be supported all designed to assist in overcoming current shortages of trained personnel, information, knowledge, and skills that restrict the effectiveness of AID and other agencies concerned with natural resource development activities in the LDCs. These components include: (a) specialized information collection and dissemination covering resource problems in the LDCs, the state-of-the-art of relevant technology,

and the type and location of institutional and manpower resources; (b) a program of graduate studies and faculty seminars; (c) curriculum development; (d) the application of new technologies to LDC resource problems, with adequate emphasis on the socio-political-administrative factors; (e) consultant and advisory services; and (f) linkages with natural resource institutions both in the U. S. and other developed and developing countries. The products should contribute directly to, and benefit from, TA/OST projects in the areas of forestry, environmental training, remote sensing applications, and mineral assessment. In addition, they should provide a broader perspective and new expertise in support of the design and implementation of development activities sponsored by other AID bureaus and offices which impact on, or are affected by, the land and associated natural resources.

While it is difficult to identify specific projects prior to establishment of the institutional linkages, the information system, and analysis of LDC information, the following are offered as examples of the type of activity areas which are judged to be currently significant for many of the LDCs, and the pursuit of which will result in an increased University of Arizona capability.

- (a) Remote Sensing. The utilization of aircraft and satellite data in both the imagery and magnetic tape format will be utilized for resource mapping of such parameters as agricultural cropping patterns, soils, land use, buried areas, and vegetation. This technique coupled with the training aspects of remote sensing techniques to be conducted both here and abroad will insure a close interaction between the LDC and the University of Arizona faculty employing such inventory techniques.
- (b) Computer Modeling and Mapping. Computer mapping techniques now in use by the University of Arizona to aid in local planning relative to site location will be used for resource management and simulation for identified LDC areas.
- (c) Systems Modeling. The development of a system model for a geographical or political area to indicate the potential consequences of the development of some natural resource may prove to be a unifying concept. The idea of modeling one area with use of digitally-stored data from earlier phases of the grant may prove useful in examining alternative methods of resource management.
- (d) Systems of Information Transfer. There are two quite different activities associated with technological development. The first is that of achieving the technological expertise necessary so that the technology is developed to an engineering, economic, and physically practicable state. The next phase is the technological development into such a state that it is politically, culturally, and managerially transferable from a state-of-the-art status to practical application in appropriate governmental agencies. The University of Arizona will

pursue new techniques to accomplish this transfer of highly complicated technological developments into a format acceptable and operable by agencies with limited financial and scientific resources.

- (e) Effectiveness of Interdisciplinary Management Techniques. Universities have been slow in evolving interdisciplinary program management techniques, largely due to the lack of large-scale problem-oriented research projects, but also quite clearly related to the basic academic freedom structure of the University system. Governmental agencies also suffer from poor interdepartmental integration. While not a major goal of the 211(d) grant, it is anticipated that the questions about failure or success of management techniques may be partially answered as a result.
- (f) Comprehensive Land-Use Planning. It is envisioned that a properly composed regional land-use (natural resource use) project will offer opportunity for interaction of several faculty and students. Such a program is being proposed in Kenya (by the University of Nairobi) wherein the University of Arizona through its 211(d) program would provide education and research supervision while training Kenya or other African students. Ford Foundation has indicated an interest in collaboration and may finance portions of such a project where work will be done in Kenya. Similar programs will be pursued including the outside funding of some aspects of the projects.
- (g) Control of Desert Encroachment. Nations bordering the world's desert regions are quite concerned about causes and possible means of reversing desert encroachment. Since this problem is quite clearly delineated and of concern to AID, it is entirely possible that a meaningful study can be initiated quite early in the program.
- (h) Assessment of Environmental Impact. The University will continually review the state-of-the-art as it pertains to the preparation of environmental impact statements as required by Public Law 91-190, Section 102(c). Although this law does not apply to developing nations, the techniques by which the environmental impact is assessed will of necessity be constantly improving and it will be the responsibility of the University to maintain an awareness of these changing and improving techniques and to transmit this information through the Program to developing nations.
- (i) Knowledge of the socio-economic impacts of resource development is integral to sound planning and management, but the difficulties of assessing and quantifying the variables remain. Thus, this area will be given major attention, particularly since it is closely associated with improving the lives of the

The above areas (v-h) will become foci for the conduct of a series of related activities involving information collection and dissemination, research, and education and training projects. For example, it is planned to use grant funds to augment awards of fellowships and other support and thereby enable promising resource managers, both foreign and American, to concentrate their graduate education and training on the problems of rational, optimal management of arid land resources. One approach that will be tested involves bringing teams of LDC students and their faculty advisors to the University of Arizona for training, and subsequently utilizing them as counterparts in joint University-LDC projects conducted in the developing countries. This exposure to LDC attitudes skills and needs should be invaluable in upgrading the ability of the University to provide relevant and useful services.

In addition, University awareness of LDC conditions, problems, and requisite response capabilities will be increased through a program of workshops and seminars in the U. S. and the LDCs. These will be designed to facilitate the exchange of information about needs and opportunities with respect to natural resource management in the LDCs with special emphasis on research and development priorities and the potential application of scientific and technological advances. Special seminars will be designed to increase interaction among University faculty members, and among faculty and students--with an initial goal of helping to define research programs, identify and evaluate integrated resource management techniques, and consider new courses to increase both basic and integrative skills. In addition, workshops involving LDC participation will be conducted in the U. S. and abroad. A seminar will be organized during the first year to provide interaction among faculty members and between faculty members and appropriate specialists, with the goal of helping formulate programs of research, identify and develop integrated resource development techniques, and develop new courses to increase both basic and integrative skills.

Finally, the development and implementation of institutional linkages will be carried out which will require travel by University staff to establish contacts, and plan and subsequently manage cooperative projects; support of an information exchange program involving collaborative institutions; and financing of the equipment, logistics and commodities necessary to carry out research and training activities in the U. S. and abroad.

#### D. Critical Assumptions Outside Grantee's Control

To meet the five year objectives--including the ability of the program to be self-sustaining beyond grant termination, the assumptions listed below must prove to be correct. That is not to say that omission of any of these will cause total program failure; however, the degree of program success will be affected. It is impossible, of course, to qualify the individual importance of each assumption.

Assumption No. 1. Students both from the U. S. and the LDCs will be interested on an increasing scale in the pursuit of University education programs oriented to the international aspects of natural resources, planning and management (since viability of University programs depend critically on student demand).

Assumption No. 2. LDCs will desire and seek cooperation and linkages with the University of Arizona to the extent of providing students, information, and facilities and local support for cooperative research.

Assumption No. 3. Close cooperation by AID Washington will materialize on a continuing basis, so that as development objectives, needs and constraints change, the University will be in a position to identify and assess such changes in a timely manner. We also assume that AID/W, through the Office of Science and Technology, will assist in evaluation of the information and criteria on which the University bases its selection of LDC institutional linkages, participate periodically in meetings of the Grant Policy Committee, and will facilitate contacts for the University with AID missions and LDC administrators. Further, that AID will play a key role in identifying training needs, helping to locate outstanding LDC participants, circularize missions regarding program activity, and facilitate the linking of the AID and University information systems.

Assumption No. 4. Additional funding outside this grant can be found to support both foreign and U. S. national students as well as specialized training programs, information dissemination and institutional linkages particularly in the latter stages of the program and beyond Year 5.

Assumption No. 5. Additional research funds will be forthcoming from AID and non-AID sources by the end of Year 2 if the University is to carry out significant studies within the LDCs. It is fundamental to program viability, and since a primary program purpose is to develop a research capacity at the University of Arizona, an obvious necessity for maintenance of that capacity and skill level is that a demand be placed upon its use. While the University will actively solicit research funds from other sources, it is assumed that AID will call upon the University of Arizona to carry out separate studies in areas related to the purpose of this grant as new requirements arise.

Assumption No. 6. Resource-oriented institutions within the U. S., other developed countries, and the UN and international family will cooperate with the University to the extent of, at a minimum, exchanging information on relevant programs, projects, new research and development, and the existence of manpower and institutional resources.

Assumption No. 7. Developing countries and international development agencies will look to the U. S. to assist with arid land problems; since U. S. expertise and knowledge which either resides in, or can be mobilized by, the University will continue to evolve at a pace where it is capable of dealing with LDC problems and is thereby attractive to the develop-

## E. Financial Plan

The grant budget and life-of-project cost sheet includes a best estimate of annual expenditure by years, outputs, and inputs. Man-months of University manpower include the Program Director; clerical/secretarial staff, graduate students, research associates, and faculty. These man-month estimates are inclusive of AID support only and do not reflect "other" sources of support.

Estimates are provided for such "other" anticipated funding sources and includes conversion of some functions to State support, further AID support, and support from other agencies such as UNEP, Ford, Rockefeller, etc. As described in the discussion of University commitment, there can be no specific agreement to convert from AID support to State funds, although the intent is clearly spelled out in that section and is evidenced in the projected development of new (other) funds.

The budget indicates a fourth and fifth year decline in AID participation. This is based on the expectation of funding from other sources rather than a program decline. Projected total funding (i.e., AID plus "other" sources) increases from Year 1 thru Year 5 as follows: \$174,000; \$345,000; \$446,000; \$515,000; and \$553,000.

Although the University is optimistic about achieving the 5th year goal of \$553,000 (AID \$180,000 plus "other" \$373,000) it must be recognized that there are some basic component operations which will probably not be financed with funds currently anticipated from "other" sources and which therefore will not be continued beyond Year 5 unless additional funding materializes.

Such components include the Information System which will be reduced to a total 6th year level of around \$25,000 (local support) which is insufficient to support newsletter continuation, dissemination of project-oriented research results, and talent bank update and maintenance. In addition, there are no student stipends built into the "other" funds and no support for the international travel that will be required to sustain LDC and other overseas linkages, or for research projects. Funding for foreign workshops, seminars, etc. is likewise not included but also will be sought to continue these activities beyond the 5th year.

## FOOTNOTES TO BUDGET

1./

State funds and/or overhead funds are providing approximately \$12,000 in direct support, and these will continue to grow annually. The information system is one of several areas which will require sustained 211(d) funding. Education and training funds reflect the contribution of time by the various committee members. This is a very low estimate, and to the extent possible we will maintain records as to the time actually spent in meetings and document review. Since this activity involves several department heads, deans, directors, coordinators, and a vice-president, it may be difficult to carry out a precise analysis; however, the Management Committee alone will most likely contribute time in excess of the estimates.

2./

Year 1 should see supplemental funding for the education and training program. It is hoped that by that time the University can begin attracting additional State funds into the program, principally in terms of State support for new faculty members. However, new State funding is speculative and we will most likely be building the case for transfer of existing funds from less viable programs into the natural resources program. We will also pursue support for faculty through foundations, multinational organizations, and any other potential source.

3./

Adaptive research funding will be sought throughout the program. Initial contracts with multinational agencies, Ford Foundation, Rockefeller Foundation, and bilateral donors indicate a desire to fund research in the natural resource area, in developing countries, and in arid and semi-arid lands. Since we are combining all three, the proposed level of research funding should be attainable. Further, we fully anticipate some AID research projects to be requested as both AID needs and the University of Arizona competence increase.

4./

Advisory services are purely an estimate of the AID demand.

5./

International linkages should be enhanced and partially funded by the United Nations Environment Programme.

**GRANT BUDGET AND LIFE-OF-PROJECT COST ESTIMATE**

	1st Year			2nd Year			3rd Year			4th Year			5th Year			TOTAL 5 YEARS		
	man mos.	211(d)	Other	man mos.	211(d)	Other	man mos.	211(d)	Other	man mos.	211(d)	Other	man mos.	211(d)	Other	211(d)	Other	Total
1. Salaries and Wages		94,000			156,500			156,500		141,850			126,000			674,850		
2. Student Stipends		10,000			20,000			30,000		30,000			10,000			100,000		
3. Library (Xerox & acquisitions)		5,000			4,500			4,000		4,000			4,000			21,500		
4. Research (not applicable as separate item)																		
5. Travel		10,000			15,000			25,000		25,000			10,000			85,000		
6. Equipment and Supplies		3,000			4,000			5,000		5,000			3,000			20,000		
7. Publications (research, newsletters, resource papers)		3,500			6,000			8,000		8,000			8,000			33,500		
8. Other (Fringe 14% of #1 + computer time \$1,000/year)		14,500			24,000			31,500		21,150			19,000			110,150		
<b>TOTAL INPUTS</b>		<b>140,000</b>			<b>230,000</b>			<b>260,000</b>		<b>235,000</b>			<b>180,000</b>			<b>1,045,000</b>		
<b>OBJECTIVE/OUTPUT</b>																		
1. Information System	50	50,000	12,000	50	50,000	15,000	50	50,000	18,000	50	50,000	20,000	50	50,000	23,000	235,000	88,000	323,000
2. Education and Training	25	54,000	25,000	40	90,000	30,000	40	90,000	40,000	35	74,500	60,000	25	50,000	85,000	358,000	240,000	598,500
3. Adaptive Research	20	15,000	0	30	58,500	50,000	35	83,000	100,000	35	83,000	150,000	25	67,000	200,000	316,000	590,000	816,500
4. Advisory Services	0.5	1,000	0	0.7	1,500	10,000	1.0	2,000	13,000	1.5	2,500	25,000	2.0	3,000	25,000	10,000	73,000	83,000
5. International Linkages	6.5	20,000	0	7.3	30,000	10,000	8.0	35,000	15,000	7.0	25,000	25,000	5	10,000	40,000	125,000	90,000	215,000
<b>TOTAL BY OUTPUT</b>	<b>102</b>	<b>140,000</b>	<b>27,000</b>	<b>128</b>	<b>230,000</b>	<b>115,000</b>	<b>134</b>	<b>260,000</b>	<b>186,000</b>	<b>128.5</b>	<b>235,000</b>	<b>280,000</b>	<b>107.5</b>	<b>180,000</b>	<b>373,000</b>	<b>1,045,000</b>	<b>991,000</b>	<b>2,036,000</b>

#### IV. LINKAGES AND UTILIZATION

Selected, broad-based linkages between the University of Arizona and institutions in the U. S. and abroad is viewed as a key output of the program, a subject that was consequently treated in depth in Section III.B, "Major Objectives/Outputs." For purposes of this section, suffice to say that these linkages are also perceived as being a principal vehicle for achieving the other outputs of the Grant, and particularly in stimulating and facilitating utilization of the University's evolving capabilities both during and after the 5-year funding period.

Since it was not mentioned earlier, it should be pointed out that specific consideration has been given to the possible involvement of minority institutions. The University will seek out participation of minority institutions expertise on an ad hoc basis to fill gap areas (e.g., Prairie View in tropical soils). The University currently has a sizeable enrollment of Mexican-Americans and American Indians and has, for a number of years, been carrying out cooperative projects on Indian reservations in the Southwest.

With respect to utilization of institutional capacity the University believes that by focusing on ecosystems and resource problems of major international concern (i.e., arid and semi-arid lands) and on mobilizing the preeminent U. S. capabilities to address these interests, the potential for effective, widespread utilization of the capacity developed under the Grant will be maximized. In addition, a deliberate attempt has been made to concentrate outputs in areas in which a demand currently exists, and in which recent AID studies indicate that the interest of the LDCs and development community will grow. Specific elements built into the Grant to stimulate utilization include:

- major emphasis on providing a single source of information about U. S. capabilities and activities in the natural resource field;
- preparation and distribution of an international newsletter and state-of-the-arts reports which, through an identification of capabilities and sources of information, should trigger interest and involvements by LDC and international institutions;
- initiation of research projects to be carried out in collaboration with LDC institutions, some of which will be in the LDCs;
- sponsorship of seminars and workshops in LDCs to disseminate information generated under the Grant on resource management problems, alternative remedial approaches, and the technological state-of-the-art; and
- education and training activities which will involve exchanges of teams of LDC students and their faculty advisers to increase University percep-

tion of LDC needs and capabilities, and to promote project continuation and sustained interest when the teams return home.

It is expected that the outputs from the Grant (the information resources, advisory services, and research results) will be used by AID/W and the Missions, other international development agencies engaged in resource management projects as well as both developed and developing nations.

## V. EVALUATION AND REPORTING

The ability to plan and specifically detail the outputs of a grant operation of this nature is exceedingly difficult. Therefore, at some point between the first year and year and a half of Grant operations, appropriate representatives of the University of Arizona will be prepared to meet with AID officials to review and reassess the statement of Grant purpose, the specific objectives/outputs to be produced, their magnitude and timing, means of verification or progress and completion, and critical assumptions. At this time, both parties may agree that specific objectives/outputs should change in priority, in scope or direction, or remain as originally contemplated. Such a review shall also include a presentation and analysis of the grantee's basis approach and methodology, the need for action by AID or other organizations outside the control of the grantee, and any need for formal revision of Grant terms and conditions, expected results, etc.

In addition to the submission of annual reports, the grantee will seek occasions to consult with and involve AID in professional interchanges including exchange of visits (and possibly staff), workshops and seminars, and joint travel. AID will also serve *ex officio* on the Grant Policy and Management Committees.

During the fourth year of the Grant, an AID team will be invited to meet on-site with the grantee to jointly review performance by both parties and grantee accomplishments with emphasis on new knowledge and opportunities, linkages, and actual and potential use of institutional capacity. At that time, the University will be prepared to discuss grant expiration, revision and alternatives as deemed appropriate and within the framework of current AID policies and priorities and LDC needs.

It is envisioned that after five years: (a) the University will be recognized internationally as a center of excellence within the U. S. for information, expertise, and an applied research and development capability related to integrated resource management in the arid and semi-arid LDCs; (b) this expertise and orientation will be absorbed into the academic mainstream of the University; (c) there will be a continuing and significant involvement of the University with LDC and international organizations; and (d) financing will be available for sustaining selected program elements.

To assess progress toward achieving these objectives during the life of the grant, preliminary milestones have been established for each of the five output areas. However, one of the first tasks to be undertaken by the University is development of a baseline to establish the magnitude and nature of current activities in each of these areas, and against which future progress can be measured.

## APPENDIX A

### UNIVERSITY OF ARIZONA EXISTING PROGRAMS OF EDUCATION AND RESEARCH RELATED TO NATURAL RESOURCES

1. Agricultural Resources. In many developing nations, the uses of natural resources usually are intimately linked to agricultural production and development. Consequently, the existence of a modern agricultural program at this University improves our capability to develop a well-rounded program in natural resources management and planning. The agricultural curricula train specialists at the B.S., M.A., and Ph.D. levels for many types of careers in education, research, business, food science, international service, manufacturing, processing, marketing, conservation, communications, farming and ranching. This University has gained pre-eminence in arid lands agriculture, and has placed considerable emphasis on sharing modern agricultural technology with developing nations, as evidenced for example, by AID contracts in Brazil and Turkey.

2. Geosciences, Water, Energy Resources. The Departments of Geosciences, and Mining and Geological Engineering are actively involved in the search for and exploitation of metallic and non-metallic mineral resources. The Departments of Chemical Engineering and Metallurgical Engineering deal with the recovery of these minerals from the matrix in which they occur as well as the development and application of manufacturing processes for the product. Further, these and other units are involved in activities associated with environmental protection. The Department of Mining and Geological Engineering, in cooperation with local industry, offers colloquia on mining and the environment. The Department of Geosciences and the Arizona Bureau of Mines are producing a model of the Tucson Basin focusing on geologic hazards. In turn the model is being used in a special two-year problems course sponsored jointly by the College of Architecture and the Department of Geosciences, where architectural students in design studies are attempting to show the relationship between geologic hazards and such projects as floodplain development, high-rise building, sewage disposal, and other associated aspects of urbanization.

The origin, distribution, and properties of the waters of the earth are a concern of several units: including the Departments of Hydrology and Water Resources; Soils, Water, and Engineering; Civil Engineering; Watershed Management; the Office of Arid Lands Studies; the Water Resources Research. Numerous seminars and courses tying water resources to other resources, environmental protection, public policy, and land use planning are also offered as noted in following sections.

The study of physics, economics, ecology, environmental impacts, silting problems, and policy formulation as related to the overall energy problem is being carried on by many units of the University. The Departments of Geosciences

and Hydrology and Water Resources are studying the origin, occurrence, and uses of geothermal energy and the Department of Optical Sciences is conducting research on solar energy, and the many aspects of hydro-electric power are covered in the curricula of the Colleges of Agriculture, Earth Sciences, Engineering, and Mines. The Departments of Architecture, Civil Engineering, Geography and Area Development, Hydrology and Water Resources, Mining and Geological Engineering, and others, are developing course work directed toward environmental protection and energy production. The Department of Government and its affiliated Institute of Government Research are conducting research into environmental policy making and the effects of power generation of the Navajo Indian socio-political system.

3. Range Resources. Technical range management courses, including general range management, range ecology, plant identification, evaluation and planning advanced topics, and research techniques, are taught in the Department of Watershed Management. To be fully effective, however, range management training and research must be integrated with research and supporting courses in such associated fields as watershed management, forestry, wildlife, soil, plant, and animal sciences, recreation, economics, and other fields. From the faculties of these fields, advisory committees are formed to advise and guide students in the selection of curricula and the conduct of research that will prepare them to deal with the problems of multiple-use management of range resources.

In support of such programs, the University has the advantage of being so located that students have the opportunities to study range management in several vegetation zones. Desert shrub, semi-desert grasslands, oak woodland, chaparral, pinyon-juniper, and forested rangelands are all located within short distances from the campus.

4. Wildlife Resources. Both Bachelor and Masters of Science degrees in Wildlife Biology are offered at the University of Arizona. The doctorate, while also offered through the Department of Biological Sciences, is a general Ph.D. degree in biology. Federal-and-State-supported Cooperative Wildlife and Fisheries Units serve as two nuclei for this training. The Cooperative Wildlife Unit, active for more than two decades, supports undergraduate academic training and graduate training and research. Four Federally-salaried wildlife and fisheries biologists operate in many departments and colleges. Specialists within the Department of Biological Sciences cover wildlife biology, mammalogy, ornithology, herpetology, behavioral plant and animal ecology, ichthyology, oceanography, and environmental physiology while the general faculty cover the basic classical botanical and zoological areas.

Other departments offer courses and conduct research that directly relate to the Wildlife Resources degree program, and participate as well in the direction of special projects, graduate committee responsibilities, and inter-related topics for the minor. Range management, outdoor recreation, watershed management, biochemistry and nutrition, animal pathology, anthropology, and archaeology, soils, and others may be cited as evidence of the integrated and cooperative efforts ongoing in this field.

5. Forest Resources. The University of Arizona attracts scientists who are interested in ecology because of its unique location at 750 meters elevation in the desert surrounded by four mountain ranges, two of which rise over 2,700 meters and are covered with coniferous timber. Life zones ranging from the Sonoran through the Canadian are within an hour's driving time from the campus, giving scientists a ready laboratory for wildlands research. Very early work at the University attracted scholars from abroad, especially from countries with mild or arid climates. Although a few forestry courses were taught early in the history of the University, it was in 1959 that a full forestry program was instituted as an integral part of the Department of Watershed Management in the College of Agriculture, and now accredited by the Society of American Foresters. There are several units unique to the University of Arizona that stimulate interdisciplinary studies. Those of special interest to forest science include the Laboratory of Tree-ring Research, the Water Resources Research Center, the Institute of Government Research, and the Office of Arid Lands Studies.

The commitment of the University to the study of renewable natural resources has meant a thrust towards research that deals with the improvement of environmental quality. There are at least twenty-four formal research projects in the Department of Watershed Management alone that show the breadth and depth of the research program. Briefly, the optimization of water and timber quality and quantity from the forested zones in Arizona is emphasized in several projects, the impact of various land uses on the environmental quality is considered in many studies, and land use planning is receiving growing attention. Computer technology and remote sensing, in addition to other techniques, are being used in systems analysis, resources inventory, and decision making research. The administration and faculty have been responsive to new knowledge requiring frequent revisions in research projects, as well as curriculum, in order to maintain a modern program in forest land resource research and management.

6. Fisheries Resources. Fisheries sciences at the University of Arizona, both teaching and research, are well-developed with most of the functions of each currently carried out by faculty and staff in the Departments of Biological Sciences and Watershed Management. In the former, there are groups working in both freshwater and marine areas. On-campus and off-campus laboratory facilities are available for undergraduate and graduate students.

7. Recreation Resources. Undergraduate professional curricula in recreation are located in the Departments of Public Administration and Watershed Management. In the former, the emphasis is on urban recreation and recreation programs. In the Department of Watershed Management, the major in Natural Resource Recreation emphasizes non-urban, natural resource-oriented recreation management and planning. Graduate students may develop programs involving recreation as a problem or research area in Agricultural Economics, Geography and Area Development, Public Administration, Urban Planning, Hydrology and Water Resources Administration, and Watershed Management. New research is being undertaken to measure the impact of recreation use on water quality and to determine the social carrying

8. Human, Social, and Institutional Resources. The University's traditionally strong commitment in the areas of the physical resources of water, minerals, forests, range, and energy has a comparable focus in the behavioral sciences, with consequent activities ranging from studies of resources in the developmental process to concern for environmental education. Several categories of instructional and research activities treating the human and social aspects of resource development and management, as well as the attributes of developing societies and areas, may be outlined under the following four groupings:

The subject matter of one category may be identified as the developing areas themselves--their peoples, societies, cultures, economics and problems, exemplified by comparatively conventional course work and research in regional geography (Latin America, Africa, etc.) history, oriental studies, government, anthropology, and sociology.

A second category of work focuses on general principles and problems: resource conservation and management, the economics and politics of development, the processes of cultural change and modernization, and perception of environment and environmental law.

A third category relates to spatial or areal diversification, structuring, integration, and interaction of land and resource use and development, exemplified particularly by work in geography, urban and regional planning and economics as well. This aspect demands integration of technical knowledge about resources with the analytical tools for policy formation and decision-making within particular socio-cultural contexts.

A fourth category is the general realm of analytical techniques and decision-making technologies. The University now has substantial capabilities in this area, much of it relevant to resource appraisal, policy analysis, and the construction of both descriptive and analytical models of resource development and management schemes in developing areas. Analytical capabilities are well developed in such departments as Economics, Systems Engineering, Management, and Hydrology and Water Resources, but their applications to the integrated management of resources in developing areas would be greatly developed under the Program.

Resource and environmental attitudes and perceptions permeate all depths associated with water resources development at the University. Insofar as resource development hinges on people's perceptions, key personnel in the departments of Geography and Area Development, Psychology and Government will play an essential role in the program. Hydrology and Water Resources has an ongoing project involving several students comparing Arizona and Oregon in terms of the impact of citizen attitudes on planning and policy choices. Environmental Education (Education 201) attempts to bring these concerns for attitudes and values in resource development into the educational process. Water, Society, and the Environment (Water Resources Administration 201) is engaged in integrating attitudinal considerations into the classroom.

The Department of Economics has a major area of strength and commitment in the resources-environmental field, including studies of the economic potential of fuel and non-fuel minerals in the undeveloped Four Corners region, analysis of fuel rate structures, economics of energy production and distribution, and economics of pollution. Courses in the economics of development, international trade, and micro-economic theory (economic institutions, firms, etc.) complement these and similar research programs. Dovetailing with these interests are efforts of the Department of Agricultural Economics, building particularly in the area of water economics and arid lands, such as the course Environmental Economics (Agriculture Economics 176).

The College of Law, Department of Agricultural Economics, Department of Government, Department of Economics, and the Institute of Government Research and others have common concerns relative to natural resource institutions, legal structures, and policy-making. The College of Law has taught and conducted research in the field of Water Law and Natural Resources Law. The Institute of Government Research is studying the Impact of new procedures on agencies involved in resource decision-making by integrating this work with that previously done on the organizational structure of the agencies themselves and their clientele. Some of these same efforts are being integrated also into a graduate seminar on Environmental Policy (Government 399). The Institute is also sponsoring resource planning and management related research in the following areas: (a) development of methodologies and analytical perspectives for the comparative analysis of environmental decision-making in developing nations, developed nations, regional institutions, and international politics; (b) scientists' impact on resource and environmental policy decisions; (c) environmental resource problems and the emergence of international policies; and (d) the use of information in resource decisions.

The Departments of Government and Watershed Management are supervising cooperatively a Watershed Management Ph.D. dissertation on "Resource Managers' Use of Scientific Advice and Scientific Information." The Department of Public Administration currently offers an advanced seminar in Environmental Administration.

The Department of Anthropology has emphasized the development process and resources in relation to cultural development, notably through ongoing projects dealing with the social implications of water resource development in newly developing areas, and settlement patterns and social characteristics in tropical rain forest agriculture. Considerable work has been done in Costa Rica on the effect of an unstable ecology on the squatter movement. The Department offers an advanced seminar in Cultural Ecology (Anthropology 399).

## APPENDIX B

### UNIVERSITY OF ARIZONA INTERNATIONAL INVOLVEMENT IN AREAS RELATED TO NATURAL RESOURCES AND/OR ARID LANDS

#### 1. Current AID 211 (d) Grant, Watershed Management

An existing AID 211 (d) Grant, to the Department of Watershed Management, University of Arizona, may serve as an example of our existing capability in the field of integrated program development, with concomitant international implications. Entitled "Optimum Utilization of Water Resources for Agriculture, with Special Emphasis on Systems Analysis of Watershed Management under Conditions Characteristic of Less Developed Countries," inter-related training, research, and information service competencies fostered by this program include the following subject areas:

- (a) Development and economic evaluation of land management practices for optimizing productivity of watersheds including alternative goals of maximum on-site use of moisture, or maximum water yield for downstream use consistent with stabilization of the site and maintenance of water quality.
- (b) Formulation of simulation models for predicting the time and space distribution of water within watersheds. Special attention is given to generalized prediction models which, when adapted to specific physical parameters of a developing nation, can be used by its land planners, administrators, and specialists.
- (c) Development of decision-making procedures for planning, designing and managing natural resource systems through use of systems analysis techniques or the integration of quantitative analysis and economic concepts.

Accordingly, appropriate courses and research have been developed during the first three years of this program. For example, Watershed Management 305 deals with hydrologic modeling, and Watershed Management 345 is concerned with applications of systems analysis techniques to watershed management decision-making, including consideration of water, timber, forage, outdoor recreation, wildlife and ecosystem stability. In addition, several theses and dissertations pertaining to these subject matter areas have been completed, and others are in progress. Faculty from Systems Engineering and other appropriate departments have been involved in many of these efforts.

This grant has also supported consulting work and travel in developing nations, where faculty has expertise, particularly in Latin American and Near East countries. One faculty member spent five weeks in eight South American countries in 1977. A primary objective of this trip was to increase our

familiarity with watershed management problems in developing nations, including consideration of water, timber, forage, wildlife and institutional factors. This trip was a cooperative effort involving AID, the Peace Corps, and the University of Arizona. Another faculty member spent three weeks in Nigeria during the summer of 1972 as a member of a multidisciplinary AID study team.

The courses, research, recent travel abroad, and experience fostered by the existing 211 (d) program will enhance and complement the proposed new 211 (d) program in natural resources management and planning. As shown above, the existing program concentrates on watershed management in particular, a subject matter area that will provide direct input for the proposed new program. In addition, appropriate institutional arrangements have been made at the University of Arizona to assure coordination between the programs.

## 2. College of Agriculture Brazil Program

The Brazil Program initiated in 1963 with a contract between the University of Arizona, the U. S. Agency for International Development (USAID) and the University of Ceara, Brazil. The objectives are to adapt the philosophy of the U. S. land-grant college in Brazil and to assist the University of Ceara in becoming a regional focus for stimulating agricultural production and improving rural life.

There is a free exchange of faculty members. The University of Arizona faculty in the agricultural disciplines serve at the University of Ceara, while the faculty members from the Brazilian University of Ceara study advanced degrees at the University of Arizona and other institutions, and are visiting agricultural operations in the United States.

## 3. Programs with the Environmental Research Laboratory

### (a) Abu Dhabi and Kharg Island (Iran) Programs

A program derived from the Puerto Penasco Project of the mid-1960's. The first year-round power-water-food facility in Abu Dhabi is assuring a plentiful supply of high quality produce. With construction complete, and in preparation for complete control by the local people, the University of Arizona has withdrawn most of its resident staff.

Techniques for growing profuse quantities of vegetables on the desert such as the Arabian Peninsula at Abu Dhabi are being copied in similar institutions on Kharg Island, Iran.

### (b) Power, Food, Water, and Agriculture - Puerto Penasco, Mexico

Arizona's Environmental Research Laboratory and the Centro de Investigaciones Cientificas y Tecnologicas joined together in the mid-1960's and

developed techniques for growing profuse quantities of vegetables on the desert within controlled environment greenhouses. The present goal of these two research agencies is to apply this technology to aquaculture

Investigators from the Universities of Arizona and Sonora have begun experimentally rearing shrimp in controlled-environment enclosures (aquacells) on the Gulf of California at Puerto Penasco. The objective is to permit the large-scale farming of shrimp under precisely regulated conditions.

#### (c) Indian Reservation Programs

On the Quechan Indian Reservation north of Yuma, Arizona, the University of Arizona has assisted the Quechan tribe in the design, construction and early operation of a 5-acre commercial greenhouse facility. Production is managed by the tribe with the Environmental Research Laboratory acting in an advisory capacity. The facility consisted of two commercial greenhouses and a nursery for a total of five acres. The nursery building was completed in Fall, 1972 and a crop was grown in it for the purpose of training tribal personnel in horticulture techniques. Production acreage was finished in March, 1973 at which time the entire five acres were put into full production.

On the Papago Indian Reservation near Sells, Arizona, the University assisted in the construction of small (3200 sq. ft.) greenhouses for the Papago Secondary School System. The greenhouses were used as training facilities in Vocational Agricultural programs operated by the school.

This project was built with state administered federal funds (ESEA; Title III) for innovative programs in teaching Business Management.

#### 4. Hydrology and Water Resources Department

Following an initial three-week hydrology course for a group of 14 from the Mexican Ministry of Water Resources in 1971, a continuing program of cooperation has been in operation between University of Arizona and the Ministry of Water Resources, the National University of Mexico, and the Mexican National Council of Science and Technology. These efforts include the training of graduate students.

The Department also runs a cooperative research project with Hungary and a Ford Foundation supported graduate training program in water resources administration which has a team of five Phillipine students pursuing graduate degrees and a team research program studying Phillipine water resources administration. Further, the department is pursuing a cooperative program of research and teaching with Saudi Arabia.

#### 5. Laboratory of Tree-Ring Research

Over twenty wood samples of precisely dated wood prepared by Mr. Thomas

Harlan and Dr. Bryant Bannister in the University of Arizona Tree-Ring Laboratory, and preprocessed by the University's Laboratory of Isotope Geochemistry, have been distributed to leading radiocarbon laboratories throughout the world. The study of these precisely dated samples, being carried out in cooperation with the Australian National University of Canberra, will result in the US wood being accepted as the new primary standard for all C-14 dating assays.

In a major modern tree-ring studies project, Dendrochronologist Marvin A. Stokes is leading a team of four University of Arizona experts in a study of Northern Mexico that would enable paleoclimatic periods in the Sonoran and Chihuahuan desert areas to be postulated, and allow correlation of tree growth with historic weather records. It will also aid hydrologic research and planning, as well as provide an absolute dating framework for past and future investigations in the area.

Other ongoing projects are active with Israel, Canada, Argentina, Chile, New Zealand, Taiwan, and Peru. At the recent International dendrochronology conference held at the University of Arizona, a cooperative program of data assimilation was agreed upon including University of Arizona, Russia, Poland, France, Ireland, Germany, Switzerland, Italy, Spain, and Canada.

#### 6. Anthropology Department Program in Mexico

Just off the Mexican coast of Yucatan lies the island of Cozumel, site of archaeological field work jointly undertaken by Dr. William L. Rathje, Department of Anthropology (University of Arizona) and Jeremy Sabloff (Harvard), in cooperation with archaeologists from the Mexican National Institute of Archaeology and History. It is possible that the island has been occupied since 300 A.D., first as a trading center of the Maya Indians, and later was the launching point for Cortes in his conquest of Mexico. Thus far the Arizona-Harvard group has uncovered the remains of a relatively large settlement which surface-remains had previously led archaeologists to believe consisted of four different villages. The settlement complex includes a temple dating from about 125 A.D.

#### 7. Biological Sciences Department

The Department of Biological Sciences through NASA funding has undertaken a remote sensing study of the marine environment of the Upper Gulf of California. The Project involves simultaneous investigation of the ocean by satellite aircraft and ocean sampling. The contract between the University of Arizona and the National Aeronautics and Space Administration calls for the formation of a master plan of oceanographic research with the participation of Mexican research institutions. Dr. John Hendrickson, professor of biological sciences, is director of the program. Working with him are scientists from the University

of Oceanography of the Mexican Navy.

8. College of Law

Courses are offered in Water Law, Mining Law and Public Land Law which are large concerned with the management and multiple use of natural resources in semi-arid regions. Courses in Land Use Planning and Administrative Law are also related to the allocation process and multiple uses of resources. Another member of the law faculty has helped direct the study of teachers from Colombia and Costa Rica in commercial law and law and economic development and he is a consultant to AID and Latin American Universities. His specialty is international commercial transactions.

9. Oriental Studies Center

The Center coordinates teaching and research relating to the Middle East, South Asia, Southeast Asia, and East Asia. The disciplines represented are anthropology, art, economics, geography, government, history, philosophy, sociology, and Oriental languages and civilizations.

The University of Arizona is a member of several consortia which annually offer summer language programs in Chinese and Japanese, Hindi-Urdu, and Arabic.

10. Office of Arid Lands Studies

(a) Arid Lands Information System

The Office of Arid Lands Studies has developed a computerized arid lands' information system which is international in scope. As a focal point of arid lands scientific information, ALIS receives inquiries from throughout the world and is currently establishing institutional ties with Israel, Mexico, and Australia and establishing links through UNEP. The ALIS and its associated programs at the Office of Arid Lands Studies has produced international scholarly publications including Deserts of the World, Arid Lands in Perspective, Food, Fiber, and the Arid Lands, Arid Lands Research Institutions: A World Directory, Arid Lands Abstracts, and special resource papers on salinity, geothermal energy, groundwater law, and desertification.

(b) Jojoba Project

The University of Arizona Office of Arid Lands Studies (OALS) continues to coordinate the Indian jojoba activities sponsored by the Office of Economic Opportunity and other cooperating agencies. This includes maintenance and continued development of an international jojoba information system located at the OALS, as well as coordination and distribution of harvest products, and agency and Indian coordination.

Planned activities include providing needs to the Southwestern Arboretum for establishment of a gerin plant nursery, conducting an economic feasibility study and an environmental impact study of the Indian jojoba industry, conducting studies leading to the development of an Indian jojoba cottage industry, and research by reservation Indians to improve the efficiency of harvesting native jojoba. Edward F. Haase of the OALS staff is now coordinating the jojoba project at the University.

## 11. Miscellaneous Consulting and/or Other Interdisciplinary Projects

### (a) MIT Sahel-Sudan Project

Dr. E. Lendell Cockrum, Professor, Department of Biological Sciences and Mammalogist, Agricultural Extension Service, and Jerry Matlock, Professor, Soils, Water, & Engineering, are presently under contract to the Massachusetts Institute of Technology to perform work in the Sahel-Sudan Project. The project is a multidisciplinary approach to the evaluation of alternate strategies for the Sahel-Sudan area of Sub-Saharan Africa. This is an area of nomadic animal husbandry and subsistence farming, primarily dependent upon rainfall.

Dr. Cockrum is also involved in a P. L. 480 project with TAPNE (Tanzania Association for the Protection of Nature and Environment) and the newly established Tanzania Museum in an in-depth study of Tanzanian mammals which include geographic distribution, agricultural and public health impact, rodent population phenomena, and lastly, a definitive book on Tanzanian mammals.

Dr. Matlock is also involved in the Brazil program previously discussed and the watershed management program involving the Departments of Agronomy and Plant Genetics; and Soils, Water, and Engineering of the College of Agriculture. This project is nearing the end of a five-year effort to improve the use of systems analysis in watershed management. CARES, a special language for programming mini-computers, has been developed as part of the project. Field research is underway to identify plants most efficient in water use and to test new techniques of dry farming.

### (b) Recent Consulting

Dr. Jimmie S. Hillman, head of the Department of Agricultural Economics, is the director of a two-year program to provide technical assistance to the Agricultural Planning and Economics Research Organization of Turkey. One University advisor, Dr. John L. Fischer, has been assigned to Ankara for two years and at least three other experts have visited Turkey for short periods to advise on serious applied agricultural economics research problems and policy issues.

Dr. Jack Johnson, the Director of the Office of Arid Lands Studies, spent two months visiting eight African and Middle Eastern countries during

capabilities, and opportunities for Unkenes if this Grant is approved. Promising opportunities (i.e., significant and relevant resource problems coupled with LDC institutional interest in cooperative efforts) were identified in Kenya (ground water management); Ghana (assessment of potential impact of drought); Tunisia (desert encroachment); Syria (Arab Arid Lands Research Center); Tanzania (park management); Sudan (desertification, mineral resources, and arid land architecture); Ethiopia (desertification); and while attending FAO meetings in Rome and UNEP meetings in Kenya he was able to establish program interest in several Asian and Latin American countries, especially Pakistan, Chile, Peru, Argentina, and N. E. Brazil.

### (c) Miscellaneous Projects of Interest

#### (1) Physics Department Faculty Exchange

Faculty Exchange Program between the Physics Department of the University of Arizona and the Instituto de Fisica of the Universidad Nacional Autonoma de Mexico. The primary objectives of this program are to further research and experimental programs between the two universities and countries.

#### (2) Cususwash

The University plays a major role in the Council of U. S. Universities for Soil and Water Development in Arid and Sub-Humid Areas. Members of the consortium include the University of Arizona, the University of California, Colorado State University and Utah State University. Presently programs are underway in Latin America and Pakistan.

#### (3) Latin American Studies Center

The Latin American Area Center offers an interdepartmental program designed for students who plan a career in government, business, or teaching. The Center offers a Bachelor of Arts degree, a Master of Arts degree, and a doctoral minor in Latin American studies. A student with an interest in the Latin American area may choose a course of concentration in one department and at the same time enrich that concentration, with the approval of his advisor, with related studies in other departments. Related studies may be cultural or professional. Portuguese and Spanish languages are required at appropriate levels of competence.

#### (4) Center for English as a Second Language

This is an intensive program in English as a Second Language at the University of Arizona. Classes meet approximately 5 1/2 hours a day for 5 days a week. Classes are offered in speaking, understanding, reading comprehension, and composition. Daily laboratory practice is required. In addition, the daily seminar emphasizes the understanding of a second culture through movies, special lectures, trips, etc. Intermediate and advanced students are taught such skills as the use of the dictionary, techniques of study, note-taking,

use of the library, and the taking of subjects in a second language.