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IMPROVING CAPACITY OF CUSUSWASH UNIVERSITIES
FOR WATER MANAGEMENT
FOR AGRICULTURE

REPORT NUMBER V

COLORADO STATE UNIVERSITY



Grant No. AID/csd 2460

November, 1974

211(d) Annual Report

Date due 1 December 1974

Date 11 November 1974

Grant Title: OPTIMUM UTILIZATION OF WATER RESOURCES WITH EMPHASIS
ON WATER DELIVERY AND REMOVAL SYSTEMS AND RELEVANT
INSTITUTIONAL DEVELOPMENT

Grantee: Colorado State University

Grant Program Director: Maurice L. Albertson

Sponsoring Technical Office: Bureau of Technical Assistance
Office of Research and Technical Grants

Statistical Summary: Period of Grant: 23 May 1969 to 22 May 1974

Amount of Grant: \$750,000

Expenditures for Report Year: \$128,554

Accumulated: \$750,000

Anticipated for next year: \$100,000

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I. NARRATIVE SUMMARY

A. Principal Accomplishments

1. Summary of accumulated accomplishments

During the initial five-year period of the 211(d) institutional grant, CSU has, within the major objectives, studied the optimum utilization of water resources with emphasis on water delivery and removal systems and relevant institutional development. A brief description of what has been accomplished is as follows:

a. Increased the competence of the CSU faculty in research, and teaching it has developed institutional capabilities to work with AID, World Bank, United Nations, and others in helping to develop LDCs to increase their economic and social conditions through increased agricultural production. In accomplishing these objectives CSU has increased the faculty by twenty-two (22) new members who are all working in the area of water resources development. Thirteen (13) of these positions were fully or partially supported initially by the 211(d) grant funds which enabled the departments to employ these faculty and thereby increase the competence and capabilities of CSU. For more detail see Chapter III.

b. CSU in the past five years has expanded its course offerings by improving eighteen (18) courses and adding eleven (11) new ones. These courses are now being fully supported by University funds. These course offerings have established an interdisciplinary program for students interested in water resources to receive a cross section of courses from both the engineering and social sciences aspects of this field. Prior to the grant the existing courses were taken primarily by students in the department in which courses were taught. As a result of the grant, however, many of these courses have been revised and new ones added. Furthermore, engineering and agricultural students are taking social science courses and vice versa. These courses are listed in detail in Appendix A.

c. Research on water delivery and removal systems has been further expanded by the wide variety of new funding which has been generated by the faculty as a result of the grant funds. The 211(d) grant funds have stimulated an interest to develop an approach to research in the full dimension of water resources problems as it

pertains to the economic, sociological, and technical fields. Joint research programs have been established both at CSU and with the other CUSUSWASH universities. Through the results of this type of research, assistance is being furnished to the LDCs to help eliminate problems encountered in water delivery and removal systems. The total expansion of the research program at CSU is outlined in Appendix B.

d. Chapter III and Appendix H give greater detail on the competence of the CSU Staff, and the ways in which this competence has been utilized.

e. By the use of the 211(d) funds over the past five years, CSU has been able to develop an interdisciplinary team approach which is showing significant payoff. One major factor in developing this interest and activity is the interdisciplinary seminar which was established from 211(d) grant funds, see Appendix E. The seminar is now being offered as a course for credit for graduate students by the university and is supported by three colleges and six departments. CSU also has research contracts which involve four or five colleges and many departments. For details, see Appendix B.

f. Detailed information on achievement of specific objectives by CSU are included in Chapters III, IV, V, and VI.

g. The potential operational significance and benefit to the LDCs has been demonstrated by (1) the request for use of the services of the CSU faculty; (2) the added courses for the benefit of foreign graduate students; (3) the increase in research funding which has worldwide application; and (4) the publications on research projects which will benefit both the economy and the agricultural production of LDCs, see Appendixes A, B, F, and H.

h. Of major importance is the interest and activity both on campus and abroad which has developed as a result of the 211(d) grant. This includes the joint and cooperative activities with the other Council universities as stated in Chapters III and VI.

II. DETAILED REPORT

A. General Background and Description of Problem

When CSU joined with Utah State University, University of California, Davis and the University of Arizona to form the Council of U.S. Universities for Soil and Water Development in Arid and Sub-Humid Areas, the problem of water management in the LDCs was recognized as a priority item by the Council. Utah State University, University of Arizona and Colorado State University were all funded through the 211(d) Section of the Foreign Assistance Act of 1961 to receive funds to increase their competence and field of interest to enable these universities to assist the LDCs in overcoming the problem of water management. Utah State University has special emphasis in "on-farm water management;" Colorado State University in "water delivery and removal systems and relevant institutional development," and the University of Arizona in "watershed systems." Since these universities were recognized as among the most competent in the U.S. in the field of water management, they were selected to receive the 211(d) grant funds. Because irrigation is of extreme importance to the agriculture of a large portion of the LDCs, the increased competence in water management created by these grants has been of central importance to optimize agricultural development in the LDCs.

B. Purpose of the Grant

With the funds from the Grant, Colorado State University will continue to improve its level of excellence with respect to planning, development, management, and utilization of water resources management with special emphasis on water delivery and removal systems and relevant institutional development related to the needs of less developed countries.

Since the 211(d) grant has been extended for another year, this report covers the activities and progress during the first five year period. As stated in the narrative summary, the objectives of the program, which are outlined in the purpose and objectives, have been fulfilled. Appendix H of this report describes the increased competence of university staff; Appendix D shows a detailed list of foreign graduate students who have chosen CSU because of its excellence in these programs; Appendix B lists the expansion of research being done at CSU; Appendix A lists the increase and expansion of course offerings for a truly

interdisciplinary program for both U.S. and foreign students; Appendix E has a copy of the program for the interdisciplinary seminar. Appendix H, Sections D and E lists the workshops, conferences and publications which have resulted from the 211(d) grant. The additional faculty hired at CSU has helped alleviate the shortage of qualified professional personnel, these are listed with a short resume in Appendix C. In Appendix H, Section A the capabilities of CSU faculty to serve as advisors and consultants is stated. Through the publications, the foreign research assistants, and the use of CSU faculty on an international level in conferences, seminars, institutes and workshops, there has been created a greater understanding of the LDCs crucial problems relating to water resource management. Lines of communication have been developed and linkages have been established, which are reported in greater detail in Chapter III.

C. Objectives of the Grant

1. Specific objectives (as stated in grant document)
 - a. Expand its professional staff in the various departments of the University which are now involved, or which would like to be involved, in water resources activities related to the needs of the less developed countries.
 - b. Expand its number of graduate students in these departments from or interested in, the less developed countries.
 - c. Expand its departmental research programs and activities related to the needs of the less developed countries.
 - d. Expand its course offerings in these departments--including interdisciplinary courses--which are related to the less developed countries.
 - e. Expand special activities, and initiate new ones, in the United States and abroad which are related to research, teaching, and service--e.g. seminars, exchange programs, institutes, conferences, and publications which are concerned with the less developed countries.
 - f. Help to alleviate the critical shortage of qualified professional personnel with international interests, experience, and expertise, and with cross-cultural insights.
 - g. Expand its capability to serve in advisory and consulting capacity to various individuals, government agencies, industries, business, and other organizations who have an interest in

activities abroad. It would be understood, however, that substantial specific services in this area will be funded by AID and any other sponsoring agencies under separate contractual arrangements.

h. Improve its understanding of the nature of less developed societies, and find ways and means of assisting them to resolve crucial problems relating to water resources development and management.

i. Develop an exchange of personnel and publications, and other programs of interaction, which will help to establish steady and effective lines of communication between Colorado State University and the less developed countries.

D. Review of Objectives

Within the stated objectives of the 211(d) grant, emphasis was placed on expanding the expertise of CSU in the stated fields. This was achieved by:

1. Hiring new faculty, several of whom had outstanding records in water resources
2. Developing truly interdisciplinary study programs for graduate students and faculty
3. Funding both U.S. and foreign students who were able to study problems which are applicable not only to a specific country but also have worldwide application to water delivery and removal systems and institutional development.

It was recognized at the outset that technical problems, such as water delivery and removal, had not been solved in the past because, in large part, of the economic and social conditions in the LDCs. Therefore, the CSU grant emphasized an interdisciplinary program which included both the technical aspects and the social sciences. Indications of the success of this grant are illustrated, as noted in Chapter V, by:

1. The requests for the services and expertise of CSU faculty to work in the LDCs;
2. The foreign graduate students who have returned to their country in positions of responsibility and authority;

3. The establishment of a program whereby foreign students will return to their countries to complete the research work for their degrees, and

4. By the list of graduate student research (Appendix F) which has application worldwide to water delivery and removal systems.

There were no modifications made in grant objectives during this five year period. There were times when AID placed special emphasis on issues which were not mentioned in the original document. It was strongly emphasized by AID that CSU was to look at only water delivery and removal systems and relevant institutional structures, so this is where CSU's funds and time were utilized.

E. Organizational Study of CSU

It is recognized that during the conduct of a program there is need for continuous review and modification. In a desire to have periodic re-examination of the academic and research organizational structure in relation to its functions, CSU has carried out an organizational study. This study will help further to improve organizational structure so that it will better assist the institution to:

1. Respond quickly and efficiently to changing societal needs,
2. Readily identify and implement instructional innovation,
3. Capitalize on the availability of off-campus as well as on-campus learning and research situations,
4. Utilize interdisciplinary approaches to instruction, research and service wherever appropriate,
5. Provide quality learning experience to students in logical sequence,
6. Implement sound management principles of economic efficiency and utilization of human resources,
7. Encourage continuous interaction between research and instruction and
8. Provide appropriate circumstances for students to make meaningful education and vocational choices.

The study effort has encompassed approximately two years to date. This study has helped CSU to identify the most appropriate organizational structure for academic and research areas at Colorado State University to insure that the institution fulfills these functions as effectively and efficiently as possible.

F. Development of State Support

CSU has also initiated a major effort to develop stronger State financial support for research and creative activities; to devise an administrative structure that integrates research and academics at the administration level and provides the necessary continuity at all levels of administration to optimize the further growth of research creativity and teaching. Financial administration within the University has improved significantly in recent years and is judged to be the best in higher education in Colorado. However, CSU is further upgrading the University's financial administrative services so that it can minimize the accounting activity at the college, departmental and project leader levels, thus increasing the efficiency of the project.

CSU endorses the concept that performance planning, coupled with accountability for performance, should be practiced conscientiously by all professionals who function as a part of the larger organizational unit. Most important, it is intended to give more attention to the importance of research work done abroad by the faculty. CSU has a commitment to increase continually its overseas activities in the water resources field.

III. ACCOMPLISHMENTS

A. Introductory Statement

The grant provided a part of the funds necessary for CSU to become more competent in the area of water delivery and removal systems and institutional development. CSU has improved its level of excellence with respect to planning, design development, management, and utilization of water resources as the grant purpose relates to the needs of the LDCs.

The original target at the end of the first five year period was to expand and improve the involvement of five departments (Agronomy, Agricultural Engineering, Civil Engineering, Economics, Political Science and Sociology) in assisting LDCs and for faculty to be available for both short and long term assignments in the less developed countries. The fact that this has been accomplished has been documented by the many requests which CSU has received for professional assistance to have these faculty serve both in the U.S. and overseas.

1. Objective #1 professional staff

In expanding its professional staff in the various departments, CSU anticipated that the faculty would become involved in water resources activities as they relate to the grant purpose. This has been accomplished and is documented by research achievement, the level and content of courses offered, publications and the requests for CSU services.

Dr. John Reuss is currently on leave to work with the Environmental Protection Agency on developing soils science and related research as an integral part of the environmental research effort as it will effect both the in-house and extramural components. He also advised students interested in foreign agriculture with specific interests in water management projects.

Professor Gaylord Skogerboe has traveled to Pakistan serving as a consultant and conducted a two week short course in Pakistan covering the following topics: (a) irrigation structures; (b) flow measurement and (c) salinity control. Professor Skogerboe also spent time touring the irrigated areas in Pakistan to review the present status of irrigation distribution systems.

Professors Skogerboe and Wynn R. Walker have undertaken a study regarding the relationships of the irrigation distribution system to water management and salinity in Pakistan.

Dr. Alan C. Early joined the Agricultural Engineering Department in September, 1973. He has been working on the use of knowledge of water delivery systems to optimize cropping patterns and food production. Dr. Early also prepared a case study on the Water and Power Development Authority of Pakistan for the Workshop on Water Delivery and Removal Systems held at CSU in April and May.

Dr. William E. Hart advised Mr. Stephen W. Smith on research on water conveyance designs which will be suitable for distribution to small (1 to 5 acre) plots. Dr. Hart also spent two (2) months in Pakistan working on water courses and land leveling projects.

Dr. W.D. Kemper, who has been on the staff of the Agricultural Engineering Department, will assume a 2 year assignment as chief of party of CSU's field operation of the Water Management Project in Pakistan.

Professors Skogerboe, George Radosevich (Department of Economics), and Evan Vlachos (Department of Sociology) have planned and prepared the program for an International Conference on Global Water Law Systems in Valencia, Spain in the summer of 1975. The 211(d) grant provided the funding and interdisciplinary program that brought these individuals in different departments to work together to foster this important conference.

Dr. Gene Wilken, previously funded under the 211(d) grant, continues his work on resources management on small farms while on leave in Mexico. The past 211(d) funding assisted Dr. Wilken in improving his professional capabilities to the point where he now has obtained other funding from the National Science Foundation for small farm resources management in developing countries. Dr. Wilken spent '73-'74 academic year in Mexico, Guatemala, and Honduras on a study of resources in water, soil, and space management in labor-intensive farming systems. This project was supported by the Foreign Area Fellowship Program and the National Science Foundation. Through Dr. Wilken's support and encouragement under the grant program, an environment of interest and expertise was created which not only enhanced professional competence but resulted in outside funding to benefit the LDCs.

During the past year, Dr. Radosevich served as Economic Affairs Officer and Water Law Specialist for the Water Resources Section, Resources and Transport Division, United Nations, New York. Dr. Radosevich has developed a widespread reputation in the field of water law and administration and is the Director of the International Conference on Global Water Law Systems to be convened in Valencia, Spain, during July, 1975.

Dr. Ronald Tinnermeier has become widely known in the area of small farm development, especially in the field of agricultural credit.

Drs. Maurice L. Albertson and Everett V. Richardson are working in Asia and South America with various government organizations on water delivery and removal systems. Dr. Richardson has been working with the Ministry of Public Works on the development of the Orinoco River in Venezuela.

A cooperative agreement has been signed by the University of Los Andes and Merida and CSU to strengthen the cooperative program. It appears that CSU will be able to develop a cooperative program with the water resources division of the Ministry of Pakistan and with the Civil Engineering Department of ULA that will be beneficial to both the United States and Venezuela.

Financial support was provided Professor George L. Smith to increase his competence in water resources systems as related to irrigation management practice in arid and semiarid regions of the world. Specially, the financial support was used to develop a program in the efficient application of irrigation water to farmland in cooperation with representatives of the other members of the consortium who served on the Committee. These were: M.A. Massengale, University of Arizona, J. Paul Riley, Utah State University, Warren Hall, Colorado State University, John Hanks, Utah State University, Ivan Stewart, University of California, Davis, William Franklin, Colorado State University and Robert Danielson, Colorado State University.

Professor Henry P. Caulfield, Jr., who has an international reputation in the water resources field, taught both graduate and undergraduate level courses, supervised research assistant work and directed the interdisciplinary seminar on international water resources management. Professor Foss directed 1972-73 progress toward the Ph.D. in Political

Science, a program which carries a distinct resources thrust and which will complement CSU's known areas of strength.

Dr. Evan Vlachos' support under the grant has so expanded and broadened his competence that he has developed a rapport with the Departments of Economics, Agricultural Engineering and Civil Engineering which enables the CSU faculty to prepare papers and reports which consolidate the technical and sociological considerations in irrigation water management as it relates to water delivery and removal systems. Dr. Vlachos established contact, gave a series of lectures, and worked with the Water Resources Company in Athens, Greece in assisting them in water related problems. In working with Dr. George Radosevich on the Conference on Global Water Law Systems contacts were established with the Water Board of London, England and with the Water Resources Section, Resources and Transportation Division, United Nations, New York. Dr. Vlachos also holds a joint CSU appointment in the departments of Sociology and Civil Engineering.

Dr. Warren A. Hall, currently Director of the Office of Water Resources Research in Washington, D.C. is on leave from the CSU Department of Civil Engineering and will be returning to the campus in January 1975. Dr. Hall pioneered the subject of and has written a book on, Water Resources Systems Engineering. Dr. Hall is widely recognized in the field of water resources systems and water resources planning and management.

More detailed information on the competence and expansion of expertise of CSU faculty is stated in Appendix H, Section A.

This competence is further exemplified by the requests received by the CSU faculty for their services. Some of the major requests are:

a. Dr. Huntley H. Biggs is presently on a two year tour of duty with the Resources Development Corporation in Iran.

b. Dr. Wayne Clyma, Dr. Alan C. Early and Dr. W.D. Kemper are serving with the Water Management Contract team in Pakistan. Each on a two year tour of duty.

c. Dr. William E. Hart, Professor Gaylord Skogerboe and Dr. David R. McWhorter have served as short-term consultants for the Water Management Contract at the request of USAID/Pakistan.

d. Dr. George E. Radosevich returned to CSU in January 1974 after serving a one year assignment with the United Nations in New York as Economic Affairs Officer and Water Law Specialist. Dr. Radosevich has served USAID as a Water Law Specialist in Pakistan. He will also serve as Director of the International Conference on Global Water Law Systems to be held in Valencia, Spain during July 1975.

e. Dr. Willard Schmehl served as an irrigation agronomist, for AID through the Basic Order Agreement, with two team members from Utah State University (Irrigation Engineer) and University of Arizona (Water Resources Engineer). The team provided guidance to the Bicol Program Office, USAID/Phillipines in the development of a long-range water management project as a component of the Bicol Basin Program. Dr. Donald Drew and Dr. Norbert Ackerman, both stationed at the Asian Institute of Technology in Bangkok, have also been serving as consultants to the Bicol Basin Program.

f. Dr. David B. McWhorter was requested by AID/Washington through the BOA to provide the technical services needed to advise and give guidance to USAID/Pakistan regarding their program of assistance for the Agriculture sector of Pakistan. The services include determining the number, type, locations and design specifications of skimming well installations at Tandojam and Mona in Pakistan. The work was coordinated with the officials of Tandojam and Mona, the CSU field party, and USAID--utilizing the research results that CSU developed in other field installations in Pakistan.

g. Dr. Maurice L. Albertson served on a short-term assignment for AID/Washington to provide technical assistance to review the potential for an institutional relationship between the U.S. and Pakistani institutions and for the preparation of a detailed plan of action utilizing the proposed institutional grants. This report was made prior to departure from Pakistan and submitted to USAID/Pakistan.

h. Professor Henry P. Caulfield was invited by the United Nations, at their expense, to serve as a consultant at the United Nations Seminar on Water Administration in New Delhi, India. He is now on the U.N. consultants list and is serving on the Committee to plan for the World Water Conference to be held in Buenos Aires, Argentina in 1977.

Professor Caulfield also served as a special lecturer for Dr. V. Yevjevich under a National Science Foundation contract in cooperative scientific research for the University of Sarajevo, Yugoslavia. The international travel expense is paid from the NSF Contract funds and the in-country travel and fees are paid through local currency funds. Professor Caulfield has received a request for a second visit in the fall of 1974.

i. Dr. Ronald L. Tinnermeier, because of the competence developed under the grant, will begin a two year assignment with USDA and Federal Extension Service working directly with USAID on land tenure, small farm development, and taxation. In December 1973, Dr. Tinnermeier traveled to Paraguay at the request of the AID Mission to work with the Ministry of Agriculture in small farm development.

2. Objective #2 graduate students

Expansion of graduate students at CSU is a continuing process. As the reputation of CSU becomes better known throughout the world, more and more applications are received from foreign students to do graduate work at CSU. This is verified by Appendix D in which 276 graduate students from 65 countries were studying at CSU. These students will return to their countries so their advanced education will benefit their own government. The number of U.S. students who studied under the grant in the field of water resources illustrates the interest of these students in the LDCs. Thirty-one U.S. students did research beneficial to LDCs during the first five years of the grant. As stated in more detail in Appendix H, Section B, and Chapter VI, the training of both U.S. and foreign students has had a direct benefit to LDCs.

3. Objective #3 research

The expansion of departmental research and level of activities has partially been stated in Objective #1 and is further documented in Appendix B for the total research funded at CSU in the past two year period. The original workplan was to develop interest and obtain research in the field of water resources. The increase in this type of research shows the extent to which this objective has been achieved.

4. Objective #4 course offering

A partial list of course offerings at CSU is stated in Appendix A. Eighteen (18) courses have been upgraded and eleven (11) new ones have been added. The most important aspect of the expansion and improvement of courses, is the interdisciplinary water resources program which has been established at CSU. This helps the technician understand the social and economic problems and vice versa, and is documented by the courses established for non-engineering majors.

5. Objective #5 special activities

The expansion of special activities is the Interdisciplinary Seminar, now held weekly and made available to graduate students for credit. This Seminar is planned and participation is from six departments (Agricultural Engineering, Agronomy, Civil Engineering, Economics, Political Science and Sociology). Appendix E covers the program for the reporting year. Another on-going activity is the International School for Water Resources and Associated Programs. A list of these participants is shown in Appendix G. A more complete report on special activities is also given in Appendix H, Section D.

6. Objective #6 alleviate critical shortage

By the grant funds CSU has helped alleviate the critical shortage of qualified professional personnel with international interest by supporting faculty to enable them to pursue research and establish contacts in the field of water resources. Here again, this is demonstrated by the requests for the services of CSU faculty. (See Appendix H, Section A.) The international travel is listed in Appendix H, Section F and the library additions in Appendix H, Section E.

7. Objective #7 consulting capacity

The expansion of the CSU faculty and University capabilities, and the use of faculty for advising and consulting is stated in Objective #1 and Appendix H.

8. Objective #8 understanding less developed societies

Through expansion and improvement of course in the social sciences, the interdisciplinary seminar, experiences on overseas assignments, research activities, and interaction with students from other countries, the CSU faculty has acquired a greatly improved understanding of the less developed societies, see Chapters III, V, VI and

Appendixes A, B, E, and H. Appendix B lists some of the research funds obtained for this purpose. CSU also through the Committee of the Colorado Association of International Education is establishing a data bank and roster of faculty with capabilities to assist LDCs as requested.

9. Objective #9 personnel and publications exchange

An exchange of personnel and publications is shown in detail in Appendix H, Section A and Section C, in the competence of CSU faculty; Appendix D lists the foreign students studying at CSU; the extensive international travel performed by staff and the number of linkages established are given in Appendix H, Section F. Many of the publications purchased have been sent overseas, and all of the research reports are sent to AID Washington, USAID Missions and foreign government agencies. An abstract of all reports is furnished AID for their distribution. All of these are effective lines of communication between CSU and the less developed countries.

Chapter III and Appendix H state in greater detail the U.S. personnel who have developed an interest and who have gone overseas to assist the less developed societies. Appendix D and Appendix C illustrates the large degree of foreign students, staff, faculty and administrators who chose to come to CSU.

Many distinguished visitors have chosen to come to CSU during the reporting year as a part of a personnel exchange. Some of these are:

1. Mr. M. Anandkrishnan
Science Attache
Indian Embassy
Washington, DC
(formerly Professor of Engineering at
Indian Institute of Technology,
Kanpur, INDIA) September 1974
2. Mr. Ali Khan
Vice Chancellor
University of Peshawar
Peshawar, Pakistan August 1974
3. Mr. Sadik Toksoz, Program Officer
Water and Land Resources
The Ford Foundation
55 Lodi Estate
New Delhi 11003
INDIA October 1974

4. Sankara Subramaniam, Director
Committee on Social-Economic Development
C/D 48/1 V.K. Nagar,
Durgapur - 10
West Bengal
INDIA 713210
September 1974
5. Dr. Miklos Domokos
Research Institute for Water Development
Budapest, HUNGARY
May 1974
6. Dr. Laszlo David, Head
Engineering Secretariat
National Water Authority
Budapest, HUNGARY
May 1974
7. Professor Yu A. Rozanov
(a citizen of USSR and staff member)
International Institute of Applied System Analysis
Vienna, AUSTRIA

IV. IMPACT OF SUPPORTED ACTIVITIES IN ACHIEVING GRANT PURPOSE

A. Grant Accomplishments in Achievement of Grant Purpose

As a result of the initial five year funding of the 211(d) grant, the supported activities have accomplished the purpose of the grant. As listed in the general objectives these are stated as follows:

*1. The expansion of the CSU professional staff is documented in this report by: (1) the number of new faculty (2) the requests received for CSU faculty services (3) the number of departments involved, and (4) the interdisciplinary program established at CSU. All of which are in the field of Water Resources as related to water delivery and removal system and institutional development.

2. The number of graduate students who received support from the grant and the number of foreign students who come to CSU for graduate study, as documented in this report, shows the expansion of graduate students who are now studying in the field of water resources with research applicable to LDCs. The new interest which has developed for study and research to help the LDCs is demonstrated by the foreign students returning to their own country to do their research programs.

3. The new increase in funding at CSU for research in the area of water resources (See Appendix B) not only shows the increase in research but also shows the interdisciplinary interest for water resources and the LDCs which has been developed at CSU.

4. The expansion of the number of courses established by the grant--including interdisciplinary courses--and now being continued and supported by the State of Colorado justifies the use of grant funds for this purpose of initiating new courses. All courses are international in nature. The change in CSU policy to allow graduate research to be done in a foreign country further indicates CSU's interest and willingness to help the LDCs.

5. Special activities which have been established as a result of the grant, include research, teaching and service. The interdisciplinary seminar attracts faculty and students campus wide. It covers the field of water resources problems on a worldwide basis, as exemplified in the program in Appendix E. Student exchange programs

*Without restating the objectives the numbers correspond to the objective number listed in the grant document.

have been established with the LDCs. Publications from research by both the faculty and the graduate students level have worldwide application. Details on these activities are given in Appendix H of this report.

6. The expertise developed at CSU because of the grant and documented by the requests from all agencies for these services shows how CSU has helped to alleviate the critical shortage of qualified professional personnel. The information bank being developed by CAIE, (as a result of CSU initiation) is another example of interest by CSU faculty to assist the LDCs both in research and overseas assignments.

7. The expansion of CSU's capabilities to serve as advisors and consultants as requested, and funded by other sponsoring agencies under separate contractual arrangements, demonstrates the increase of these capabilities as a result of grant funding.

8. The funds spent on library material and publications and the establishment of the international water resource library as a component of the CSU Library have had a significant effect in improving the understanding of the less developed societies. This has enabled both faculty and students to develop research and study programs to assist the LDCs in resolving their crucial problems relating to water resource development and management with special emphasis on water delivery and removal systems.

9. The development of an exchange of personnel and publication for interaction to establish linkages as effective lines of communication is documented in the report by the foreign student programs, the international travel of faculty and students, the increase and number of requests received by the University to assist personnel from the LDCs to come to CSU, and the ever-increasing interest of CSU faculty in obtaining international research funding.

B. Spin-offs from Grant-Related Activities to U.S. Domestic Problems

An important spin-off from the grant-related activities are the new courses and the improved and upgraded courses now being offered at CSU, see Appendix A.

The Department of Economics offers undergraduate and graduate courses in agricultural economics, development economics, and water and natural resource economics--all of which are supportive of the 211(d) program but done without using grant funds. However, the grant has

provided an important link between the formal courses on the one hand and the on-going field research in the developing countries on the other. This linkage has provided information for a continual revision of course material relating to the LDCs.

In addition to their work on water delivery and removal in Pakistan, Professors Skogerboe and Walker are doing extensive work on salinity in the Grand Valley of Western Colorado. This work is being funded by Environmental Protection Agency and has received national acclaim. In this research Professor Skogerboe discovered the similarity between Pakistan and the Grand Valley and that the U.S. experience was helpful in looking for related solutions to salinity problems in Pakistan.

Dr. Evan Vlachos has actively participated as chairman, and author panel member, and discussant in the following conferences (only partly supported by 211(d)).

1. "Social Well Being/Quality of Life Dimension in Water Resources Planning," Logan, Utah
2. "On-Farm Water Management and Implementation Symposium," in Park City, Utah, and conducted at the request of AID/Washington.
3. Workshop on International Development," Fort Collins, Colorado
4. Participated as a panel member in the Environmental Design Section of the annual meeting of the American Society of Civil Engineers.

V. OTHER RESOURCES FOR GRANT-RELATED ACTIVITIES

Through the support of AID and other organizations CSU conducts an International School for Water Resources. The School was established to provide a structure to meet the need for improving professional personnel in water resources engineering to learn new techniques, to encompass up-to-date knowledge, and to broaden outlooks.

The School provides a tailored-made program to meet the needs of each individual and agency. The International School has no faculty of its own but utilizes existing faculty in the various departments of the eight colleges at CSU. The flexibility of the program and the time periods allowed by the International School permits, participants to conform to the stipulations of many different sponsoring agencies.

A list of participants for FY'73-'74 are attached in Appendix G. A copy of the Bulletin giving more detailed information on the International School is available upon request to Professor Victor A. Koelzer, Director, International School for Water Resources and Associated Programs, CSU.

The CSU College of Agricultural Sciences offers an International Agricultural Program. The program is designed to assist in coordinating and supporting programs involving foreign students, trainees, and visitors sponsored by AID/W, USAID/Missions, FAO, IIE, and other organizations in accordance with formal or informal agreements on a case by case basis. The program also provides for coordination and support of programs of training and orientation for CSU students preparing to go overseas. The average length of study of each student is approximately two (2) years and about 90 percent of the students are in the Graduate School.

The program has also been expanded to provide agriculture seniors and post-graduate agriculture students to participate in a work-study program in Latin America and an Agriculture Intern Program in Francophone, West Africa.

In August 1974, CSU, in cooperation with Adams State College and the Agency for International Development, held a workshop for the International Students in the San Luis Valley on "Keys to Agricultural Development" at the local level. During the past ten (10) years an average of 15 students per year have participated in this workshop.

A 211(d) Workshop was held at CSU during the reporting period as an overall discussion on the impact of the 211(d) grant funds. Ten papers were presented and case studies and discussions were held on the last two days of the Workshop.

The Workshop served several functions:

1. To bring together experts in the field of water delivery and removal systems to analyze the practical application and directions for future research
2. To prepare a publication for better understanding, better planning, and design information
3. To integrate the institutional and social science aspects of water delivery and removal systems with physical planning and design aspects

Appendix K further outlines the objectives of the Workshop, contains a copy of the program and lists the titles of papers presented.

CSU has long had a reputation for attracting foreign students to its campus. The Office of International Education assists foreign students in their housing, registration and many other aspects of a foreign student studying at CSU. The 211(d) grant funds have enhanced this program. For the '73-'74 academic year there were 276 students from 65 countries, with 245 graduate students, 26 undergraduate students, and 5 nondegree students at CSU. A complete list of these students is in Appendix D.

M.L. Albertson is Chairman of the Board of the Colorado Association for International Education. This Association is made up of participants from eighteen (18) universities, colleges, and institutions, seventeen (17) in Colorado and one (1) in Wyoming. The Association was organized for the purpose of enabling the institutions of higher education to develop cooperative programs in the field of international education. CAIE conducted five seminars during the year '74-'75 "The Emerging World of East Asia" held at the University of Colorado Boulder; "Global Dimensions in U.S. Education: the University" held at the University of Denver; "Colorado Business and Higher Education: Partners in International Exchange" hosted by the University of Northern Colorado, Greeley; and "American Foreign Policy in the Middle East" held at the U.S. Air Force Academy, Colorado Springs, Colorado. A fifth seminar

"International Development" was hosted by Colorado State University. One of the guest speakers was from AID and AID funds and 211(d) grant funds were used to assist in this seminar, see Appendix K for a copy of the Program and participant list.

At the present time CAIE is developing a computerized information retrieval system for the purpose of compiling an information bank of the international experiences, talents and interests of faculty members in the member institutions. This will indentify to those faculty who are interested in activities and assignments of an international nature. It also identifies the competence and expertise available for international activities.

This illustrates one of the many ways that the competence of the faculty is being utilized as a result of grant funds.

Research under Colorado Project 125 and AID Water Management Research Contract was continued under the direction of Dr. W.T. Franklin to evaluate the effect of water quality and methods of irrigation on the salt content of return flows used in the irrigation system. As part of the study, a computerized chemical model was formulated for Pakistan conditions. The program was tested for Pakistan water by C.N. Ahmad of Pakistan. Some limitations were observed, but the model was found to be generally satisfactory. The results contribute to the evaluation of the salt content of drainage water from irrigation systems.

The Agricultural Engineering Department has continued to organize and conduct the Irrigation Practices Training Course (sponsored by the USDA) for foreign engineers and soil scientists. This Course has been a significant addition to the resources which CSU makes available to the LDCs.

In Appendix B water related contracts are listed. Some of the major projects which have grant related activities are as follows:

<u>Project</u>	<u>Funding Agency</u>
Grand Valley Salinity Control Demonstration Project	EPA
Irrigation Practices, Return Flow Salinity, and Crop Yields	EPA
Irrigation Return Flow Quality Literature Abstracting	EPA
Water Quality Control in Mine Spoils	EPA

<u>Project</u>	<u>Funding Agency</u>
Transport of Salts in Irrigation Return Flow	OWRR
Consolidation of Irrigation Systems	OWRR
Recycle and Utilization of Livestock Manure through Subsurface Injection	EPA
Salinity Control Technology in Grand Valley	EPA
Technical Services	AID
Land Management of Subsurface Liquid Residuals	NSF
Systematic Procedure for Taxing Agricultural Pollution Sources	NSF
Water Resource Optimization	Colo. Exp. Sta.
Water Resources Hydraulics	Colo. Exp. Sta.
Groundwater Management	Colo. Exp. Sta.
Hydrometeorology	Colo. Exp. Sta.
Soil Salinity and Irrigation Water Quality	Colo. Exp. Sta.
Economic and Institutional Analysis of Water Quality Standards and Management	Colo. Exp. Sta.
Farm Investigation Water Management	Colo. Exp. Sta.
Optimal Operation of Sprinkler Irrigation Systems	Colo. Exp. Sta.
Quantification of Water-Soil-Plant Relation for Efficient Use	Colo. Exp. Sta.
Solubility of Heavy Metals in Soils	Colo. Exp. Sta.
Irrigation Practices, Return Flow Salinity	Colo. Exp. Sta.
Energy Production from Agriculture Products	Colo. Exp. Sta.
Design Criteria for Interceptor Drains	Colo. Exp. Sta.
Irrigation Flow Metering	Colo. Exp. Sta.
Mathematical Modeling of Small Watersheds	Colo. Exp. Sta.
Experimental Investigation of Small Watershed Floods	Colo. Exp. Sta.

Because of the heterogeneous--social, political, agricultural, systems engineering--make-up of the Irrigation Management Program as a subcommittee of the Integrated Approaches Committee of CUSUSWASH, each member institution has been able to develop broader as well as deeper insight into the various components, and their interrelationships, of an irrigation water management system as related to irrigation water delivered to, or retrieved from a farm field. The delivery of irrigation water to a field, for example, might satisfy the soil moisture

requirement of the crop, but failure to recognize the need for drainage--
water retrieval--will usually lead to the subsequent establishment of
undesirably high water table and/or salinity conditions within the soil
profile as evidenced in the Indus Basin of the Pakistan-Indian subcontinent.

VI. UTILIZATION OF INSTITUTIONAL RESPONSE CAPABILITIES IN DEVELOPMENT PROGRAMS

A. Summary of Utilization

In Table III A and III B the request for assistance received during the reporting year are tabulated.

B. Specific Details of Utilization

Both Colorado State funding and contract and grant funding in the Department of Agronomy are used for research that is closely related to the 211(d) grant. Specific capabilities in water resource management of various members of the Agronomy Staff have encouraged an increase in both foreign and U.S. graduate students in Irrigation Agronomy.

Drs. W.T. Franklin and R.S. Whitney, Department of Agronomy, continue as advisors for an Economics project that is evaluating the impact of the quality of water delivered to an irrigation project on economic returns from the crops produced. The results have general application to problems of irrigation development in LDCs where irrigation water supplies are of low to marginal quality.

The Department of Agronomy provides academic and program advisors for nondegree foreign students enrolled in the International School for Water Resources Environmental Management. Three students transferred during the year from the International School to M.S. degree programs in the Department of Agronomy.

Two Pakistani graduate students in Economics, Bashir Ahmad and Mumtaz Rana, although not funded under the 211(d) grant, also presented seminars on land leveling and agricultural credit, respectively. A number of Economics graduate students regularly attended the seminar, although none were funded under the grant. The student involvement is explained largely by faculty involvement and interest in the water resource problems in the developing areas of the world.

The Department of Economics offers undergraduate and graduate courses in agricultural economics, development economics, and water and natural resource economics, see Appendix A, all of which are supportive of the 211(d) program but at no expense to the grant. However, the grant has provided an important link between the formal courses on the one hand and the on-going field research in the developing countries on the other. This linkage has provided material from a continual revision of course material relating to the LDCs.

Dr. Gene Wilken, Professor of Geography, previously funded under the 211(d) grant, continues his work on resources management on small farms while on leave in Mexico. The past 211(d) funding assisted Dr. Wilken in improving his professional capabilities to the point where he now has obtained other funds from National Science Foundation and Foreign Area Fellowships Program for small farm resources management in developing countries.

During the past year Dr. Radosevich served as Economic Affairs Officer and Water Law Specialist for the Water Resources Section, Resources and Transport Division, United Nations, New York. While there, his background and experience were greatly expanded. The opportunity to serve with the United Nations was partially a result of his previous involvement and the expertise he acquired under the 211(d) program. The results of the one-year assignment have further enhanced his work in the area of water resources. Dr. Radosevich has developed a widespread reputation in the field of water law and administration and, as explained elsewhere, is the Director of the International Conference on Global Water Law Systems to be convened in Valencia, Spain, during July 1975.

During the one year's leave of absence serving with the United Nations, Dr. Radosevich went on Missions to Argentina, Costa Rica, and Ethiopia to render advice and assistance for water institutional projects. Since returning from this assignment, he has repeatedly rendered assistance to the United Nations on report critiques and program formulation.

In January, 1974, a USAID fellowship trainee from Baluchistan, in Pakistan arrived for a special assistance program on parameters and preparation of a water code for Baluchistan, with particular emphasis on groundwater development. This trainee was selected jointly by the Planning Commission of Baluchistan and Dr. Radosevich during an earlier visit the latter had in Pakistan. Upon completion of this program, the trainee and Dr. Radosevich will have prepared a draft water code for the province and continued assistance will be rendered.

Similar programs and assistance are anticipated for Afghanistan and Nepal.

Dr. Ronald Tinnermeier has become widely known in the area of small farm development, especially in the field of agricultural credit. Requests for his services are being received from AID missions, international development agencies, and private consulting firms, largely due to his 211(d) involvement which permitted among other things the preparation of papers on small farmer credit institutions.

Dr. Tinnermeier's services have been requested by USDA and the U.S. Federal Extension Service to work with USAID/Paraguay on land tenure, small farm development and taxation.

Dr. K.C. Nobe, Chairman of the Department of Economics, again has participated in the 211(d) program. This past year he agreed to assume continuing responsibilities related to Dr. Biggs' objectives when he went to his overseas assignment in January, including participation in the International Interdisciplinary Seminar on Water Resources Management and serving as Dr. Biggs' replacement on the Seminar Planning Committee. In November, he was an invited participant and expert witness at an AID Conference on "Expanded Agricultural Sector Analysis Program" in Chicago. This meeting focused in particular on the relative success of various universities with 211(d) programs in developing staff capability in assisting agricultural and water resource programs in developing nations. The Conference had a particularly beneficial side effect for the Department of Economics. Through interaction with Dr. Carl Eicher, a prominent economic development expert from Michigan State University, CSU was able to hire a former student of his as an Assistant Professor. Dr. Edward Sparling has expert training in African development problems and has had former Peace Corp experience in that area. Dr. Nobe was also invited to participate as an Asian development expert in an AID-sponsored conference at the University of New Mexico in February; however, due to time conflicts, he elected to send Dr. Radosevich as his replacement to this conference. During the summer of 1973, Dr. Nobe was invited to join an AID evaluation team for water development in Afghanistan. He periodically receives requests for his services and/or his recommendations on potential employees from a number of consulting firms engaged in international agricultural and water development activities.

The Agricultural Engineering faculty members have continued to participate, organize and sponsor the Irrigation Practices Training Course (sponsored by the USDA) for foreign engineers and soil scientists. This course has been a significant added resource to CSU and the world.

The technical capability of Professors Gaylord Skogerboe and Wynn Walker of the Agricultural Engineering Department has been significantly enhanced during the period of the 211(d) grant; and thus the ability to lend expertise to the problems in developing countries has been improved. In late November of 1973, Professor Skogerboe traveled to Pakistan to advise local personnel on flow measurement and water course studies. Because of his vast experience in the control of salinity on and from agricultural lands, the trip also provided the opportunity to compare scope and format of salinity problems.

Graduate students both U.S. and foreign who have chosen CSU because of its reputation and interest on water delivery and removal systems developed through 211(d) are listed in Appendix D and F. These lists contain the currently enrolled students within the six departments supported by the grant funds. Funding for these students is outside of grant funds but because of the interest created by grant funds, these students chose CSU.

The Department of Sociology continued a sustained interest in the question of water delivery and removal. The Sociology faculty have worked in the Committee on the Irrigation Handbook, prepared outlines and worked closely in developing format. In addition reviewed for inclusion in the handbook the following three books:

1. J. Pereira. Land Use and Water Resources
2. Franji and Mahajan. Irrigation and Drainage in the World
3. L.M. Canter. A World Geography of Irrigation

Dr. Evan Vlachos has worked closely with Dr. Radosevich in preparing a plan for consideration of AID, Rockefeller Foundation, U.N., and Ford Foundation for a Workshop on "Global Water Law Systems" to be held in Valencia, Spain, with emphasis on irrigated agriculture.

Dr. Vlachos worked throughout the year in developing the "Workshop on Water Delivery and Removal Systems" and actively participated for four days in April 30 - May 3, 1974. He also prepared and presented a paper entitled: "Water and Society" at the above Workshop, see Appendix K,

and has worked actively in the Conference on "Population and Development" in organizing the program, and chairing a panel.

George L. Smith, CSU and J. Paul Riley, USU, have been the primary motivating force behind the Irrigation Management Program Committee composed of representatives from Utah State University, University of California, at both Davis and Riverside, University of Arizona, and Colorado State University. This Committee has been able to develop a broad as well as an in-depth grasp of the components of irrigation management practices and their interrelationships, as related to irrigation water delivered to, or received from a farm field. The delivery of irrigation water to a field, for example, might satisfy the soil moisture requirement of the crop, but failure to recognize the need for drainage--water retrieval--will usually lead to the subsequent establishment of undesirably high water table and/or salinity conditions within the soil profile as evidenced in the Indus Basin of the Pakistan-Indian subcontinent.

The committee utilized their competence in developing programs and generating funds from the Office of Water Resources Research which will provide research in the area of more efficient use of low grade water delivered to the farm plot --resulting in a direct benefit to the LDCs.

The appendixes attached as part of this report illustrates the foreign graduate students and visitors who have chosen to come to CSU because of the outstanding programs offered. Appendix B states the amount of funded research related to water resources which was granted to faculty at CSU for the past two years. This also demonstrates the interest in research which has been developed as a result of the grant funds.

C. Progress in Establishing and Maintaining Linkages

As stated in Chapter III on ACCOMPLISHMENTS, the CSU faculty have established and are maintaining linkages with many of the less developed societies. Several faculty have accepted overseas assignments and received funds from other agencies as a result of the grant funds.

Below is a partial list of some of the major linkages established by CSU faculty.

<u>Name</u>	<u>Country</u>	<u>Official or Organization</u>
1. Dr. David Freeman	Pakistan	West Pakistan Agric. College, Lyallpur University of Punjab, Lahore University of Peshawar, Peshawar
2. Dr. W.R. Schmehl	Pakistan	Dr. Inam-UL-Haque, Head, Soils Dept. WPAU, Chief Engr., Reclamation Mr. Allah Bakheh, WAPDA Chief Engr. Admin. Mr. S.M. Auid, WAPDA, Soils Res., Land Mr. Nur-UD-Din, Reclamation Doc. Director, Ayub Research Mr. Nanwar Hussain, Min. of Agriculture, Agronomist, GOP Dr. Iraj Poestchi, Pahlavi University
3. Dr. E.V. Richardson	Caracas, Venezuela	Pres. Hector Silva National Institute of Sanitary Works
4. Prof. Henry Caulfield	Yugoslavia	Dr. Trumick, University of Sarajevo Dept. of Civil Engineering
5. Dr. John Reuss	U.S.A.	Environmental Protection Agency
6. Prof. Gaylord Skogerboe	Pakistan	Ministry of Agriculture
7. Dr. William E. Hart	Pakistan	MOP
8. Dr. George Radosevich	Pakistan, Spain Taiwan & U.N.	Ministries of Agriculture and Government Agencies dealing in water law
9. Dr. Gene Wilken	Mexico, Guatemala, Honduras	Ministries of Agriculture
10. Dr. Ronald Tinnermeier	Paraguay	Ministry of Agriculture
11. Dr. Huntley Biggs	Iran	Ministry of Agriculture
12. Dr. Manuel Alers-Montalvo	Latin America	German Uzeatequi B. National Director CIDIAT
13. Dr. Maurice L. Albertson	Pakistan	Dr. M. Athaullah, Chairman Department of Civil Engineering Engineering College University of Peshawar Peshawar, Pakistan Mr. Sarfraz K. Malik Chief, Water & Power Section Planning Commission Government of Pakistan Islamabad, Pakistan
	Afghanistan	Dr. Abdul T. Fimo Assiffi Operation and Maintenance Division Helmand Valley Authority Kabul, Afghanistan
	Thailand	Dean Aroon Sorathesn Culalonghorn University Bangkok, Thailand
	Nigeria	Mr. Herbert R. Albrecht, Director and Dr. John L. Nickel, Associate Director

VII. NEXT YEAR'S PLAN OF WORK AND ANTICIPATED EXPENDITURES

A. Purpose

The general purpose of the 6th year of the 211(d) grant to Colorado State University is to focus and sustain, within a utilization framework, an institutional response capability to assist the LDCs in solving their food and nutrition problems. The purpose to be in the Water Chain concept with each of three Universities (Arizona University, Colorado State University and Utah State University) having primary responsibility in one aspect of the water chain. These primary responsibilities are:

Arizona University--Optimum utilization of land and water resources for agriculture with special emphasis on watershed development and management. (Watershed Management).

Colorado State University--Optimum utilization of land and water resources for agriculture with special emphasis on water removal and delivery systems and relevant institutional development. (Water Delivery and Removal Systems).

Utah State University--Optimum utilization of land and water resources for agriculture with special emphasis on on-farm water management. (On-Farm Water Management).

Each university to have secondary purposes in the other two aspects of the water chain. And most importantly they are to build and sustain an inter-institutional response capability for optimum utilization of land and water resources for agriculture in the LDCs.

B. General Objectives/Outputs

The major objective is to sustain a quality teaching, training, research, knowledge transfer and consultive capability in water removal and delivery systems for utilization by the LDCs for increased food production. The program is to be integrated with Arizona University and Utah State University to obtain a total response-capability in the water chain for the soil-water crop production function. The integration is to be accomplished by monthly meetings with the 211(d) grant director at these two universities and frequent consultations with the director and trustees of the Council of U.S. Universities for Soil and Water Development in Arid and Sub-Humid Areas. These meetings and consultations are to plan joint research, training, consulting etc. activities. The major outputs for our joint efforts have been identified as:

1. Center for collecting, evaluating and dissemination of knowledge related to water delivery and removal systems in the LDCs
2. Education and training
3. Adaptive research
4. Consulting capability
5. Linkage and utilization

These outputs are interrelated and complementary. A seminar on water-soil-crop interaction if properly designed would have all outputs. It would build and utilize the information center (Output 1); serve as education and training for LDCs personnel (Output 2); disseminate the results of adaptive research or determine types of needed adaptive research; establish and sustain valuable linkages; and finally, maintain the institution consulting capability.

1. Center. Colorado State University will continue to maintain a center of competence in Water Resources for International Development and Food Production. The staff of specialists in all related fields will be maintained. These include irrigation engineering, agronomy, soils; food processing, handling and storage; water quality (salinity, sediment and biological), groundwater, drainage, natural resources, and development economics, hydrology, water resources systems and river mechanics.

The International School for Water Resources will be maintained. This is an interdisciplinary nondegree school for short or long term (two weeks to two years) training of LDCs people in all phases of water resources. From five to twenty-five people are in the school at any one time. They are sponsored by UN, FAO, LDCs, and private foundation. The school is self-supporting and utilizes the total competence of the University.

The current outstanding library on water resources will be sustained with acquisitions, cataloging and exchange capability maintained almost totally with university funds. Although some grant funds will be utilized for specialized book purchases or journal subscriptions. The reading room at the Engineering Research Center, which contains some rare works on Water Resources such as Emory Lane's collection of sedimentation, has been absorbed into the general library. This means that

the collections will be cataloged and maintained by general library appropriations.

2. Education and training. Education and training programs for LDCs technicians will be maintained and strengthened. Utilization of courses and programs already established by LDCs personnel will be emphasized. The International School of Water Resources, which was discussed in the previous section, will be maintained. This school is primarily utilized by LDCs technicians. Some have used the school as a springboard to a Master of Science degree. Practically all the students who attended the International School have returned home. Often these students have maintained contact with us for specialized help. Thus, a linkage is formed.

Short courses for LDCs and American personnel will be presented. Some of these courses will be developed in cooperation with the other 211(d) directors and will utilize personnel from the other universities. It is anticipated that specialized courses in Hydrology, Farm Management, River Mechanics, Water Resources Planning which were developed and presented in the past will be repeated. These courses were self-sustained. The problem is that the attendees are from the higher ranks of the bureaucracy in the LDCs. How much trickles down to the operating level is a question. In cooperation with an educational center in an LDCs short courses could be packaged and presented in an LDC.

Colorado State University has excellent facilities for taping courses and considerable experience through its SURGE, CO-TIE and other programs of preparing and sending courses all over the western United States. SURGE is an acronym for State University's Resources in Graduate Education by video tape. SURGE was started in 1967 and has 525 persons enrolled in the present quarter. Many of the persons getting an M.S. degree never attended a class on campus. Presently we have a contract with the University of Catania, Catania, Italy to develop a TV tape course in Water Resources Management and are taping our basic Hydrology course for use by the Asia Institute of Technology. These activities will be expanded and the resources made available to CUSUSWASH.

Manuals describing how to design or establish certain structures or practices will be written. These will probably be used in the short course but will be available for general distribution.

Some U.S. graduate students will be trained for service in the LDCs and where possible they will work on a research problem in an LDC. Seminars and workshops will be held in developing countries. A seminar dealing with water and soil management for erosion control is being scheduled for 1976. The water and the soil consortium will cooperate with AID in organizing and conducting this seminar.

Institution building services will be provided to universities and research centers in the form of taped lectures, visiting professors, training of their personnel, consulting services, etc. Examples are our contracts with the University of Peshawar in Pakistan, and the University of the Andes at Merida Venez.

3. Adaptive research. Emphasis will be on research that will solve problems in the LDCs and in adapting research results for utilization by the LDCs.

An international symposium was held at Park City, Utah, October 1973, on research needs for On-Farm Water Management. This symposium identified 13 principal areas of water management deficiencies. This was not a complete list but the Symposium felt it defines the principal areas of deficiency. These were:

1. Physiological responses of crops to environmental stresses;
2. Optimal crop productivity relationships of water and other inputs;
3. Methods for systematically transferring crop productivity functions geographically;
4. Improved on-farm systems, including drainage, and measuring and control structures;
5. Improved production systems and understanding of climatic variables for rainfed agriculture;
6. Improved prediction of quantity and quality of surface and subsurface water supplies and improved storage and distribution procedures for optimal on-farm water management;
7. Methodology to identify critical technological innovations or systems;
8. Improved "systems" to facilitate or deliver appropriate water management technology;
9. Farmer motivation;

10. Methods for involving farmers in the planning and management of water distribution systems;
11. Approaches to needed water rights legislation;
12. Prediction of economic consequences of alternatives; and
13. Techniques for predicting socio-economic problems.

These recommendations will be the focus of the adaptive research effort of the three universities with each emphasizing or concentrating on the areas of special competence. However, research projects at any member institute will involve and utilize special competence of the other universities. And wherever possible the special competency or facilities in the LDCs. An example of the latter is our joint project with West Pakistan Water and Power Authority to determine the water and sediment transport capacity of the Link Canals. This research will provide a reference document for the design of Irrigation Canals in any part of the world.

An important part of the program will be the development of State-of-the-Art documents on water removal and delivery system.. Emphasis will be on State-of-the-Art documents of practices in the LDCs. These will emphasize, wherever possible, the reasons for these practices in the LDCs. We should not recommend changes unless we are sure they will achieve the designed ends and will not upset some unknown ecological balance.

4. Consulting capability. Colorado State University has responded to many requests by LDCs, UN, AID, CUSUSWASH, World Bank and others for technical assistance. These have ranged from the request of a single scientist to survey a special problem in the LDCs such as the building of a dam in Pakistan, degradation of the Nile resulting from Aswan Dam, seepage problem in the irrigation systems of Egypt, or furnishing a member or members of survey teams. We feel a moral obligation to respond to requests from CUSUSWASH and AID. But in any case we try, both as individual professors and as an Institution, to respond to requests for technical assistance.

Working with CUSUSWASH the University has provided experts for several teams of professionals to serve as advisors. The "Basic Ordering Agreement" AID/csd-3703 has enabled the consortium and CSU to respond rapidly with a minimum of red tape. Through this ordering

agreement it is possible for AID to obtain specialists in agronomy, irrigation, irrigation law, civil engineering, economics, soils, meteorology, food processing and storage, nutrition, ecology, watershed science, forestry, etc. Other users have access to this expertise and do utilize it.

The 211(d) grant will be utilized to maintain and strengthen our consulting capability in the field of land and water utilization for agriculture.

5. Linkage and utilization. Colorado State University proposes to strengthen the linkages with the CUSUSWASH Universities, AID, LDCs institutions, FAO, International centers such as CIAT, CIMMYT, and ITTA, the Soils Consortium Foundations, Development Banks and other donors. Through these linkages there will be a network established for information exchange and dissemination. Provisions will be made for exchange of students, staff research and publications.

The 211(d) grant will be used by the directors to establish a network of institutions working on water and soil problems in the LDCs.

C. Specific Objective/Outputs for the 6th Year

In the following paragraphs specific objective/outputs and targets are delineated for the coming year. These specifics are related to supplementary Tables I and II A.

1. Center for collection, evaluating and dissemination of knowledge

Addition will be made to the library on water delivery and removal systems.

A manual will be written on the State-of-the-Art of the design of unlined canals.

An International Symposium on Global Water Law Systems is planned for July or August 1975 to be held in Spain. This is a joint 211(d) effort of CSU, AU and USU. The results of this conference will be a reference document on the water laws as they exist in the LDCs. Linkages will be established with this symposium.

A State-of-the-Art training manual on Fluvial Mechanics and Sedimentation with emphasis on resistance to flow and sediment transport in sand bed channels and streams.

2. Education and training

A short course on watershed management is being planned in cooperation with Arizona University (AU), Utah State University (USU) and the National Center of Arid Land Investigation (CNIZA) Mexico. The course will be put on as a pilot test at Saltillo, Mexico. It is planned to make the course available to other LDCs such as Pakistan and Peru.

An International Seminar on Soil Erosion in Arid, Semiarid and Sub-Humid Tropics is planned in cooperation with The Soils Consortium, CUSUSWASH and the 211(d) directors at AU and USU.

Three or four American graduate students will be supported on adaptive research on water problems. Part of their support will be to further their interest and desire to work in the LDCs in water delivery and removal problems.

3. Adaptive research

Development and improvement of methods to reduce seepage from earthen channels. Research will be conducted on the design of impervious low cost sealing of canals. Presently an M.S. student is studying the design of side slopes for the installation of plastic liners.

Overall planning of water delivery systems with emphasis on optimizing of water delivery for crop production considering water storage, quality and groundwater.

A mathematical model will be developed for determining the movement and exchange of water between groundwater and surface water.

Research into the State-of-the-Art on saline water control and conjunctive use of ground and surface water to facilitate drainage and increase available water supply.

An M.S. study on the design of sediment excluders and ejectors for the control sediment input into canals and to the farm.

Development of a mathematical model to route water and sediment through a canal or river.

A State-of-the-Art report on water delivery and removal systems in the LDCs. One of the reports will be on Thailand and another on Pakistan.

4. Consulting capacity

One faculty member in the field of Irrigation Engineering with emphasis on saline water problems will be added to the Agricultural Engineering Department.

Work with the Director of CUSUSWASH to answer requests for specific consultants by AID and other donors.

5. Linkage and utilization

A survey trip will be made by Dr. E.V. Richardson, CSU 211(d) director, Dr. David Thorude AU 211(d) director and Dr. Howard Peterson, USU 211(d) director to several of the LDCs. These will be either in Asia, Latin America or Africa. The purpose of the trip will be to establish a network of institutions working on problems of water utilization in agriculture, to develop linkages with scientists and officials working in the LDCs to determine the specific problems that the LDCs have with regard to Water Utilization, and to inform AID officials, LDCs officials, etc. on the capabilities that exist at the three institutions.

Continued effort will be made to make the present linkages more meaningful. This will be accomplished by exchange of staff and reports with other centers that are working with LDCs and with LDCs institutions. Faculty members will be urged to take a more active interest in the problems that their counterparts in the LDCs are encountering.

VIII. INVOLVEMENT OF MINORITY PERSONNEL AND WOMEN

In adding faculty and graduate students to the University, a conscious effort has been made to add minorities and women. We have been more successful with students than faculty because there are so few technically trained minorities and women. Unfortunately, it has been difficult to convince minorities and women that there are opportunities in a technical career.

The College of Engineering sends out faculty to area high schools with predominantly minority students (Blacks and Chicanos). Several of these schools are in the Denver area. We have a summer intern program for Blacks. These programs have not been attracting a significant increase in minorities. We think, however, that in time this will change.

We have increased the number of women enrolled in engineering with a significant increase in freshman women engineering students. Also, we expect to graduate two women with Ph.D. degrees next year (1974-75) in Water Management. They were partially supported by the 211(d) grant.

The following U.S. minorities have been involved in the program.

	<u>Faculty</u>	<u>Graduate Students</u>
Women	1	2
Blacks		
Spanish Americans	1	
American Orientals	4	2

TABLES

The following tables show the distribution of grant funds from the beginning of the Grant through the fifth year.

Table I reports the estimated expenditures used to support each of the objectives in the Grant for the reporting period and the cumulative period of time. These amounts reflect the funds distributed over the past five years to the six departments who contributed to the grant objectives.

Table II A states the expenditures under the grant according to line items for each of the five years as well as the cumulative total.

Table II B shows a detailed breakdown of the expenditures during this reporting period.

Table III A and Table III B state the requests for assistance received by CSU during this reporting period. CSU was able to fill all but one request received for the past year.

Table I
 Distribution of 211(d) Grant Funds and Contributions From Other Sources of Funding*
 Reporting Period 23 May 1973 to 22 May 1974

Grant Objectives/Outputs	211(d) Expenditures			Non 211(d) Funding** Amount
	Period Under Review	Cumulative Total	Projected Next Year ^{1/}	
1. Expand professional staff	28,289	236,693		
2. Expand graduate students	30,139	214,323		
3. Expand research programs	26,148	38,572		
4. Course offerings	1,116	47,778		
5. Expand special activities	12,698	44,381		
6. Help to alleviate critical shortages of qualified professional personnel	4,857	42,095		\$1,750,000
7. Advisory and consulting	5,827	41,324		
8. Improve understanding of the nature of the LDCs	16,270	43,136		
9. Develop an exchange and open lines of communication	9,680	42,093		
TOTAL	\$135,024	\$750,395	\$99,605	\$850,000

* These figures are your best estimates

** Include other AID projects if relevant

^{1/}Given in supplementary Table I

Table II A^{1/}
 211(d) Expenditure Report
 Actual and Projected Summary
 Under Institutional Grant AID/csd-2460
 Reporting Period 23 May 1973 to 22 May 1974

	Expenditures to date		Projected Expenditures			
	Reporting Period 5	Cumulative Total	Y E A R			
			1	2	3	4
	1973-74		1969-70	1970-71	1971-72	1972-73
Salaries	66,506	339,713	55,460	53,587	84,594	79,566
GRA	29,374	200,516	21,977	37,044	59,695	52,426
Travel	3,334	56,575	4,351	19,470	13,188	16,232
Equipment	-	3,427	213	3,118	-	96
Office Expense and Computer	30,292	124,262	13,132	19,291	28,082	33,465
Library and Publications	5,518	25,902	6,077	1,188	9,515	3,604
Total	\$135,024	\$750,395	101,210	133,698	195,074	185,389

^{1/} See Table V (Supplementary Table II A) for additional details related to next years funding.

Table II B
211(d) Expenditure Report
Reporting Year Detail
Under Institutional Grant AID/csd-2460
Reporting Period 23 May 1973 to 22 May 1974

A. Salaries	% of Time	Salary	
A.C. Early	35%	\$ 5,787	
W.E. Hart	8%	1,778	
G.V. Skogerboe	8%	2,000	
W.R. Walker	8%	1,400	
J. Reuss	8%	1,508	
M.T. Chaudhry	42%	5,358	
J. Labadie	17%	2,889	
K. Mahmood	8%	1,611	
W. Shaner	17%	4,378	
G. Smith	8%	1,633	
H.H. Biggs	8%	1,467	
G.E. Radosevich	8%	1,622	
R. Tinnermeier	8%	1,768	
H. Caulfield	17%	4,933	
E. Vlachos	25%	5,567	
M.L. Albertson	33%	11,654	
			55,353
B. Other			
Library - T. Coffelt	25%	1,491	
*Clerical		11,371	
Other Non-Professional			
B.F. Frantz	33%		
M.E. Becker	8%		
M. Cook	25%	8,691	21,553
C. Fringe Benefits - 9.5% of Gross Salary- Retirement Only			
Faculty-Clerical-Non-Professional		7,010	7,010

*Includes clerical support for six departments. The percentage of time on clerical varies from 8% to 37.5%. This amount covers 12 clerical workers.

II.	Student Support	Country	Amount	
	Q.A. Khan	Pakistan	1,750	
	S.W. Smith	USA	2,375	
	J.H. Dane	Netherlands	4,703	
	G. Ahmad	Pakistan	600	
	H.G. Blank	USA	3,200	
	A. Tamburi	USA	2,150	
	J. Subramaniam	India	2,675	
	W.A. Lemma	Ethopia	2,800	
	H. Mbele-Mbong	USA	975	
	A. Nazar	Afghanistan	2,275	
	C. Doswell	USA	688	
	F. Deseran	USA	2,925	
	B. Wharton	USA	780	27,986
III.	A. Consultants		-0-	
	B. Five (5) Guest Lecturers		1,116	1,116
IV.	Travel			
	A. Domestic (19)		1,236	
	B. Foreign (1)		1,882	3,118
V.	Equipment		-0-	-0-
VI.	Library Acquisitions			
	Thesis & Dissertations		2,692	
	Small Form & Mailing		2,826	5,518
VIII.	Other			
	Telephone)			
	Postage)		13,460	13,460
	Computer)			
	Miscellaneous)			
		Total		<u>\$ 135,024</u>

The detailed line items requested by AID for this breakdown does not correspond with the line items established by CSU. Therefore, the line item totals will not always agree with the line item totals on Table II-A.

Table III A

Requests for Assistance Received During Reporting Period 23 May 1973 to 22 May 1974

A. Requests Attended

Description of Request for Assistance	Whom did you Assist?	Who Requested Assistance	Who Funded Assistance	Size of Effort		Results and Assistance
				Dollars *	Man Mons.	
To develop soils science and related research as an integral part of environmental research effort.	Environmental Protection Agency	EPA	EPA	N.A.	12MM	Tour not completed
Study of resources in water, soil, and space management in labor-intensive farming systems.	Farmers	NSF & Foreign Area Fellowship	NSF CSU FAF	\$16,000	9MM	
To study water law and water law administration as it effects the economy	governments, U.S. foreign assistance & farmers	United Nations	UN	\$30,000	12MM	Developed an international conference on Global Water Law Systems.
To study Pakistan water laws and water law administration	governments, U.S. Foreign assistance & farmers	USAID	AID/W USAID	\$ 3,300	2MM	Report and guidance to USAID on Pakistan water laws and developed Conference on Global Water Laws
To study land tenure, small farm development and taxation	Small Farmer	USDA & Fed. Extension Service	USDA & Fed. Extension Service	\$30,000	24MM	Not completed
To work with small farmer development	Small Farmer	MOA-Paraguay	AID/W	\$ 1,766	1MM	A report to assist in eliminating the lack of credit as a major constraint to small farmers

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*Approximate Figures

Description of Request for Assistance	Whom did you Assist?	Who Requested Assistance	Who Funded Assistance	Size of Effort		Why not Met?
				Dollars *	Man Mons.	
Relative success of universities with 211(d) programs in developing staff capabilities	AID	AID/W	CSU	\$ 1,000	3 days	Report to AID/W on staff capabilities
Participate as an Asian Development expert	AID	AID/W	CSU	\$ 1,000	3 days	Information to AID/W on Asia development
Two week short course on irrigation structures, flow measurement and salinity control	GOP & USAID	USAID	AID/W and USAID	\$ 4,000	1MM	Recommendation for improvements to Pakistan irrigation system
To work with CSU field staff in Pakistan on On-Farm Water Management	GOP & USAID	USAID	AID/W and USAID	\$44,500	24MM	Tour not completed
To work on water courses and land leveling	GOP & USAID	USAID	AID/W and USAID	\$ 5,800	2MM	Assistance to GOP & USAID in water courses and land leveling problems
To serve as CSU Chief-of-Party for On-Farm Water Management Research	GOP & USAID	USAID	AID/W and USAID	\$85,000	24MM	Tour not completed
Presentation of papers which consolidate technical and sociological considerations in irrigation water	ASCE, Rural Sociological Society, AWRA	ASCE-RSS AWRA	ASCE-RSS AWRA CSU	\$ 2,200	1MM	Broaden the scope of technical and sociological problems as they relate to water resources development
Assist the Government of Afghanistan in Water Legislation and Administration	Government of Afghanistan USAID	USAID	AID & USAID	\$ 2,500	1/2MM	Recommendations to USAID & GOA on water administration and legislation

*Approximate Figure

Table III B

Requests for Assistance Received During Reporting Period 23 May 1973 to 22 May 1974

B. Requests Not Fulfilled

Description of Request for Assistance	Whom did you Assist?	Who Requested Assistance	Who Funded Assistance	Size of Effort		Why not Met?
				Dollars *	Man Mons.	
Evaluation Team for water development in Afghanistan	--	USAID	--	--	--	Time and work load would not permit

Table IV--Supplementary Table I
 Distribution of 211(d) Grant Funds and Contributions From Other Sources of Funding*
 Reporting Period 23 May 1973 to 22 May 1974

Grant Objectives/Outputs	211(d) Expenditures			Non 211(d) Funding** Amount
	Period Under Review	Cumulative Total	Projected Next Year	
1. Center for collecting, evaluating and dissemi- nation of knowledge	20,274	112,770	24,000	136,770
2. Education and training	24,116	139,025	17,605	156,630
3. Adaptive Research	29,000	166,167	38,000	204,167
4. Consulting Capacity	48,954	282,063	7,000	289,063
5. Linkage and Utilizing	12,680	50,370	13,000	63,370
Total	135,024	750,395	99,605	850,000

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TOTAL

* These figures are your best estimates
 **Include other AID projects if relevant

Table V--Supplementary Table II A
 211(d) Expenditure Report
 Actual and Projected Summary
 Under Institutional Grant #AID/csd-2460
 Reporting Period 23 May 1973 to 22 May 1974

	Expenditures to Date		Projected Expenditures				Total
	Reporting Period	Cumula- tive Total	Y E A R				
			1	2	3	4	
	1973-74		1974-75				
1. Salaries ^{1/}	66,506	339,713	59,605				399,318
2. Student Stipends	29,374	200,516	15,000				215,516
3. Library	5,518	25,902	1,200				27,102
4. Research			8,000				8,000
5. Travel	3,334	56,575	5,000				61,575
6. Equipment	0	3,427	0				3,427
7. Publications	<u>2/</u>	<u>2/</u>	500				500
8. Other Direct Costs							
Officer Expenses	30,292	124,262	300				124,562
CUSUSWASH			10,000				10,000
Total	135,024	750,395	99,605				850,000

^{1/}Includes fringe benefits which ranged from 9.5% at the first contract year to 10.64 last contract year.

^{2/}Publication costs are included in Item 3 Library.

APPENDIXES

Appendix A

New Courses

Improved Courses

Appendix A

New Courses

NEW COURSES

One of the primary objectives of the 211(d) grant has been to improve our existing course offerings and to develop new ones which are related to water delivery and removal systems. To this end, 18 courses have been upgraded and improved and 11 new ones have been added by new faculty and by existing faculty whose competence has been improved as a result of the 211(d) grant.

The new courses include:

1. Irrigation Structures - with special emphasis on water delivery and removal structures
2. Farm Irrigation Systems - including international considerations
3. Water Resources Systems - which looks at the total water delivery and removal system and its relationship to specific uses such as irrigation
4. Institutions and Economic Development - which includes water resources institutions
5. Economic Analysis and Water Resource Development - which studies the economic interrelationship of the various aspects of water resource development, including delivery and removal systems
6. Geography of Native Farming Systems - which include various irrigation systems and the problems of water delivery and removal
7. Irrigation Practices in Developing Countries - which includes the way that water is delivered, applied and removed at present, and how this could be improved
8. Interdisciplinary Seminar in Water Resources Management - which is a credit course and involves students and faculty from five different colleges studying new concepts, research, existing projects, and projects which are now being planned or built
9. Planning Engineering Projects in Developing Countries - which applies benefit-cost techniques to water resource project analysis in the setting of the developing countries
10. Open Channel Flow for Non-Engineers - a course to teach non-engineers (economists, geologists, agronomists) the basic concepts of open channel flow. The course is descriptive, non-mathematical and a need-to-know informative type
11. Institutions & Economic Development - Social, political, and economic institutions as inhibitors or promoters of economic development, using Latin America as a case study.

Improved Courses

1. International Economics - Theory of international trade; payments, commercial policies, and economic integration.
2. International Economics - Balance of payments, adjustment mechanisms, and international monetary systems.
3. Economic Development - Economic problems of underdeveloped nations; analysis of key determinants of poverty or affluence; policy considerations for mobilizing resources to achieve higher levels of well-being.
4. Economic Development of Latin America - Economic and noneconomic factors influencing structures of Latin American economics; analysis of economic issues of the region: inflation, land reform, regional integration, international payments, the role of government, foreign capital.
5. Economic Development of the Far East - Selected Far East economies, emphasizing rates of growth, changing production structures, demand structures, and trade patterns.
6. Engineering for the Soil-Water Environment - Rainfall runoff, soil water movement, evapotranspiration, soil erosion, water conservation, water conveyance, irrigation and drainage.
7. Irrigation Structures - Application of fluid mechanics to problems involving water conveyance in irrigation distribution systems. Structures include canals, pipe lines, turnouts, debris and sediment removal, culverts, energy dissipators, transitions, checks and drops, field inlets, prefabricated structures and automatic water control structures.
8. Soil Conservation in Land Planning - Land capability classification and factors affecting erosion. Emphasis on soil and water conservation measures, land use management systems, and multi-purpose land use planning.
9. Dryland Soil Management - Soils, crops, and cultural practices best suited for crop production under conditions of limited rainfall, emphasizing soil and water management and erosion control.
10. Irrigation Practice - Irrigation methods, water supply and quality, irrigation water measurement, soil moisture measurement, and irrigation practices for crop plants, emphasizing soil-moisture-plant relationships.
11. Soil Physics - The physical properties of soils and their management for development and maintenance of tilth, emphasizing mechanical composition moisture, aeration, temperature, and structure as related to plant growth.
12. Soil and Water Conservation - Land classification as a basis for soil and water conservation, emphasizing those major soil and water conservation practices recommended for irrigated and nonirrigated lands.

13. Saline and Sodic Soils - Origins, properties, diagnosis, reclamation, and management of saline and sodic soils; irrigation water quality in relation to soil salinity, absorbed ions, and quality of return flow.
14. Water Resources Planning - Procedures for planning; guidelines for investigations; standards for detail and quality of basic information; procedures and criteria to be followed in forming and appraising the plans.
15. Water Resource Systems Analysis - Case studies in the application of systems analysis to water resources and related problems.
16. Groundwater Systems - Characteristics of complex combined groundwater-surface water systems; deterministic and stochastic inputs and responses; error and sensitivity analyses; application of optimization techniques.
17. Flood Control - Design flood analysis, flood routing in channels and reservoirs, structural and non structural flood control methods, economics of flood control, socio-political response of floods and flood control.
18. Water Systems Engineering - Systems analysis of water utilization systems. Planning, design, and management of sub-systems, case studies of large scale systems, sociopolitical and economic factors.
19. Erosion and Sedimentation Problems - The nature of water-borne sediment and its effect upon streams, canals, reservoirs, and structures.
20. Modern Foreign Governments - Basic principles of major foreign political systems stressing cross-national comprehension of political forces, parties, ideologies, and institutions.
21. International Organization - History, development and structure of selected international organizations, emphasizing the United Nations.
22. Public Administration - Organization and management of governmental bureaucracies; continuing and current problems of control, accountability, personnel, and finance.
23. Government and Politics of the Far East - Political background and governmental systems of major Far Eastern powers, China, Japan, India.
24. International Law - Origins, nature, functions and limits of international law and international judiciary.
25. Politics of Development and Nation Building - Search for national identity; role of political parties, political elites, military, significance of ideology, and impact of world affairs on domestic policies.
26. Advanced Studies in International Relations - Theoretical and practical aspects of International Relations focusing on one or more special problems.

27. Politics and Policy in Natural Resources Administration - The politics of natural resources policy formation and administration.
28. Politics and Policy in Water Resources Planning and Management - The politics of legislative and administrative policy development in water and related land resources planning and management-federal, federal-state, state, and local.
29. Management of Urban and Agricultural Water: National and International - Urban and agricultural water systems, in comparative international perspectives, including water uses, relationships of urban systems, to hinterland systems, conflicts and problems, management alternatives for solving standards, integrating water uses and services, and achieving social goals.
30. Seminar on the Family - Cross-cultural review of the family's role on societal change; internal organization of the family and linkages to other community institutions.

Appendix B

New Water Resources Contracts

FY '73-'74 and FY '72-'73

New Water Resources Contracts

FY '73-'74

Micro.	Water Quality Study S. Morrison	Eastman Kodak	thru 2/28/74	\$24,948
Chemistry & Ag. Engr.	Water Quality Control in Mine Soils (Upper Colo. River Basin) R.K. Skogerboe & D.B. McWhorter	EPA	6/62/73 6/24/74 +	\$21,777 \$27,297
Environ. Res. Ctr.	OWRR Allotment Program N. Evans	OWRR	7/1/73 6/30/74	\$100,000
C.E.	Evaluation of Benefits & Costs of Multi-Jurisdictional Urban Drainage Projects N. Grigg	OWRR	7/1/73 6/30/74	\$24,000
C.E.	Expanded Soil & Water Investigation - Phase II K. Brengle	Four Corners Reg. Comm	4/2/73 4/1/74	\$ 5,200
C.E.	Systemic Design of Legal Regulations for Optimal Surface Groundwater Usage H.J. Morel-Seytoux	OWRR	7/1/73 6/30/75	\$26,460
Environ. Res. Ctr.	Evaluation of Antitranspirants Increasing Runoff in Colo. Watersheds F. Kreith	OWRR	7/1/73 6/30/75	\$30,000
Pol. Sci.	Impact of Urbanization on Front	ERS	thru	\$ 2,000
Pol. Sci.	Impact of Urbanization on Front Irrigated Area N. Wengert	ERS	thru 12/31/74	\$ 2,000
C.E.	Water Rights Tabulation Update R. Longenbaugh	State of Colo.	7/1/73 6/30/74	\$12,000
C.E.	Water Data Bank Study R. Longenbaugh	State of Colo.	7/1/73 6/30/74	\$104,000
Environ. Res. Ctr.	Development of Colorado River Regional Framework for Water Resources N. Evans	OWRR	4/1/73 3/31/75	\$23,500
Micro- Bio.	Training Grant - Water Quality	EPA	9/1/73 8/31/74	\$61,944
Econ.	Systematic Design of Legal Regulations for Optimal Surface Groundwater Usage, Phase II G. Radosevich	OWRR	7/1/73 6/30/75	\$17,540
Ag. Eng.	Irrigation Practices, Return Flow Salinity & Crops Yields, Phase	EOA	12/1/73	\$75,945 \$11,374

C.E.	Stochastic Processes in Water V. Yevjevich	NSF	thru 9/30/74	\$93,300
Econ.	Agricultural Production Response K. Nobe	ERS	thru	\$ 3,200
Recreation	Feasibility and Potential of Enhancing Water Recreation Opportunities on High Country Reservoirs R. Aukerman	OWRR	7/1/73 12/31/74	\$30,000
Ag. Eng.	Grand Valley Salinity Project G.V. Skogerboe	EPA	thru 3/31/74	\$ 4,200
For. &	Little South Watershed E. Mogren & J. Meiman	Univ. of Wash.	1/1/74 6/30/75	\$ 5,053
Ag. Eng.	Implementation of Agricultural Salinity Control Technology in Grand Valley G.V. Skogerboe	EPA	2/18/74 2/17/75	\$154,780
C.E.	Highways in the River Environment E.V. Richardson	U.S. Dept. Transp.	--- 6/30/74	\$23,680
C.E.	Research Needs as Related to Development of Sediment Standards in Rivers J. Gessler	OWRR	3/15/74 6/30/75	\$ 5,000
Ext. Serv.	Paraguay Project R. Tinnermeier	USDA Coop. Ext. Ser.	11/29/73 12/22/73	\$ 1,990
Ext. Serv.	Small Farm Management Pilot Project C. Herzman	Four Cor. Reg. Comm.	11/1/73 10/31/74	\$12,880
Micro.	Water Quality Study S. Morrison	Eastman Kodak	thru 2/28/75	\$31,356
Econ.	Economic Impacts of Salinity Control Measures, Colo. River Basin R. Young	Utah St. Univ.	7/1/73 6/30/75	\$13,049
Ag. Engr.	Water Resources Management D. Kemper	AID	4/1/74 3/31/75	\$565,712
C.E.	Study of Alluvial River Mechanics with Full-Scale Verification on the Link Canals of Pakistan A.G. Mercer & K. Mahmood	NSF	4/1/74 3/31/75	\$69,300
Chem.	Surface & Subsurface Water Quality Hydrology in Mine Spoils R.K. Skogerboe	EPA	5/21/74	\$25,824
Rec. Res.	Water Quality in Wild Lands R. Aukerman	Rocky Mtn. States	6/15/74	\$10,000

B-3

C.E.	Optimum Utilization of Water Resources E.V. Richardson	AID	5/23/74 5/22/75	\$100,000
Ag. Engr.	Surface & Subsurface Water Quality Hydrology in Mine Spoils D.B. McWhorter	EPA	5/21/74	\$50,188
Ag. Engr.	Transport of Salts in Irrigation Flow	OWRR	7/1/74 6/30/75	\$10,000
Ag. Engr.	Technical Services	AID	7/15/73 9/15/73	\$ 2,500
Ag. Engr.	Land Management of Subsurface Liquid Residuals	NSF	3/1/74 2/28/75	\$51,000
Ag. Engr.	Systematic Procedure for Taxing Agricultural Pollution Sources	NSF	4/1/74 9/30/75	\$17,000
Ag. Engr.	Recycle and Utilization and Livestock Manure through Subsurface Injection	EPA	1/20/74 1/20/75	\$40,323

New Water Resources Contracts

FY '72-'73

Vet. Med. & Bio. Sc.	Water Quality Microbiology & Engineering Training Grant S. Morrison	EPA	Thru 8/31/72	\$13,251
C.E.	Int'l Conference - Water Resources Knowledge E.V. Richardson	AID	6/27/73 6/30/73	\$21,645
C.E.	Stochastic Analysis of Sediment Bed Transport H. Shen and P. Todorovic	NSF	9/15/72 9/14/73	\$36,700
C.E.	Water Rights Tabulation Update R. Longenbaugh	St of Colo. Nat. Res.	8/11/71	\$21,300
Environ. Res. Ctr.	OWRR Allotment Projects N. Evans	OWRR	7/1/72 6/30/73	\$100,000
Econ.	Systems of Management for Optimum Water Utilization R. Tinnermeier	Bur. Rec.	7/1/72 6/30/63	\$ 3,000
Pol. Sci.	Development of Techniques for Estimating Potential Water Resources Development H.P. Caulfield	USU	10/1/72 12/31/73	\$20,880
C.E.	Flow Tests J.P. Tullis	Patterson- Ludlow	to close	\$ 1,313
C.E.	Determination of Urban Water- shed Response Time E. Schulz	Army Corp Engr	10/1/72 9/30/73	\$ 9,940
Agron.	System of Management for Optimal Water Utilization K. Brengle & H. Moore	Bur Recl.	7/1/72 6/30/73	\$18,812
Agr. Engr.	System of Management for Optimal Water Utilization W.E. Hart	Bur Recl.	7/1/72 6/30/73	\$ 9,187
Agr. Engr.	Irrigation Practices, Return Flow Salinity & Crop Yields G.V. Skogerboe	EPA	10/11/72 10/11/73	\$146,476
Micro,	Water Quality Microbiology S. Morrison	EPA	9/1/72 8/31/73	\$65,958
Soc.	Consolidation of Irrigation Systems Phase II E. Vlachos	OWRR	7/1/72 6/30/73	\$25,880

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Econ.	Consolidation of Irrigation Systems Phase II G. Radosevich & P. Huszar	OWRR	7/1/72 6/30/73	\$30,390
C.E.	Water Data Bank Establishment R. Longenbaugh	State of Colo.	8/1/72 6/30/73	\$85,050
C.E.	Environmental Impact of Mississippi River Channel D.B. Simons	Dept of Army Watrwys Exp Stat (ADD)	10/17/72 12/16/72 6/8/73	\$ 8,000 \$19,000
C.E.	Systematic Design & Legal Regulations for Optimal Surface-Groundwater Usage H.J. Morel-Seytoux	OWRR	7/1/72 6/30/73	\$16,550
Ag. Engr.	Consolidation of Irrigation Systems Phase II G.V. Skogerboe	OWRR	7/1/72 6/30/73	\$12,000
Ag. Engr.	Grand Valley Salinity Project G.V. Skogerboe	EPA	thru 1/31/74	\$ 8,493
C.E.	Stochastic Processes in Water Resources V. Yevjevich	NSF	11/15/72 11/14/74	\$90,300
Pol. Sc.	Impact of Urbanization on Front Range Irrigated Area N. Wengert	ERS	12/19/72 6/30/73	\$ 2,000
Ag. Engr.	Irrigation Return Flow Quality Literature Abstracting G.V. Skogerboe	EPA	2/1/73 1/31/74	\$29,216
C.E.	Investigation of Water Resources in Karst Region V. Yevjevich	NSF	thru 12/31/73	\$39,600
C.E.	Metro Water Intelligence Systems Phase III M.L. Albertson, G. Smith, N. Grigg	OWRR	4/1/73 3/31/74	\$100,000
C.E.	Fluxes of Heat, Momentum and Tracers in Wind & Water Tunnels J. Gessler	AEC	thru 8/31/73 +	\$ 7,500 \$16,500
Ag. Engr.	Irrigation Return Flow G.V. Skogerboe	EPA		\$ 764
C.E.	Tarbella Dam Project S. Karaki	TAMS		\$ 1,820
C.E.	Study of Downwash from Stacks at the Mani Electric Co. Power Plant J. Cermak	Stearns-Rogers	11/14/73 5/31/73	\$ 8,200
C.E.	International School for Water Resources Environmental Management D.B. Simons	Various		\$12,870

ERC	Self Contained Sediment Flume E.V. Richardson & R. Asmus	Commonwelath of PA	4/12/73 4/11/74	\$82,124
C.E.	Water Management Research M.L. Albertson	AID	3/28/73 3/31/74	\$481,000
Envrion. Res. Ctr.	Comprehensive Research Program for South Plains River Basin N. Evans	Texas A&M	5/1/73 2/38/75	\$ 2,000
C.E.	Highway River Environment-- Hydraulic & Environmental Design Considerations E.V. Richardson	US Dept of Transp.	6/22/73 2/21/74	\$17,020

Appendix C
Faculty Recruitment

Appendix C

Faculty Recruitment

Huntley H. Biggs has joined the faculty. His major interest areas include theories of economic development, planning and policies for economic development. He has competency in Spanish and Portuguese. He completed his Ph.D. in economics at Vanderbilt University.

Henry P. Caulfield, Jr. was added to the staff to give additional strength in the area of economics and government. He has had extensive experience in the areas of political economics, political theory, economic theory, constitutional law, and industrial organization and control. Dr. Caulfield studied at Oxford University in 1948 and did additional work at Harvard in 1950. He has had extensive experience relative to water resources development and has served as Executive Director, U. S. Water Resources Council.

Wayne Clyma is a new faculty member in the Department of Agricultural Engineering. He obtained his degrees from Oklahoma State University and the University of Arizona. He has had experience with the USDA, Agricultural Research Service and universities. He is presently on the water management team in Pakistan.

Alan C. Early is a new faculty member in the Department of Agricultural Engineering. He is a graduate of Cornell University, with primary interests in soil and water management, water resources and aerial photographic studies.

Neil S. Grigg was added to provide additional strength in the field of water management, hydraulics, hydrology, water systems optimization and applied mathematics with special emphasis on water delivery and removal systems. He conducted his academic work at the U. S. Military Academy, Auburn University and Colorado State University. Dr. Grigg has been very active in areas of research dealing with water intelligence systems and optimum development of water resources systems.

Warren A. Hall constitutes a very fortunate choice to join CSU as a member of the faculty in Civil Engineering. He completed his university education at the California Institute of Technology and at the University of California. Dr. Hall pioneered the field of water resources systems in the United States with special emphasis on water

delivery. He is currently Director of the Office of Water Resources Research in Washington, D.C., on leave from the Civil Engineering faculty at Colorado State University. He returns to CSU in January 1975. Even though Dr. Hall is not on campus he works very closely with CSU staff and students in water resources, irrigation, dry land agriculture and related fields. Dr. Hall is judged to be one of the outstanding scientists in his field in the United States. In fact, because of his competence, Colorado State University has set up a chair titled the Elwood Mead Professorship and Dr. Hall has been assigned to this important position.

Judson M. Harper is another important addition to our faculty. He is Head, Department of Agricultural Engineering. He completed his university training at Iowa State University, taking all three degrees, B.S., M.S., and Ph.D. there. Dr. Harper's principal areas of interest deal with food technology and he has strong interests in the areas of irrigation, drainage, salinity control and solid waste management.

William E. Hart is a new faculty member in Agricultural Engineering. He completed his B.S., M.S., and Ph.D. degrees at the University of California. Areas of research activity are in theory and design of field irrigation systems, hydrology, hydraulics, irrigation engineering and related fields.

William D. Kemper has been added as a new faculty member, jointly in the Department of Agronomy and Department of Agricultural Engineering. Dr. Kemper completed his Ph.D. degree work at North Carolina State University in soil physics. He presently is the project leader for the CSU water management project funded by AID/W. He adds considerable strength and capability to engineering in the fields of soils, soil chemistry, soil physics and water management to increase crop yields. He has considerable experience in these fields with the Agricultural Research Service prior to joining Colorado State University.

John W. Labadie is a new faculty member in the Department of Civil Engineering. He completed his B.S., M.S. and Ph.D. degrees in the University of California system. His major areas of interest are water resources systems, operations research, environmental dynamics. He has been active in dry lands research. He also has been very interested in developing techniques for capturing, editing, updating and retrieving data from all types of systems studies.

Robert A. Longenbaugh has been a member of the faculty at Colorado State University for several years. However, the 211(d) grant made it possible for us to encourage Professor Longenbaugh to work toward completion of his Ph.D. degree at the University of California. His major areas of expertise are in groundwater theory, water resources systems and mathematical simulations for management of water.

Khalid Mahmood is a new faculty member in Civil Engineering. He was born in Pakistan, completed his Bachelor's degree there, his Master's degree at the University of Washington and his Ph.D. degree at Colorado State University. He has had extensive experience with irrigation systems in Pakistan. He was intimately involved in the development of the Link Canal and the irrigation projects developed under this irrigation system. He is highly competent in the fields of erosion and sedimentation, water sediment routing through irrigation systems, hydrology and hydraulics.

David B. McWhorter is a member of the Agricultural Engineering faculty. He obtained his B.S. degree from the Colorado School of Mines and the M.S. degree and Ph.D. degree from Colorado State University. His areas of interest are groundwater and porous media. He is working in the water resources management field; coordinating work at the University with work in the field.

George E. Radosevich has been added as a new faculty member in the Department of Economics. He has B.A. and J.D. degrees in law from the University of Wyoming. His major field of interest is natural resources law. He is very much interested in international water law. The acquisition of Dr. Radosevich has greatly enhanced the University's overall capability to inject the very important aspects of water law into all aspects of water resources development.

Willis W. Shaner is a new faculty member in the Department of Mechanical Engineering. He obtained his B.S. degree from Iowa State University, his M.B.A. from the Graduate School of Business, Harvard University, and his Ph.D. in Engineering-Economic Planning (Specializing in the problems of the developing countries) from Stanford University.

Morris M. Skinner is an assistant professor in the Department of Civil Engineering. The 211(d) funds have enabled us to free some of Dr. Skinner's time so that he could complete his Ph.D. degree. His professional experience includes work on open-channel flow, sediment

sealing of canals to reduce seepage loss, hydraulic investigations, and currently he is working very vigorously in the area of application of remote sensing to water resources development.

Ronald L. Tinnermeier has been added to the Department of Economics. He has his Ph.D. degree in Agricultural Economics from the University of Wisconsin. His research has related to land agrarian reform in Columbia. He is presently very active in research dealing with water management as it is related to farm management and production economics.

Evan Vlachos is a new faculty member in the Department of Sociology and Anthropology. He received his LLB degree at the University of Athens, his M.A. degree from Indiana University and a Certificate of Russian Studies from the Russian and East European Institute at Indiana University. His Ph.D. degree was obtained from the Indiana University. His areas of specialization are methodology, demography and urban studies, and comparative social structure.

Talib Chaudhry, Civil Engineering, specializes in water resources systems, optimization, conjunctive use of surface water and ground-water, salinity, and seepage. He was formerly with WAPDA in Pakistan.

Cornelis deMooy, Agronomy, specializes in soil-water relations and is presently posted with the CSU Water Management Research team in Pakistan.

Jerry Eckert, Economics, specializes in agricultural economics and the economics of water resources development and management. He is presently located with the CSU Water Management Research team in Pakistan.

Michael E. White has recently been added to the Department of Agricultural Engineering. He has a B.S. degree from the U. S. Military Academy and his graduate and legal work from the University of Southern California and Cornell Law School. He has served as a research assistant in water law and environmental law. He has been associated with several law firms in drafting state water laws, including regulation of interstate transfer of percolating water. Having Professor White's services will add significantly to the competence in the College of Engineering in the field of water law.

Appendix D

**List of foreign students
attending CSU FY '73-'74**

SUMMARY

<u>Country</u>	<u>Number of Students</u>	<u>Country</u>	<u>Number of Students</u>
Afghanistan	8	Lebanon	1
Algeria	1	Libya	14
Argentina	3	Malaysia	2
Australia	4	Mexico	8
Austria	1	Nepal	2
Brazil	8	Netherlands	5
Bolivia	1	Nigeria	7
Cambodia	2	Norway	1
Cameroon	1	Pakistan	10
Canada	15	Paraguay	1
China (Taiwan)	28	Peru	1
Colombia	8	Poland	1
Costa Rica	1	Saudi Arabia	2
Cyprus	1	Senegal	1
Czechoslovakia	1	Sierra Leone	1
Denmark	1	Singapore	1
Ecuador	2	South Africa	1
Egypt	1	Sri Lanka (Ceylon)	1
Ethiopia	6	Sudan	3
France	2	Tanzania	5
Germany	3	Thailand	13
Grenada	1	Turkey	1
Honduras	1	Uganda	3
Hong Kong	8	United Kingdom	2
Iceland	1	Uruguay	1
India	22	Venezuela	4
Indonesia	1	Vietnam	4
Iran	10	Yemen	1
Iraq	8	Yugoslavia	1
Israel	5		
Jamaica	1	Total number of students	276*
Japan	7	Total number of countries	65
Jordan	3	Total number of new students	79
Kenya	5	Graduate students	245
Korea	6	Undergraduate	26
Kuwait	1	Non-degree	5

*The number of students indicated is the number of full-time students only. It does not include practical trainees or part-time students.

NAME	FIELD OF STUDY	CLASS	NAME	FIELD OF STUDY	CLASS
AFGHANISTAN - 8			BRAZIL - 8		
Ahmad Zai, Ahmad Shah	Civil Engr.	Gr	Belculfiné, Ulysses	Atmos. Science	Gr
Aryan, Mohammad Zahir	Civil Engr.	Gr	Carvalho, Carmen	Food Sci. & Nutr.	Gr
.Jamil, Abdul	Agric. Engr.	Gr	.Desbesell, Arno Sighart	Agronomy	Gr
Kazerani, Mohammad	Mathematics	Gr	Gomide, Francisco	Civil Engr.	Gr
Mohammadi, Wali M.	Civil Engr.	Fr	.Kelman, Jerson	Civil Engr.	Gr
Mommandi, Amanullah	Civil Engr.	Gr	Ramos, Rodolpho	Atmos. Science	Gr
Nazar, Ata	Civil Engr.	Gr	.Remião, Jose Oscar	Pathology	Gr
Usman, Mohammad	Economics	Gr	Sato, Atuo	Mech. Engr.	Gr
ALGERIA - 1			BOLIVIA - 1		
Oudjit, Aissa	Mathematics	Gr	.Navallo, J. Miguel	Animal Sciences	Gr
ARGENTINA - 3			CAMBODIA - 2		
.Anchorena, Juan de	Range Science	Gr	Chhann, Sereiuddh	Economics	Gr
Cauhépé, Miguel	Agronomy	Gr	Tiv, Thean Po	Economics	Gr
.Solanes, Miguel Ricardo	International School	Gr			
AUSTRALIA - 4			CAMEROON - 1		
Andrew, John W.	Civil Engr.	Gr	Mbele-Mbong, Samuel	Atmos. Science	Gr
Beale, Ian Francis	Range Science	Gr			
.Slatter, Douglas H.	Clinical Sciences	Gr			
.Williams, Robert Henry	Food Technology	Fr			
AUSTRIA - 1			CANADA - 15		
.Loss, Walter	Civil Engr.	Gr	Burwash, Leslie	Physio. & Bio.	Gr
			Chandler, Robert	Agric. Engr.	Gr
			.Duhaime, Gregory Edgar	Phys. Ed.	Fr
			Groarke, Louis	Art	Fr
			.Lieskovsky, John M.	Indus. Science	Gr

NAME	FIELD OF STUDY	CLASS	NAME	FIELD OF STUDY	CLASS
CYPRESS - 1			FRANCE - 2		
.Soteriou, Andreas	Animal Sciences	Sp	.Guillot, Elaine	Civil Engr.	Gr
			Lefevre, Bernard	Civil Engr.	Gr
CZECHOSLOVAKIA - 1			GERMANY - 3		
.Pastalka, Thomas	Bot. & Plant Path.	Sp	Essig, Carl Joachim	Microbiology	Gr
			.Keidel, Thomas	Business	Gr
DENMARK - 1			von Recum, Freiherr Andreas	Vet. Medicine	Gr
Jacobi, Sven	Civil Engr.	Gr			
ECUADOR - 2			GRENADA - 1		
Acosta, Alejandro	Civil Engr.	Gr	Lambert, George C.	History	Gr
Zevallos, Joseph E.	Vet. Medicine	Gr			
EGYPT - 1			HONDURAS - 1		
El-Gabalawi, Nabil	Mech. Engr.	Gr	.Hinds, Andrew	English	Gr
ETHIOPIA - 6			HONG KONG - 8		
Abate, Zwedie	Agric. Engr.	Gr	Kuo, Marie	Atmos. Science	Gr
Kibreab, Tadesse	Agronomy	Gr	Law, Peter C.	Civil Engr.	Gr
Lemma, Wendim	Civil Engr.	Gr	Ma, Giin-Ping Irene	Chemistry	Gr
.Mekuria, Fisseha	Business	Gr	Mui, Chi K.	Mech. Engr.	Gr
Neghassi, Habte Mariam	Agric. Engr.	Gr	Mui, Chi Y.	Elect. Engr.	Gr
.Woldemariam, Yebio	International Sch.	Gr	.So, Ying-Hung	Chemistry	Gr
			Tang, Ching Hung	Engr. Science	Sr
			Tso, Thomasze Chung Mou	Physics	Gr

NAME	FIELD OF STUDY	CLASS	NAME	FIELD OF STUDY	CLASS
ICELAND - 1			IRAN - 10		
.Bjarnason, Jon Bragi	Biochemistry	Gr	.Ahanin, Bahram	Elect. Engr.	Fr
			Farkhoo, Lida	Mathematics	Gr
INDIA - 22			.Keyvanfar, Hadi	Microbiology	Gr
Dass, Purushottam	Civil Engr.	Gr	Mahmoodian-Shooshtari, Mohamed	Agric. Engr.	Gr
Ghosh, Subir	Statistics	Gr	Mashayekhi, Taghi	Civil Engr.	Gr
Gopu, Vijaya Krishna	Civil Engr.	Gr	Novzari-Nasab, Khosrow	Elect. Engr.	Sr
Jha, Nagendra Nath	Physics	Gr	.Parisay, Massoud	Mech. Engr.	Fr
Krishnamurthi, N.	Civil Engr.	Gr	.Shahidi, Hushang	Economics	Gr
Kulkarni, Purushottam M. (Hari)	Math & Statistics	Gr	Shariatmadar- Taleghani, Mahmood	Agric. Engr.	Gr
Latoo, Abdur R.	Forest & Wood Sci.	Gr	Yeganegi, Bahram	Civil Engr.	Sr
.Mehta, Rajiv P.	Civil Engr.	Gr	IRAQ - 8		
Menon, Jaya	Physics	Gr	Abood, Mohammed Ridha	Agronomy	Gr
Mukherji, Sanjib K.	Civil Engr.	Gr	Al-Bayati, Souad Hassan	Food Sci. & Nutr.	Sp
.Mutreja, Kedar Nath	Civil Engr.	Gr	Al-Kafawi, Abbas	Physio. & Bio.	Gr
Nagpal, Subhash	Mech. Engr.	Gr	Al-Rawi, Abed Alhamed	Mathematics	Gr
Prakash, Anand	Civil Engr.	Gr	Al-Saadi, Abdul Majeed	Microbiology	Gr
Ramachandran, Venkataraman (Ram)	Chemistry	Gr	Khalifa, Khalifa Ahmed	Fishery & Wildlife	Gr
Ramu, Kikkeri L. V.	Civil Engr.	Gr	Lafta, Halim	Civil Engr.	Gr
Rao, Anatha P. K.	Mech. Engr.	Gr	Sharif, Rassol	Microbiology	Gr
.Reddy, Seelam Vijaya	Agronomy	Gr	ISRAEL - 5		
Singh, Ram Jag	Agronomy	Gr	Berlant, Avigdor	Civil Engr.	Gr
Singh, Vijay Pal	Civil Engr.	Gr	.Fogel, Eliezer	Elect. Engr.	Gr
Srinivasan, Srivatsangam	Atmos. Science	Gr	Manor, Shaul	Agronomy	Gr
Subramaniam, Janakiram (Ram)	Civil Engr.	Gr	.Mina, Eliahou Shalom	Elect. Engr.	Gr
.Vasudevan, Krishnaswany	Chemistry	Gr	Perl, Joseph	Elect. Engr.	Gr
Vijayaraghavan, Grama S.	Agric. Engr.	PT			
INDONESIA - 1					
.Bockings, Aziz	Business	Gr			

NAME	FIELD OF STUDY	CLASS	NAME	FIELD OF STUDY	CLASS
JAMAICA - 1			KOREA - continued		
.Mathie, Kirlew	Psychology	Fr	.Im, Jeong Nam	International School	Gr
JAPAN - 7			Kwon, Soon-kuk	Civil Engr.	Gr
Henmi, Teizi	Atmos. Sci.	Gr	Oh, Suk Y.	Food Sci. & Nutr.	Gr
.Hino, Katsushige	Mathematics	Gr	Park, Kyoung Yoon	Atmos. Science	Gr
.Kato, Eiji	English	Gr	KUWAIT - 1		
Nagasawa, Hatsumi	Rad. & Rad. Bio.	Gr	.Husain, Yasseen T.	Economics	Gr
.Tanaka, Mitsuo	Mathematics	Gr	LEBANON - 1		
.Tase, Norio	Civil Engr.	Gr	Bsat, Fouad A.	Mech. Engr.	Gr
Yoshiiki, Manabu	Business	Gr	LIBYA - 14		
JORDAN - 3			Bel-Haj, Hashmy	Food Sci. & Nutr.	Gr
Al-Tell, Tariq	Economics (Agric.)	Gr	El-Baruni, Belgassem	Agronomy	Gr
Budeiri, Zafir M.	Civil Engr.	Gr	Ellafi, Omran Munir	Civil Engr.	Gr
Lozi, Salem	Forest & Wood Sci.	Gr	.El-Maihub, Saleh	Economics	Gr
KENYA - 5			El-Misawi, Elmahdi	Forest & Wood Sci.	Gr
.Mbadi, George	Physio. & Bio.	Gr	.Faris, Bashir	Civil Engr.	Gr
.Mutiga, Erastus	Clinical Sciences	Gr	Hussein, Mohammed T.	Statistics	Gr
.Price, Jennifer	Clinical Sciences	Gr	Magid, Aiad F.	Animal Science	Gr
Shatry, Alwi M.	Clinical Sciences	Gr	Mahmoud, Khaled R.	Agronomy	Gr
Varma, Sudarshan S.	Vet. Surg.	Gr	Naas, Seddik	Civil Engr.	Gr
KOREA - 6			Nashnush, Fathi M.	Food Sci. & Nutr.	Gr
.Choi, Soo Hyan	Physics	Gr	.Yazid, Sadek Mahamed	Agronomy	Gr
Hwang, Dong Ho	Food Sci. & Nutr.	Gr	Zagallai, Faisal P.	Sociology	Gr
			Zagallai, Farida A.	Sociology	Gr

NAME	FIELD OF STUDY	CLASS	NAME	FIELD OF STUDY	CLASS
MALAYSIA - 2			NIGERIA - 7		
Leong, Heryee	Statistics	Gr	Agbim, Nonye	Music Education	Sr
Tai, Kon Chin	Civil Engr.	Gr	Agbim, Nnaemeka Nathan	Agronomy	PT
MEXICO - 8			Aromose, Anthony S.	Agronomy	Gr
.Caraveo-Müller, Gerardo	Business	Gr	Buwai, Malami	Range Science	Gr
Godoy-Calleros, Ramón	Agronomy	Gr	.Fapohunda, Henry O.	Agric. Engr.	Gr
Gonzalez-Padilla, Everardo	Animal Science	Gr	Mohammad, Habib	Agronomy	Gr
Molina, José J.	Botany & Plant Path.	Gr	Monsi, Alexis	Animal Science	Gr
.Montaño, Moisés	Animal Science	Gr	Nwakalor, Lawrence	Animal Science	Gr
.Murillo, Francisco	Agric. Engr.	Gr	NORWAY - 1		
Rodríguez-Rivera, Oscar	Clinical Sciences	Gr	Iredale, Anne	Art	Sr
Trava, José L.	Agric. Engr.	Gr	PAKISTAN - 10		
NEPAL - 2			Adnan, Khalid	Mathematics	Jr
.Agrawal, Lakshman P.	International School	Sp	.Ahmad, Bashir	Economics (Agric.)	Gr
.Shrestha, Sundar K.	International School	Sp	Ahmad, Chaudry		
NETHERLANDS - 5			Nur-ud-Din	Civil Engr.	Gr
.Blaauboer, Antoon	Business	Gr	Ahmad, Ghulam	Civil Engr.	Gr
Dane, Fennechiena	Horticulture	Gr	.Kareem, Ahsan	Civil Engr.	Gr
Dane, Jacob H.	Agronomy	Gr	Khan, M. Jameel	Economics	Gr
Glas, Tjaart K.	Agronomy	Gr	Khan, Qurban Ali	Agric. Engr.	Gr
Viek, Paul L. G.	Agronomy	Gr	.Rahman, Faizur	Economics	Gr
			Raja, Asad Ulla K.	Business	Gr
			.Rana, Mumtaz Ahmed K.	Economics	Gr
			PARAGUAY - 1		
			Guerreño, Anfbal	Physio. & Bio.	Gr

NAME	FIELD OF STUDY	CLASS	NAME	FIELD OF STUDY	CLASS
PERU - 1			SRI LANKA (Ceylon) - 1		
.Ponce, V. Miguel	Civil Engr.	Gr	Fernando, Hilarion	Microbiology	Gr
POLAND - 1			SUDAN - 3		
.Luczak, Teresa Stanislawa	Agriculture	So	.El-Balla'a, Ahmed Fadalla	Civil Engr.	Gr
SAUDI ARABIA - 2			Hajer, Ibrahim	Microbiology	Gr
Al-Fadl, Saleh	Civil Engr.	Gr	Musa, Babiker	Clinical Sciences	Gr
Kholaifi, Soliman	Mathematics	Sr	TANZANIA - 5		
SENEGAL - 1			Desai, Yahwantlal D.	Mech. Engr.	Gr
.Fall, Babacar	Business	Gr	.Itang'are, George	Animal Science	Gr
SIERRA LEONE - 1			Kisugite, Moses Andrew	Agronomy	Gr
Harleston, Alex	International School	Gr	Lwakabare, Gabriel	Civil Engr.	Gr
			Urasa, Isai	Chemistry	Gr
			THAILAND - 13		
SINGAPORE - 1			Apichatanon, Opas	Elect. Engr.	Gr
			.Chotisasitorn, Mongkol	Agric. Engr.	Gr
Lee, Ying	Forestry	Sr	.Chutisilp, Pornpimol	English	Gr
			.Kemprasit, San	International Sch.	Gr
			Kutintara, Utis	Forest & Wood Sci.	Gr
			Muttamara, Sumali	Economics	Gr
			Nimmannit, Visal	Mech. Engr.	Gr
SOUTH AFRICA - 1			.Nualchawee, Kaew	Civil Engr.	Gr
Williams, Robert B.	Civil Engr.	Gr	Parvongnukul, Kiat	Clinical Sciences	Gr
			Prommool, Suthep	Earth Resources	Gr
			.Suwankasem, Chiraporn	Economics	Gr
			Wacharakitti, Sathit	Forest & Wood Sci.	Gr
			.Yupaporn, Tirasupa	Mathematics	Gr

NAME	FIELD OF STUDY	CLASS	NAME	FIELD OF STUDY	CLASS
TURKEY - 1			YEMEN - 1		
Satiroglu, Kadir D.	Economics	Gr	Al-Afifi, Mahmoud	Civil Engr.	Gr
UGANDA - 3			YUGOSLAVIA - 1		
Mukasa-Mugerwa, Eddie	Animal Science	Gr	Isailović, Dragoslav	Civil Engr.	Gr
Mukembo, George	Animal Science	Gr			
Okuna, Nimrod	Microbiology	Gr			
UNITED KINGDOM - 2					
Lugg, David G.	Agronomy	Gr			
Simpson, J. Timothy	Mathematics	Gr			
URUGUAY - 1					
.Saavedra, Alberto	Business	Gr			
VENEZUELA - 4					
.Ferraro, Luciano	Clinical Sciences	Gr			
Masini, Livia	Rec. Resources	Gr			
.Rufz, Omar Jesús	Atmos. Science	Gr			
Vargas-Semprun, Douglas	Civil Engr.	Gr			
VIETNAM - 4					
Dinh, Nguyen Duc	Physics	Gr			
Phung, Doan Van	Physics	Gr			
Tho, Duong Cong	Civil Engr.	Gr			
Van, Doan Cong	Civil Engr.	Gr			

POST-DOCTORAL, INTERNS, VISITING FACULTY

NAME	COUNTRY	FIELD OF STUDY	APPOINTMENT
Agbim, Nathan	Nigeria	Agronomy	PT
.Becker, James Y.	Israel	Chemistry	PD
.Bickermann, Albert	Germany	Physics	RS
Bokhari, Anab	Pakistan	NREL	RS
Chen, Yung Hai	China	Civil Engr.	PT
Chieh, Sherman	China	Civil Engr.	PD
.Djavanshir-Khoie, Karim	Iran	Earth Resources	RS
Doughri, Aboubaker	Libya	Microbiology	PD
.Egunjobi, James Kolarvole	Nigeria	NREL	RS
.Ellonen, Inheri (Mrs.)	Finland	English	RS
Gale, Robert J.	Canada	Chemistry	PD
Hora, Trilochan Singh	India	Botany & Plant Path.	PD
Kamata, Kazuyuki	Japan	Chemistry	PD
Knaus, Gerald Norman	Canada	Chemistry	PD
Lin, Tzu Shen	China	Biochemistry	RS
.Lövland, Jorgen	Norway	Agric. Engr.	RS
.Makino, Fumiko	Japan	Rad. & Rad. Bio.	PD
Marshall, John	Australia	NREL	RS
Nakadomari, Hisamitsu	Japan	Chemistry	PD
Nayak, Shrinivas K.	India	Civil Engr.	PD
Pineda, Mauricio	Chile	Physio. & Bio.	PD
Rai, Dhanpat	India	Agronomy	PD
.Ruprecht, Eberhard	Germany	Atmos. Science	PD
.Saleh-Rastine, Nahid (Mrs.)	Iran	Agronomy	PD
Shaw, Chia-Cheng	China	Chemistry	RS
.Siirala-Hansen, Kirsti A.	Finland	Chemistry	RS
Singh, Jamuna Sharan	India	NREL	PD
Sparrow, Elena Batista	Phillipine	Agronomy	PD
.Takino, Tokusaburo	Japan	English	RS
Tu, Grant	China/Canada	Anatomy	RS
Wallace, William J.	Canada	Biochemistry	FC
.Walter, Wolfgan	Germany	Mathematics	FC

Appendix E
International Interdisciplinary
Seminar

INTERNATIONAL INTERDISCIPLINARY SEMINAR
IN WATER RESOURCES MANAGEMENT

Annual Report for 1973-1974

together with:

- (a) Brief Evaluation of the First
Five-Year Experience; and
- (b) Statement of Plans for the Future

INTERNATIONAL INTERDISCIPLINARY SEMINAR
IN WATER RESOURCES MANAGEMENT

Introduction

In implementation for the fifth year of item eight of the operational plan for use of a five-year AID Institutional Development Grant of 1969, which called for the planning, initiation, and expansion of an "interdisciplinary seminar on development and the interrelationship of the many factors involved in development--especially in less developed countries," the International Interdisciplinary Seminar in Water Resources Management was conducted during the academic year 1973-1974 and met for two hours each week throughout the academic year. Academic year 1973-1974 is the last year that the Seminar is being conducted and funded under the AID grant of 1969.

Faculty members from seven academic departments constitute the Program Committee which critically reviews the seminar program each year and develops the plan for its conduct for the succeeding year. The Chairman of the Program Committee and the faculty member in charge of the conduct of the seminar is Professor Henry P. Caulfield, Jr. of the Department of Political Science. The other members of the Program Committee during 1973-1974 were:

Albert G. Mercer, Civil Engineering
David B. McWhorter, Agricultural Engineering
John O. Reuss, Agronomy
Ronald L. Tinnermeier, Economics^{1/}
Clarence Carlson, Fishery and Wildlife Biology
David Freeman, Sociology
Maurice L. Albertson, Civil Engineering, ex officio

Statement of Purposes

The continued purposes of the seminar program, as revised in 1971-1972, are as follows:

- A. To develop appreciation among participants--faculty and graduate students--of the diversity of factors--including

^{1/}Ronald L. Tinnermeier, Associate Professor of Economics, replaced Huntley Biggs during 1973-1974.

engineering, cultural, biological, economic, social and political--and thus, of the multidisciplinary nature of water resources management.

- B. To gain basic intellectual understanding among all participants of the concerns, concepts, methods and contribution of each academic discipline concerned with water resources management.
- C. To foster construction of interdisciplinary models for the solution of water management problems through the joint efforts of faculty and graduate students representing the disciplines relevant for the solution of such problems.
- D. To evaluate interdisciplinary models for the solution of water management problems from all points of view including those of experience practitioners and observers of water resources management.
- E. To appraise the successes and failures of water management efforts throughout the world, especially in less developed countries, in meeting human needs.
- F. To enable participants from all academic departments to gain, in successive terms and years of their participation, greater and greater resolution in their knowledge of water resources management; and thus
- G. To contribute to the achievement of increased levels of competence in water resources management among faculty and graduate students of Colorado State University.

Seminar Program for 1973-1974

The general plan developed by the Program Committee for conduct of the Seminar during 1973-1974, the final year under AID auspices, called for presentations under three general headings. In addition, it was expected that opportunities for outside speakers, as well as other presentations, would occur which should be fitted into the program. The three general topics were as follows:

1. Water Management Research--Pakistan

The general aim of this set of presentations, constituting reports of research being undertaken under the AID--financed Water Management Research Program, was to develop understanding and to discuss them as a whole in terms of the general water management strategy which they represent and as individual research units on their own merits.

2. Presentations by Graduate Students of Papers Reflecting Own Intellectual and Research Interests

Most presentations made to the Seminar during the previous four years had been made by faculty. Presentations by graduate students had only been included where they could make a presentation within the confines of a predetermined general topic. For the fifth year, the Program Committee decided that a drive should be made to obtain graduate student presentations per se.

3. Opportunities and Problems of Improving Water Management in Arid Developing Countries

Reflections from various points of view on this general topic were believed to be particularly appropriate for this fifth year. What we were trying to reach in these presentations was an appreciation of the efficacy of "outsiders" trying to improve water management in arid developing countries.

The topics covered under these three headings and the seminar leaders were as follows:

1. Water Management Research--Pakistan

A. Water Management Research--Philosophy, Goals and General Program

W.D. Kemper, Project Director, Professor, Water Management Research

B. Sediment Transfer in Turnouts and Watercourses

Khalid Mahmood, Research Associate, Civil Engineering

C. Crop Scheduling to Match Water Supply Systems

Alan Early, Assistant Professor, Agricultural Engineering

D. Effect of Water Timing on Crop Production

R.E. Danielson, Professor, Agronomy

- E. Flow Measurements and Causes of Water Losses in Watercourses
Gaylord Skogerboe, Associate Professor, Agricultural Engineering
 - F. Wells for Irrigation Drainage and Salinity Control
David B. McWhorter, Assistant Professor, Agricultural Engineering
 - G. Land Shaping and Irrigation
W.E. Hart, Associate Professor, Agricultural Engineering
 - H. Effect on Soil Water Level on Composition of Soil Air and Soil Solution
W.R. Schmehl, Associate Department Head, Professor, Agronomy
 - I. Effects of Added Organic Matter on Soil Air and Soil Solution
W.T. Franklin, Associate Professor, Agronomy
 - J. Economic Implications of Land Leveling
Bashir Ahmad, Graduate Student, Agricultural Economics,
and R.L. Tinnermeir, Associate Professor, Economics
 - K. Village Institutional Patterns and Water Management Decision Making
David M. Freeman, Associate Professor, Sociology and Anthropology
 - L. Organizations, Policies and Laws to Improve Flexibility of Water Distribution
George Radosevich, Assistant Professor, Economics
2. Presentations by Graduate Students of Papers Reflecting Their Own Intellectual and Research Interests
- A. Organization and Politics of the Government of Indonesia with Special Reference to Water Resources Management
Aziz Bockings, Graduate Student from Indonesia, College of Business
 - B. Farm Credit System in Pakistan
Mumtaz Rana, Graduate Student from Pakistan, Department of Economics
 - C. The Mekong Committee: A Comprehensive Overview
Bailey Wharton, Graduate Student from the United States, Department of Political Science
 - D. Problems of Rural Development in Ethiopia
Zewdie Abate, Graduate Student from Ethiopia, Agricultural Engineering
3. Opportunities and Problems of Improving Water Management in Arid Developing Countries
- A. Opportunities and Problems of Water Management in Pakistan
G.L. Corey (Agricultural Engineer), Chief, CSU Water Management Research Field Party, Pakistan

Jerry Eckert, Assistant Professor, Economics, CSU, and member of CSU Water Management Research Field Party, Pakistan

- B. Opportunities and Problems of American Professionals in Aiding Development in Developing Countries
Willis W. Shaner, Associate Professor, Mechanical Engineering Department, CSU
- C. Opportunities and Problems of a University in Aiding Water Management Abroad
Ronald L. Tinnermeir, Associate Professor of Economics, CSU
- D. Opportunities and Problems of Water Management in Vietnam
W. Doral Kemper, Professor of Agricultural Engineering Director, CSU Water Research Program
- E. Opportunities and Problems of Colorado State University in Aiding Water Management in Arid Countries
Daryl B. Simons, Professor of Civil Engineering, Associate Dean, College of Engineering
- F. Opportunities and Problems in Improving Water Management in Arid Developing Countries
Maurice L. Albertson, Professor of Civil Engineering
- G. Reflections on Recent Field Survey of Water Management Research - Pakistan, Vietnam and Thailand
W. Doral Kemper, Director, CSU Water Management Research Project
- H. Water Management in Developing Countries - Beneficial and Adverse Affects of Alternative Strategies for Obtaining Professional Input
Henry P. Caulfield, Jr., Professor of Political Science

Other presentations made to the Seminar during 1973-1974 were, as follows:

- A. Goals and Criteria of Water Management in the Danube River Basin
Dr. Istran Bogardi, Civil Engineer and member of the staff, Research Institute for Water Development, Budapest, Hungary
- B. Indices of Water Quality and Water Quality Insufficiencies
Dr. Miklos Domokos, Civil Engineer and member of the staff, Research Institute for Water Development, Budapest, Hungary
- C. Development of the Water Resource System of the Tszs River Basin, Hungary: Cost - Effectiveness Analysis
Dr. Laszlo David, Head, Engineering Secretariat, National Water Authority, Budapest, Hungary

D. Methodological Problems of Large Scale Water Resource Systems

Professor Yu. A. Rozanov, a citizen of the USSR and staff member, International Institute of Applied Systems Analysis Vienna, Austria

E. Water Distribution Rules Within Irrigation Systems: Colorado, Utah, and Spain

Dr. Raymond L. Anderson, Agricultural Economist, USDA and Economics Department, Colorado State University

F. Evaluation of the International Interdisciplinary Seminar in Water Resources Management After Five Years

Henry P. Caulfield, Jr., Professor of Political Science

Attendance

Twenty-eight two hour seminars were held during the three terms of 1973-1974. Approximate average attendance per session among graduate students was thirty; and among faculty, six.

Faculty usually in attendance were from the departments of agricultural engineering, agronomy, civil engineering, economics and political science.

The major fields of graduate students taking the seminar (GS 797) for credit (one credit per term) during each of the three terms were, as follows:

MAJOR FIELDS OF GRADUATE STUDENTS TAKING GS 797

	<u>Fall 1973</u>	<u>Winter 1974</u>	<u>Spring 1974</u>
Agricultural Engineering	3	3	3
Agronomy	2	2	1
Business Administration	1	1	1
Civil Engineering	5	4	2
Economics	3	4	2
Sociology	<u>-</u>	<u>1</u>	<u>-</u>
Total	14	15	9

The nationality mix, between American and non-American, of those taking the Seminar for credit were as follows:

BACKGROUND OF GS 797 GRADUATE STUDENTS:

	American and Non-American		
	<u>Fall 1973</u>	<u>Winter 1974</u>	<u>Spring 1974</u>
American	3	4	2
Non-American	<u>11</u>	<u>11</u>	<u>7</u>
Total	14	15	9

Most of the non-American graduate students are from Southeast Asia, Northern Africa and South America.

EVALUATION OF THE FIVE-YEAR SEMINAR EXPERIENCE

"Evaluation of the International Interdisciplinary in Water Management After Five Years" was the subject of the Seminar lead by Professor Caulfield on May 15, 1974. At the outset, he and Professor Albertson reviewed the origins of the Seminar in Item Eight of the AID Grant of 1969 under Section 211(d) of the Foreign Assistance Act and initial planning efforts leading to establishment of the Program Committee. A statement of purposes of the Seminar was adopted early in the work of the Program Committee which is substantially the same as that set forth above.

Professor Caulfield, by use of slides and two overhead projectors, compared the statement of purposes with a listing of general titles of sets of Seminar presentations, quarter by quarter, for the five years. The relationship of each set of presentations to the purposes was noted. In addition, it was noted that a number of Seminar presentations did not always fall into these sets; such as presentations on the functions relating to water of the United Nations, World Bank, FAO, AID and Inter American Development Bank and special presentations by outsiders on Iran, Ceylon, India, Pakistan, Mekong River Basin, USSR and Hungary. The several special presentations by Dr. Gilbert White of the University of Colorado were also recalled.

Evaluation was focused on adequacy of faculty and graduate student participation and on program achievement in relation to purposes. During the first three years no credit was offered. Some thirty to forty students attended each presentation. Between eight and fifteen students took the Seminar (GS 797) for credit during the last two years. Total student attendance has been slightly down, on the average, during

these years. Faculty participation fluctuated between three and twelve for each presentation during the five years.

Of the students who were interested in the Seminar, but did not attend some or all times, pressure of required courses in their own disciplines appears to have been a major constraint. For faculty, inconsistency with career and research goals plus lack of released time from other obligations, appear to have been major constraints. These findings are not based upon surveys, but are based upon discussions that Professor Caulfield had with faculty and students over the five years and comments of those present at the evaluation seminar.

Professor Caulfield graded program achievement in relation to purposes, as follows:

- | | |
|---|----|
| A. To develop multidisciplinary appreciation | A |
| B. To gain basic intellectual understanding of all disciplines involved | B+ |
| C. To foster construction of interdisciplinary models | C |
| D. To evaluate interdisciplinary models | D |
| E. To appraise successes and failures of water management efforts around the world | B |
| F. To enable participants, in successive terms and years, to gain greater resolution in knowledge of water management | B |
| G. To contribute to achievement of increased levels of competence at CSU | B |

Other faculty and graduate student participants in the evaluation seminar, who spoke up, said that they felt Professor Caulfield's evaluation was too tough. Be this as it may. All agreed that the cutting edge of intellectual advance--in terms of assisting in solution of public problems in water management, both at home and abroad, is in rigorous interdisciplinary modeling and its evaluation. The Seminar advanced appreciation of this insight, but it did not advance appreciably at CSU rigorous interdisciplinary modeling. To have accomplished more in this regard would appear to have required specifically earmarked funds for this purpose, in order to provide released time for faculty and support for graduate students.

Plans for the Future

The AID Grant is extended for an additional year, but no funds have been earmarked for central funding to continue GS 797 in 1974-1975. The Program Committee has decided not to abandon the substantive content of the Seminar, but to try to conduct it without central funding. A faculty member from an interested department will take the lead each term in conducting the Seminar under an appropriate course number related to his department, and his department is expected to release his time on the basis of resident instruction funds to make his efforts possible. This departmental responsibility will be shifted from one department to another each term as will the course number of the offering.

The Program Committee has also concluded that the Seminar, henceforth, should emphasize interdisciplinary subjects most pertinent to the Water Management Research Program that is headed by Dr. Doral Kemper. The departments, on this basis most heavily involved in terms of research funding, will be: Agronomy, Agricultural Engineering, Economics, and Sociology. However, Civil Engineering and Political Science continue their interests.

The overall Program Committee chairman, starting in 1974-1975, will be Dr. Gaylord Skogerboe of Agricultural Engineering, who will be heading up the Water Management Research Program while Dr. Kemper is in Pakistan during the next two years. GS 797 per se, the interdisciplinary course administered by the Graduate School will be held in suspension in 1974-1975 on the possibility that new sources for central funding may arise.

Appendix F

Research Assistants and Abstracts of Their Reports

Appendix F

Research Assistants and Abstract of Their Reports

The following students completed their requirements for a degree and were partially funded under the 211(d) grant for the reporting year:

<u>Name</u>	<u>Department</u>	<u>Degree Received</u>
Mr. Qurban Ali Khan	Agricultural Engineering	M.S.
Mr. Atta Mohammad Nazar	Civil Engineering	M.S.
Mr. Bailey F. Wharton	Political Science	M.S.
Dr. Lemma Wendim-Agegnehu	Civil Engineering	Ph.D.
Dr. Alfred J. Tamburi	Civil Engineering	Ph.D.
Dr. Larry Caswell	Economics	M.S.
Dr. Mohammad T. Chaudhry	Civil Engineering	Ph.D.

An Abstract of each of the above papers is attached as part of this Appendix.

F-2

THESIS

IRRIGATION MANAGEMENT IN PAKISTAN

Submitted by
Qurban A. Khan

In partial fulfillment of the requirements
for the Degree of Master of Science
Colorado State University
Fort Collins, Colorado
January, 1974

ABSTRACT

IRRIGATION MANAGEMENT IN PAKISTAN

Providing enough food, feed, and fibre for a rapidly growing population is the challenge facing the less developed countries today, and Pakistan is no exception. Crop production and yield per acre is not at an acceptable level. An extensive irrigation network has been built in Pakistan to provide an increased and relatively regulated water supply. Several old inundation canals have been converted to perennial or non-perennial canals. Several multipurpose projects have also been constructed.

The role of various governmental agencies concerned with irrigation water management has been described. The functions and administrative set-up has been discussed, along with advantages and limitations of present organizational arrangements.

The development of the surface water resources helped in bringing more area under cultivation and increase crop production, but later it also created the twin menace of waterlogging and salinity. Various measures to tackle this problem have been taken with the help of different foreign agencies. After reviewing the existing literature, some recommendations for improving on-farm water management and rehabilitating watercourses have been made in order to alleviate salinity problems, while providing additional quantities of water to the farm.

Qurban Ali Khan
Agricultural Engineering Department
Colorado State University
Fort Collins Colorado 80523
January, 1974

F-4

THESIS

A LABORATORY STUDY OF BED MATERIAL WITHDRAWAL IN FARM TURNOUTS

Submitted by

Ata Mohammad Nazar

In partial fulfillment of the requirements

for the Degree of Master of Science

Colorado State University

May, 1973

ABSTRACT

The phenomenon of bed material withdrawal through a farm turnout was studied in an indoor laboratory flume. Depth of flow in the flume, discharge in the flume, turnout elevation from the concrete bed of the flume, and the discharge through the turnout were the variables whose effect on the variation of sediment discharge through the turnout was to be determined.

The statistical analysis of the data (Eq. 5-1) indicates that the sediment discharge through the turnout is almost directly proportional to the sediment concentration in the flume. Data taken at two different turnout elevations confirmed (Fig. 5-3) that most of the sediment load was transported close to the bed of the channel and the variation in sediment concentration at higher elevations from the bed of the channel was not significant.

Based on a series of special runs plus visual observation, it was found that the amount of sediment discharge through the turnout was significantly affected by the bed form movement in the flume. A collapse of sharp peak or unstable bed formation which was irregular in time and space in the vicinity of the turnout would increase the sediment discharge through the turnout considerably. The analysis of data shows that the scour pit formation near the turnout remains geometrically similar under different conditions of flow in the flume and the turnout. It was also found that the depth of scour pit increases with an increase in the discharge ratio.

F-6

THESIS

THE MEKONG COMMITTEE: AN ORGANIZATION OF SYNTHESIS

Submitted by
Bailey Frazier Wharton

In partial fulfillment of the requirements
for the Degree of Master of Science
Colorado State University
Fort Collins, Colorado
June, 1974

ABSTRACT OF THESIS

THE MEKONG COMMITTEE: AN ORGANIZATION OF SYNTHESIS

In October of 1955 the four Indo-Chinese riparian states of Laos, Thailand, the Khmer Republic and the Republic of Viet-Nam agreed to form the Committee for Coordination of Investigations of the Lower Mekong Basin (the Mekong Committee). The Mekong Committee is composed of one member from each of the riparian states with the job of coordinating investigations into the possible development of the resources of the Lower Mekong Basin.

This thesis is designed to analyze the work of the Mekong Committee as an organization of synthesis designed to unite the Lower Mekong Basin (the thesis) and the riparian states of the Basin (the antithesis) under the aegis of the United Nations Economic Commission for Asia and the Far East.

To end this the thesis concentrates on determining the successfulness of the Committee in maintaining its own organization by means of a compatible membership. Secondly, determining the successfulness of the Committee's program in terms of its goals contrasted to its accomplishments.

With success established it then proceeds to analyze the Committee in terms of those factors primarily responsible for the Committee success formula. The factors responsible for both Committee and project success are analyzed.

With the factors isolated we can then return to the original thesis and comment on the Committee as an organ for investigations into water resource development. It can then be determined to what

extent the Committee has succeeded in synthesizing the political and natural elements found within the Lower Mekong Basin of Southeast Asia.

Bailey Frazier Wharton
Political Science Department
Colorado State University
Fort Collins, Colorado 80521
June, 1974

F-9

DISSERTATION

METHODOLOGY

FOR

THE SELECTION AND TIMING OF WATER RESOURCES PROJECTS
To Promote National Economic Development

Submitted by

Lemma Wendim-Agegnehu

In partial fulfillment of the requirements

for the Degree of Doctor of Philosophy

Colorado State University

Fort Collins, Colorado

July 1974

ABSTRACT OF DISSERTATION
METHODOLOGY
FOR
THE SELECTION AND TIMING OF WATER RESOURCES PROJECTS
To Promote National Economic Development

The methodology developed in this dissertation is designed to facilitate the selection and timing of water resources projects to optimally achieve "a priori" specified national economic development through desired strategies. The methodology is composed of several analytical procedures.

The input-output model is used to simulate the national economy thus further facilitating consistent projections of the elements of final demands in accordance with the national economic development objectives and strategies, and assessing the total and incremental requirements for sectoral outputs of goods and services at designated future time periods. A mathematical model for the selection and timing of water resources projects for their implementation, in other words for the formulation of an optimal national water resources development program, has been developed and its application demonstrated on an example problem. The model incorporates important factors such as economic efficiency of projects, demand targets for project outputs of goods and services necessary to achieve desired national economic growth, resources capabilities and limitations, and project interrelationships. Incorporation of these and other related factors makes the model reflective of the real world problem it is intended to aid in solving.

The application on an example problem convincingly indicates it to be a very useful tool indeed in the national economic planning process. This exercise also reveals the avenues for further research and improvement.

Lemma Wendim-Agegehu
Civil Engineering Department
Colorado State University
Fort Collins, Colorado 80523
July, 1974

F-12

THESIS

GEOLOGY AND THE WATER RESOURCE SYSTEM
OF THE INDUS PLAINS

Submitted by

Alfred J. Tamburi

In partial fulfillment of the requirements
for the Degree of Doctor of Philosophy
Colorado State University
Fort Collins, Colorado

ABSTRACT

GEOLOGY AND THE WATER RESOURCE SYSTEM
OF THE INDUS PLAINS

An interdisciplinary study of the water resource system of the Indus Plains has produced new geologic and technologic perspectives which will enhance the development of the resource,

Geologic investigations have revealed new resource potential as well as potential geologic hazards. For example, study of sediment source areas in the Indus Basin reveals that geology is an important influence on sediment production in the fluvial system. Re-interpretation of the classical geologic history of Pakistan in the continental drift context has also had important consequences for the water resource system. These consist of new energy sources for groundwater pumping and location of regions of tectonic instability in the canal command areas.

It is suggested that the geothermal energy potential of a portion of the Indus Plains be developed to provide low cost power for groundwater pumping. The energy outlook for Pakistan would be improved both by the substitution of geothermal power for hydrocarbon power, and by new areas of hydrocarbon potential discovered as a result of geologic interpretation in the drift context.

Re-interpretation of Pakistan's geology in the continental drift context has also resulted in an improved understanding of tectonism in the Indus Plains. The effects of tectonism on the rivers and canals are then investigated, and recommendations made for the minimization of adverse effects.

New techniques suitable for the investigation of secular crystal deformations are described, and it is proposed that geophysical methods be used to determine deformation rates for ongoing tectonism in the Indus Plains. Such an application would also serve to monitor induced subsidence caused by groundwater extraction in the Indus Plains.

Technologic innovations have also produced a new perspective for water resource development. Innovations in dam building technology with advances in anti-seismic design of earth dams make re-evaluation of the surface storage program essential.

A technology to construct earth dams by direct blasts in the kiloton range has been developed in the Soviet Union. This method, together with investigations of landslide dynamics and nuclear explosions undertaken in the U. S., is suggested for development of large scale storage on the upper Indus. This single project is suggested as an alternative to the World Bank Plan for surface storage in the Indus Basin.

Improved definition of the return period for damaging earthquakes in Pakistan suggests that the seismic danger has been underestimated for several proposed surface storage sites. In addition, adequate anti-seismic design will require extensive design changes in the proposed earth dams. In contrast, blast development of a single large scale storage site on the upper Indus is considered more attractive due to the inherent seismic stability of an embankment created by blasting.

Together, the geologic and technological investigations suggest several development alternatives whose economic implications should be evaluated as rapidly as possible.

F-15

THESIS

PUBLIC INVESTMENT IN MEXICO'S NORTH PACIFIC

Submitted by

Larry L. Caswell

In partial fulfillment of the requirements

for the Degree of Master of Science

Colorado State University

Fort Collins, Colorado

August, 1973

ABSTRACT OF THESIS

PUBLIC INVESTMENT IN MEXICO'S NORTH PACIFIC

The purpose of this thesis is to examine the role of public investment to promote economic development. Mexico was chosen as a case study, with particular interest in the North Pacific region. The principal focus is on public investment in water delivery and removal systems. The thesis examines relevant institutional arrangements behind Mexican public investment in water delivery and removal systems; the role the resultant expanded agricultural system plays in overall economic growth and development; the structural effects of such investment; and the theoretical implications of investment strategies.

A theoretical framework for public investment is first established to provide a background for the remainder of the thesis. The next topic is the growth in Mexican agricultural output, and the role of the agricultural sector in an expanding economy. The relevant institutional arrangements and political forces which influenced the sectoral and regional distribution of public funds for water delivery and removal systems are examined next. Then the North Pacific region and the remainder of Mexico are compared with respect to investment in water delivery and removal systems and with respect to differences in the structure of agriculture. Finally, the regional distribution of this investment is evaluated in terms of the theoretical framework established earlier.

Larry Lee Caswell
Economics Department
Colorado State University
Fort Collins, Colorado 80521
August, 1973

F-17

DISSERTATION

CONJUNCTIVE USE OF INDUS BASIN WATERS
PAKISTAN

Submitted by

Mohammad Talib Chaudhry

In partial fulfillment of the requirements
for the Degree of Doctor of Philosophy
Colorado State University
Fort Collins, Colorado

ABSTRACT

CONJUNCTIVE USE OF INDUS BASIN WATERS
PAKISTAN

This study is a part of the "Grow More Food" campaign of our civilization for world peace and prosperity. It provides a working mathematical model for analyzing and optimizing the conjunctive use of surface and ground water resources of West Pakistan. In specific terms, the objective of the study is to determine the size of the canal system, the surface reservoir, and the ground water pumping facilities, such that, when the system is operated optimally, the capital and operation and maintenance costs of meeting the given irrigation water requirements are minimized.

For developing the required optimizing model, the area under the Marala-Ravi Link canal system in Rechna Doab (Punjab) is selected as a model area. This area is a part of the huge interconnected and complex Indus Basin Irrigation System. A system decomposition procedure is used to uncouple the model area from the rest of the system to obtain a physical model. The physical model is then transcribed into a mathematical model. The result is a nonlinear and complex problem. Using an empirical-scientific approach, the problem is simplified and decomposed into a two level problem. The upper level problem is solved by simple parametric programming. For the lower level problem two one-dimensional dynamic subprograms are used. Since selection of an optimal system design involves testing of a large number of alternatives, the direct application of the foregoing formulation requires several hours of computer time. A systematic search algorithm has been

developed which reduces the computer time to about 1% of that required without it.

The scope of this study is limited to only a relatively small subset of the overall conjunctive use problem in West Pakistan. Some other problems, however, are identified and suggested for future research.

The model is applicable to the canal systems with fresh water aquifer areas in West Pakistan and other regions with monsoon controlled surface hydrology. With extension of the model by including the water quality parameter, it can be applied to the other canal command areas.

The results of this research indicate that by optimal conjunctive use management of the Indus Basin Irrigation System in Pakistan, the available water resources can be used more efficiently and at a lesser cost; the ground water aquifer can serve as a functional reservoir and a recycling facility, considerably increasing the usable water resources; and the present "use-when-available" supply system could be developed into a "supply-on-demand" system. This will make other technological, social, and economic inputs more effective and meaningful. As a result, the agricultural produce in the country could potentially be increased by 5 to 6 times. Continued research extension and development are necessary to explore this potential and determine its attainability.

Mohammad Talib Chaudhry
Civil Engineering Department
Colorado State University
Fort Collins, Colorado 80521
March 1973

Appendix 3

International School for Water Resources and Associated Programs

Appendix G
 PARTICIPANTS FY '73-'74
 FOR
 INTERNATIONAL SCHOOL FOR
 WATER RESOURCES AND ASSOCIATED PROGRAMS

Participant	Highest Degree	Home Country	Financial Assistance Provided by	Length of Time in School	Dates	Special Interest	Remarks	Award
Al-Afifi, M. A.	B.Sc.,Ag.	Yemen	FAO	8 mo.	1/73-8/73	Irrigation Agronomy	Soil Specialist & Head of Soil Section, Ministry of Ag. & Agrarian Reform, Entered Grad. Sch. Agronomy Fall 73, M.S. Sum. 74	Certificate
Lopez, Antonio Y.	B.S.,C.E.	Colombia	AID thru Univ. of Nebr.	9 mo.	1/73-9/73	Water Resources	Engr. Hydrologist, SCMH. Entered Grad. Sch. Civil Engr. Fall 73	Diploma
Kwon, Soon-Kuk	B.S.,Ag. Engr.	Korea	AID	12 mo.	1/73-12/73	Water Control & Utilization	Jr. Research, Inst. of Ag. Engr. & Utilization, Entered Grad. Sch. Ag. Engr. Wtr. 74, M.S. Sum. 74	Diploma
Choopiban, Viset	B. of Engr., E.E.	Thailand	UN thru Bur. of Rec.	3 mo.	3/73-6/73	Power Systems	Electrical Engr., Nat'l. Energy Authority	Certificate
Ahnad, Chaudry, N.	M.Sc.,Chem.	India	FAO	6 mo.	3/73-12/73	Soils & Irrigation	Asst. Research Officer (soils) with Directorate of Land Reclamation, entered Grad. Sch. Agronomy Wtr. 74	Diploma
Agrawal, L. P.	B.Sc.,Engr.	Nepal	Ford Foundation thru UN-IEE	3 mo.	9/73-12/73	Irrigation Mgmt.	Engineer, Dept. of Irrigation, Hydrology, Meteorology, entered Grad. Sch. Ag. Engr. Wtr. 74	Certificate
Harleston, Alex E.	B.S.,C.E.	Sierra Leone	UN	12 mo.	3/73-3/74	Water Engineering	Sr. Executive Engr., Ministry of Works M.S., C.E., June 1974	Diploma

Participant	Highest Degree	Home Country	Financial Assistance Provided by	Length of Time in School	Dates	Special Interest	Remarks	Award
Shrestha, Sundar K.	B.S., Chem.	Nepal	FAO	12 mo.	6/73-6/74	Plant Virology	Asst. Plant Pathologist, Plant Pathology Section, Dept. of Ag. Ed. & Res.	Diploma
El Balla, Ahmed F.	B.S.	Sudan	FAO	12 mo.	9/73-9/74	Hydrology of Sub-surface Aquifers	Hydrologist, Ministry of Irrigation	Diploma
Kemprasit, San	B.S.	Thailand	AID	9 mo.	9/73-6/74	Water Resources Engr.	Civil Engr., Rural Development, Grad. Sch., Civil Eng., Sum. 74	Diploma
Im, Jeong Nam	B.S., Ag.	Korea	FAO	9 mo.	6/73-3/74	Soil Physics	Sr. Soil Physics Res. Officer, Soil Survey Div., Inst. of Plant Environment, Office of Rural Development, Grad. Sch., Agronomy, Spr. 74, M.S. Sum. 74	Diploma
Nolde Mariam, Yebio	B.S., Ag.	Ethiopia	FAO	6 mo.	9/73-3/74	Irrigation Agronomy	Agronomist for Irrigation Research, Grad. Sch., Agronomy	Certificate
Solanes, Miguel R.	Doctorate Law & Govt.	Argentina	UN	12 mo.	9/73-9/74	Water Resources Mgmt.	Specialist in Water Law & Administration Grad. Sch. Fall 74, Economics	Diploma
Omerkheil, M. K.	B.S.	Afghanistan	UN	6 mo.	1/74-6/74	Design of Civil Engr. Structures	Civil Engr., Provincial Dev. Dept.	Certificate

Participant	Highest Degree	Home Country	Financial Assistance Provided by	Length of Time in School	Dates	Special Interest	Remarks	Award
Mommandi, Amanullah	B.S.	Afghanistan	UN		1/74-	Water Resources	Civil Engr.-Costing, Water Survey & Irrigation Authority, Failed Grad. Sch.	
Ahmadzai, Ahmad S.	B.S.	Afghanistan	UN		1/74-	Water Resources Planning	Asst. of Planning Engr., Water & Soil Survey Authority, Ministry of Ag. & Irrigation, Failed Grad. Sch.	
Bhattacharai, Badri P.	B.S. B. Law	Nepal	AID	3 mo.	1/74-3/74	Groundwater Investigation/Water Chem.	Lab Tech., Groundwater Investigation Project, Ministry of Ag.	Certificate G-3
Jafar, Ata M.	B.E.,C.E.	Pakistan	AID		1/74-	Water Law & Related Aspects	Executive Engr., Irrigation & Power Dept., Gov't. of Baluchistan, Quetta	
Chavenia, Tomas O.		Philippines	FAO	3 mo.	3/74-6/74	Water Resources	Irrigation Sup't. I, Pili-Fulan-San Francisco Rivers Irrigation System, Sorsogon, Philippines	Certificate
Masagli, Amelia Clara Simone		Argentina	UN		3/74-		Asst. Research, INCYTH (CELA), Mendoza, Argentina	
Turbak, Abdulanis Sulaiman		Saudia Arabia	FAO	6 mo.	3/74-9/74	Irrigation & Drainage	Head & Instructor of Irrigation Drainage Section, Farm Engineering Training Centre, Riyadh, Saudia Arabia	Certificate

Participant	Highest Degree	Home Country	Financial Assistance Provided by	Length of Time in School	Dates	Special Interest	Remarks	Award
Lanna, Antonio Eduardo Leão		Brazil	IIE		6/74-	Land Use & Water Mgmt.	Professor at Centre d'Hydrologie Applique de Porto Alegre. Teaches hydrology-Analysis of Systems	
Tharatabhand, Chalood	B.S., Ag.	Thailand	FAO		6/74-	Soil Fertility	Soil Fertility Officer, Kalasin Project	
Thunya-Udom, Boripat	B.S.,Ag.	Thailand	FAO		6/74-	Irrigation Agronomy	Rice Researcher, Kalasin Project	
Udomsiang, Prayoon	B.S.,Ag.	Thailand	FAO		6/74-	Various Aspects of Agricultural Extension	Extension Officer, Kalasin Project	
Abraha, Berhane	M.S., CE	Ethiopia	UN		9/74-	Engineering Economics, Water Resources Econ.	Regional Manager, Co-manager of Water Supply Project, Nat'l. Water Resources Commission, Addis Ababa	
Bhorntus, Chavalit	B.S.,CE	Thailand	Royal Thai Embassy		9/74-		Engineer, Highway Dept., Material Testing & Research Div., Bangkok	
Kadri, Sadek Ahmed	B.S.,Geology	Libya	FAO		9/74-	Development of Ground-Water Resources & Irrigation	Geologist, General Water Authority, Government of Libya	

Appendix H

**Detailed Account of
CSU Accomplishments**

CSU Accomplishments

A. Accomplishments of Faculty

One of the original objectives as set forth by the 211(d) Institutional Grant was to expand the professional staff in various departments and to become more involved in water resource activities as it relates to water delivery and removal systems and institutional development in helping to meet the needs of less developed countries.

The original target at the end of the first five year period was to develop a magnitude of involvement from five departments (Agronomy, Agricultural Engineering, Civil Engineering, Economics, Political Science and Sociology) to have staff expertise developed to assist LDCs and for faculty to be available for short and long term assignments in the less developed countries. This has been documented many times in the requests received by CSU for professional assistance for these faculty to serve both in the U.S. and overseas. The following illustrate the competence gained and used by the professional staff as a result of the 211(d) Grant:

1. Agronomy

Dr. John Reuss, Department of Agronomy, has participated in the International Interdisciplinary Seminar and has been working with both staff and students in the College of Agricultural Sciences, in the Foreign Agriculture program and in Agronomy Club stimulating numerous programs on agricultural problems in LDCs. His work and presentations have been concerned primarily with modelling the delivery of water to irrigation projects and the water removal systems. He also has been advising students interested in foreign agriculture with specific interests in water management. Dr. Reuss is currently on leave to work with the Environmental Protection Agency on developing soils science and related research as an integral part of the environmental research effort as it will effect both the in-house and extramural components.

2. Agricultural Engineering

Very little irrigation is practiced in much of the humid and sub-humid areas of the LDCs. Crops are dependent upon natural rainfall which, although adequate in quantity is often poorly distributed throughout

the normal growing season. An irrigation system utilizing small, on-farm storage reservoirs would allow better use of precipitation during the normal cropping season, with corresponding increased yields. However, simple conveyance and distribution systems must be developed so that local farmers can use them on their small village plots.

Research plans include:

1. To develop a distribution and application system. The basic system will carry water from a storage reservoir and supply it to short furrows, closely attended by the irrigator.
2. To develop simple tillage tools that will form beds and furrows suitable for conveying and delivering water required for the growth of the major staple crops of maize, rice (furrow irrigated), and other crops.
3. To select some soils in Colorado with intake rates similar to those in tropical countries, demonstrate the systems proposed.
4. To develop management schemes which extension personnel can use to spread the systems on to the farm level.
5. To utilize published rainfall, crop yield and climatic data for a developing area, demonstrate that the proposed method is economically sound.

To accomplish these objectives of the Grant, both faculty and research assistants have pursued research in these areas. Professor Gaylord V. Skogerboe has traveled to Pakistan serving as a consultant and conducted a two week short course in Pakistan covering the following topics: (a) irrigation structures, (b) flow measurement, and (c) salinity control. He has also spent time touring the irrigated areas in Pakistan to review the present status of irrigation distribution systems. This tour allowed for a more realistic assessment of the current work on making recommendations for improvements to Pakistan's irrigation distribution systems, as well as providing more meaningful discussions at the short course.

Irrigation and Salinity. Professors Skogerboe and Wynn R. Walker have undertaken a study regarding the relationships of the irrigation distribution system to water management and salinity in Pakistan. Moh Mahmoodianshooshtai has been assigned to assist in this effort. The faculty are already deeply involved in such efforts in

the western United States, and now would like to apply this knowledge to West Pakistan. This greatly improves the capability of the faculty in undertaking meaningful research applicable to the water management and salinity problems in Pakistan and as these issues relate to worldwide irrigation problems.

The worldwide implications of this work are many fold. First, water delivery and measurement problems are areas of specific interest to irrigation planners in the developing countries, and thus, this material has wide general applicability. Second, a large amount of general information and design procedures have been collected into a few presentable sources. Consequently, a potential exists for developing additional useful design manuals, as well as preparing short courses which would facilitate rapid dissemination of project results in other countries. Finally, the faculty feel that their technical competence has reached a level where their expertise should be channeled towards problem evaluation and solution in developing countries.

Dr. Alan C. Early joined the Agricultural Engineering Department in September, 1973. He has been working on utilization of water delivery systems analysis to optimize cropping patterns and food production. His work is important because it looks at characterizing an existing water delivery and removal system and then provides ways for the water user to optimize his beneficial use of the water. Dr. Early has also developed and taught a water conveying delivery and irrigation course for non-engineers. He contributed to the weekly seminar on water delivery and removal systems and presented a seminar during the winter quarter entitled "Adapting the Cropping Pattern to the Water Supply." This presentation made a case for the potential for multiple cropping to effect a more efficient utilization of the existing water supply, and hence to produce a greater total amount of food and fiber for a developing nation. A case was also made for adaptive research to determine appropriate technologies and mechanization to effect the change to multiple cropping.

Dr. Early also prepared a case study on the Water and Power Development Authority of Pakistan for the Workshop on Water Delivery and Removal Systems held at CSU in April and May. This paper analyzed the

Authority as an organization, which plans, designs, supervises and constructs water delivery and removal systems. The topics included the historical evolution of WAPDA, the purposes and functions of WAPDA, the organizational structure of WAPDA, WAPDA's role in planning and design and construction of irrigation and drainage facilities, and WAPDA's interaction with other Pakistan departments. The paper was concluded by a critical evaluation of the Authority's accomplishments and shortcomings. In September of 1974, Dr. Early will be joining the CSU Water Management Research Staff in Pakistan for a two-year tour of duty. This demonstrates the utilization of 211(d) support on faculty in building competence and expertise which is beneficial to the LDCs.

Dr. William E. Hart advised Mr. Stephen W. Smith on research on water conveyance designs which will be suitable for distribution to small (1 to 5 acre) plots. Dr. Hart also spent two (2) months in Pakistan working on water courses and land leveling projects. His interest and competence has been greatly enhanced by the support furnished under the grant. Another example of building competence which has been utilized by the LDCs. Dr. W.D. Kemper, who has been on the staff of the Agricultural Engineering Department, has also assumed a 2 year assignment as chief-of-party of CSU's field operation of the Water Management Project in Pakistan.

During this reporting year, Professors Skogerboe, George Radosevich (Department of Economics), and Evan Vlachos (Department of Sociology) have planned and prepared the program for an International Conference on Global Water Law Systems to be held in Valencia, Spain during the summer of 1975. The 211(d) grant provided the funding and interdisciplinary program that brought these individuals together from three different departments to plan and conduct this important conference.

Another important accomplishment this year was the teaching of AE 555 "Irrigation Structures" in which much of the class material was derived from 211(d) grant supported research. During the course, significant improvements were made in the lecture notes which will allow revision of Water Management Technical Reports No. 6, 16, 17 and 18. As a result of this recent foreign and teaching experience, Professor Skogerboe has been made Co-Project director of the Water Management Research Project located primarily in Pakistan.

With the increased foreign role being assumed by Professor Skogerboe, a great deal of emphasis has been placed on making available the information developed with the support of 211(d) grant funds to foreign personnel. Water Management Technical Report No. 16 has been modified into a Colorado State University Experiment Station Bulletin (Technical Bulletin No. 120) and 2500 copies have been distributed in the western United States. Hopefully, the verification of this information will soon be demonstrated and can be highly recommended for Pakistan and other developing countries. The Agricultural Engineering faculty have also been working directly with AID in preparing a short publication on cutthroat flumes in both English and metric units for free flow conditions which will be distributed worldwide.

3. Economics

The 211(d) funding for Economics still serves as a catalyst for further improving the capabilities of the Economic staff in the areas of economic and agricultural development and water regulation and organizational structures.

Drs. Huntley Biggs, Ronald Tinnermeier, and George Radosevich participated regularly in the International Interdisciplinary Seminar on Water Resource Management, each conducting a seminar on a predesignated subject relating to their work and relevant to students and faculty. Dr. Biggs was also a member of the Planning Committee for the Seminar. Two Pakistani graduate students, Bashir Ahmad and Mumtaz Rana, although not funded under the 211(d) grant, also presented seminars on land leveling and agricultural credit, respectively. A number of Economics graduate students regularly attended the seminar, although none were funded under the grant. The student involvement is explained largely by faculty involvement and interest in the water resource problems in the developing areas of the world.

Dr. Gene Wilken, previously funded under the 211(d) grant, continues his work on resources management on small farms while on leave in Mexico. The past 211(d) funding assisted Dr. Wilken in improving his professional capabilities to the point where he now has obtained other funding from National Science Foundation for small farm resources management in developing countries.

Dr. Wilken spent 1973-1974 academic year in Mexico, Guatemala, and Honduras on a study of resources in water, soil, and space management in labor-intensive farming systems. This project was supported by the Foreign Area Fellowship Program and the National Science Foundation. Through Dr. Wilken's support and encouragement under the grant program, an environment of interest and expertise was created which not only enhanced professional competence but resulted in outside funding to benefit the LDCs.

Dr. George Radosevich has been engaged in examining and analyzing the local organizational arrangements for the spectrum of water delivery, use, and removal, as well as the related legislation creating or enabling the formation and operation of such entities. The organizational structures of the United States, Spain, and Taiwan were described in a paper presented to the Workshop on Water Delivery and Removal Systems and Related Institutional Structures. In addition to this effort, during the past year Dr. Radosevich served as Economic Affairs Officer and Water Law Specialist for the Water Resources Section, Resources and Transport Division, United Nations, New York. While there, his background and experience were greatly expanded. The opportunity to serve with the United Nations was a result of his previous involvement and acquired expertise under the 211(d) grant. The results of the one-year assignment have been further enhanced through 211(d) work performed in March of 1974. Dr. Radosevich has developed a widespread reputation in the field of water law and administration and is the Director of the International Conference on Global Water Law Systems to be convened in Valencia, Spain, during July, 1975.

Dr. Ronald Tinnermeier has become widely known in the area of small farm development, especially in the field of agricultural credit. Dr. Tinnermeier, because of the competence developed under the grant, will begin a two year assignment with USDA and Federal Extension Service working directly with USAID on land tenure, small farm development, and taxation. In December 1973, Dr. Tinnermeier traveled to Paraguay at the request of the AID Mission to work with the Ministry of Agriculture in small farm development. These requests are a direct result of the increased competence that Dr. Tinnermeier developed because of the financial assistance furnished by the 211(d) funds.

This support has enabled Dr. Tinnermeier to devote time and research in the field of small farm development and agricultural credit. Dr. Tinnermeier also presented a paper, "The Impact of Small Farmer Credit in Peru," at a Workshop on Empirical Studies of Small-Farm Agriculture in Developing Countries held at Purdue University.

Lack of credit is often a major constraint with the introduction of new technologies for small farms. The building of new water delivery or removal systems, or their repair, often requires large capital outlays. The availability of capital and its distribution is greatly affected by the existing credit institutional arrangements.

4. Civil Engineering

The faculty in the Department of Civil Engineering have continued the research work and teaching in the field of water removal and delivery systems. Working with CUSUWASH in this field and pursuing linkages in LDCs continue to be a major factor in the role of C.E. faculty.

Dr. Shaner is continuing to develop research plans and instructional programs in the economic analysis of water delivery and removal problems. Due to his competence gained by grant funds, it is anticipated that Dr. Shaner will have his research funded by other agencies in the coming year. Dr. Mahmood who was supported by grant funds is developing mathematical models for the water delivery systems taking into account the complex problem of sediment transportation as it pertains to water delivery and removal systems in LDCs. Drs. Maurice L. Albertson and Everett V. Richardson are working in Asia and South America with various government organizations on water delivery and removal systems. Dr. Richardson has been working with the Ministry of Public Works on the development of the Orinoco River in Venezuela. A cooperative agreement has been signed by the University of Los Andes at Merida and CSU to strengthen the cooperative program. It appears that CSU will be able to develop a cooperative program with the water resources division of the Ministry of Pakistan and with the Civil Engineering Department of ULA that will be beneficial to CSU and Venezuela.

Financial support was provided Professor George L. Smith to increase his competence in water resource systems as related to irrigation management practices in arid and semiarid regions of the world.

Specially, the financial support was used to develop a program in the efficient application of irrigation water to farmland in cooperation with representatives of the other members of the consortium who served on the Irrigation Management Program Committee. These were: M.A. Massengale, University of Arizona; J. Paul Riley, Utah State University; Warren Hall, Colorado State University; John Hanks, Utah State University; Ivan Stewart, University of California, Davis; William Franklin, Colorado State University; and Robert Danielson, Colorado State University.

Two objectives were achieved in the preparation of the program:

1. Because of the heterogeneous-social, political, agricultural, systems engineering-makeup of the Committee, each member was able to develop a broader as well as an in-depth grasp of those components, and their interrelationships on irrigation water management system as related to irrigation water delivered to or retrieved from a farm field. The delivery of irrigation water to a field, for example, might satisfy the soil moisture requirement of the crop, but failure to recognize the need for drainage -- water retrieval -- will usually lead to the subsequent establishment of undesirably high water table and/or salinity conditions within the soil profile as evidenced in the Indus Basin of the Pakistan-Indian subcontinent. In addition, the irrigation water management system of delivery and retrieval of irrigation water must function within a broad social-political-biological environment. For instance, in the early days of irrigation in the western United States, physical facilities were built to transport water to the land, but failure to recognize the need for effective socio-political-economic institutions at the user (farmer) level resulted in the bankruptcy and collapse of many of these early developments. Recognition of the role of the socio-political-economic institution is even more important today in the development of efficient irrigated agriculture of the L.D.C.'s.

2. The development of a program framework whereby existing knowledge of farm water delivery and retrieval could be synthesized into a general and broadly applicable set of procedures for increasing the efficient use of farm water of low quality such as the saline water now being used in the Indus Basin.

The program summarized in item 2 above has resulted in the development of two ongoing research programs under the sponsorship of the office of the Water Resources Research. By title, the research programs are "Water Production Functions and Predicted Irrigation Programs for Principal Crops as Required for Water Resources Planning and Increased Water Use Efficiency" and "Optimizing Crop Production through Control of Water and Salinity Levels in the Soil." These research programs are aimed basically toward the more efficient use of low quality water delivered to the farm plot. Professor Smith is participating as co-principal investigator in both of the above proposals.

Competence developed as a result of the grant fund has enabled Professor Smith to fulfill the responsibilities and expertise needed to gain further research and funds to continue to develop research in water delivery and removal problems as they apply to LDCs.

5. Political Science

A considerable amount of non-U.S./AID resources supported both the interdisciplinary seminar and the development of the Ph.D. in Political Science referred above. In addition, 211(d) and non-U.S./AID funds supported Professor Caulfield whose many activities included consultation for the United Nations, and the Governments of India and Yugoslavia.

The faculty in this department have continued to have a dominant interest in water resources development with special emphasis on water delivery and removal systems.

A considerable amount of non-U.S./AID resources supported both the interdisciplinary seminar and the development of the Ph.D. in Political Science referred above. In addition, 211(d) and non-U.S./AID funds have supported Professor Caulfield whose many activities included consultation for the United Nations, and the Governments of India and Yugoslavia.

Professor Caulfield, who has an international reputation in the water resources field, taught both graduate and undergraduate level courses, supervised graduate thesis work and directed the interdisciplinary seminar on international water resources management, See Appendix E.

6. Sociology

Dr. Evan Vlachos' support under the grant has so and broadened his competence that he has developed a rapport with the departments of Economics, Agricultural Engineering and Civil Engineering which enables the CSU faculty to prepare papers and reports which consolidate the technical and sociological considerations in irrigation water management as it relates to water delivery and removal systems. Dr. Vlachos also holds a joint CSU appointment in the departments of Sociology and Civil Engineering. Dr. Vlachos has been invited to participate in and present papers at the meetings of the American Society of Civil Engineers, Rural Sociological Society, Irrigation and Drainage Section of ASCE, the American Water Resources Association and others. Dr. Vlachos also had an opportunity, as a result of competence developed through grant funding, to work with World Bank, the Army Corps of Engineers, and a number of private companies concerning larger problems of water resources and an assessment of the role of water planning both in the U.S. and abroad. Dr. Vlachos has also been responsible for significant progress in his Department to bring about an understanding and acceptance of the role of the sociologist in an essentially engineering field of water delivery and removal systems. Students and faculty have been oriented and trained in the problems of water development and an understanding of how natural resources, and their utilization and limitations affect the rate of development of many nations.

Dr. Vlachos is also developing the capabilities within the Department to respond to problems in water removal and delivery systems through research into the interface of water and society and an understanding of the dynamic processes involved in the interconnection between water supply, water control, water distribution, water utilization and water reclamation, and through faculty and staff participation in conferences and seminars. Through moderately supported by Grant Funds, the entrainment and other effects generated include:

1. Adding a whole new educational dimension in the Sociology Department.
2. Receiving an appointment as a Sociology/Engineering Professor to inject the Sociologist's viewpoints to the Engineer in the field of Water Resources Development and Research.

3. An increasing use is being made of the Sociologist, both on and off campus, on the workability of the interdisciplinary approach to solving development problems. Dr. Vlachos has had extensive input on the interdisciplinary approach on research developed through CUSUSWASH.

Grant funds have made it possible for Dr. Vlachos to now have a joint appointment in both Sociology and Engineering, to participate as an advisor with other departments on theses and to develop competence as truly an interdisciplinary faculty. Some of these activities are as follows:

(a) Working with the Council Committee on the Irrigation Handbook. prepared outlines and worked closely in developing format.

(b) Participated in the theses of the following: Mohammad Talib Chaudhry, Herbert G. Blank, Ata M. Nazar, Janakiram Subramaniam, all engineering graduate students.

(c) Worked closely to prepare, organize, and run a two-quarter sequence of a faculty-student seminar on "Limits to Growth" with particular emphasis on population and water resources.

(d) Participated as a panel member to the Environmental Design Section of the annual meeting of the American Society of Civil Engineering in New York.

(e) Published as editor Transfer of Water Resources Knowledge. Fort Collins: Water Resources Publication, 1973, 540 p.

(f) Currently working with F. Deseran (GRA) on a library resource project attempting to put together a document dealing with library resources and material relevant to the study of development and planning with emphasis on the use of natural resources.

(See Appendix I)

B. Research Assistants

1. Agronomy

Only one research assistant is receiving grant support. Mr. Jacob Dane, under the direction of Dr. Arnold Klute, has been conducting research on the effect of salts on the hydraulic conductivity of swelling soils. Removal of irrigation water from the soil profile is affected by the hydraulic conductivity of the soil, which is in turn affected by the salt content of the water. A review of the pertinent literature has been made and a pilot model of a permeameter for the studies has been

constructed and tested. The permeameter provides for the measurement of the hydraulic conductivity of a swelling soil as a function of solution composition, external (overburden) load, soil water suction, and water content. Most previous studies of the effect of salts on hydraulic conductivity have been conducted on saturated soils, with no control or measurement of the bulk density, and water content. The information to be obtained from the present study will be useful in predictions of water and salt movement occurring during drainage of soils.

The objectives of this investigation will be to determine the effect of salt on unsaturated hydraulic conductivity, find a relationship between the hydraulic conductivity and the variables on which it depends, and incorporate this relationship into the transport equation for soil-water movement.

Most studies on the effect of salt on hydraulic conductivity were conducted using saturated flow. In general, it was found that the hydraulic conductivity decreased with: i) decreasing total salt concentration; ii) increasing SAR value of the salt solution; iii) increasing ESP value of the soil; iv) increasing clay content; and v) increasing pH. Soil water diffusivity experiments for horizontal flow, however, were reported to show a decrease in diffusivity with increasing ESP of the soil and with decreasing electrolyte concentration. This study will have a direct application to the salinity problems of LDCs.

The Department of Agronomy has six undergraduates in the B.S. program "Foreign Service in Agronomy" and one graduate student working for his M.S. degree. This program emphasizes the training needed for foreign service. Another M.S. candidate has returned from the Peace Corps. With the availability of foreign students and with the International Seminars from other programs, these are excellent opportunities for training of U.S. students for foreign service.

2. Agricultural Engineering

Sixteen (16) graduate students in Agricultural Engineering have chosen CSU because of its reputation and interest on water delivery and removal systems developed through 211(d) grant. These and other graduate students in other departments are listed in Appendix D.

Stephen W. Smith, Research Assistant in Agricultural Engineering has been working on the potential of minimizing seepage losses in earth channels, which could be utilized by the agriculturalist of the developing countries, is through sealing the water channel by "puddling" the soil. When a surface soil in a wet and plastic condition has been worked until its pore space is much reduced, it becomes practically impervious to air and water and is said to be puddled. When a soil in this condition dries, it usually becomes hard and dense.

In order to study the effect of soil puddling on channel seepage losses, three sites with differing soil types were chosen on which test channels could be established. Two of these sites were near Fort Collins, and one was near Grand Junction, Colorado.

Seepage losses were monitored by using a conventional hook gauge to determine the drop in the water surface elevation with time. Between periods of taking data, the water level in the channel was maintained by a pressure regulator and float-controlled valve arrangement.

Specific goals to be accomplished. The purpose of this project is to determine the full potential of soil puddling for channel lining by determining, for various soils,

(a) How much the water infiltration rate is reduced by puddling both in the laboratory and field.

(b) By what means the soil can best be puddled under the constraints of the developing country.

Present status of accomplishments. The field work associated with this project is now completed, and analysis of the data is underway. A detailed outline of the thesis which will result from this research is finished, and the thesis itself will be finished by February 1975.

Relationship of your research with grant objectives. This research is particularly important in areas of the world where good quality water is at a premium for water to be conserved and not wasted. Decreasing the amount of water lost during transport is obviously a means of better utilizing available water resources.

How will this research benefit and possibly be utilized by the developing countries? If the puddling of soil does prove to be a reasonable method for reducing seepage losses in delivery channels, it

is a method that could be readily utilized by a developing country with a labor intensive economy. This channel lining method should require only hand tools, but could probably be adapted to some type of animal drawn tool also.

Mr. Qurban Ali Khan is now finalizing his reasearch program on small irrigation structures used in West Pakistan, and utilizing this information in designing such structures. This new information will be compared with the existing information to determine:

1. Which structures have adequate design information;
2. For those structures having inadequate design information;
 - a. Use existing data to improve design information, or
 - b. State the requirements for gaining the additional needed design information.

Mr. Khan, in concluding his study on small irrigation structures used in Pakistan will write his thesis "Irrigation Management in Pakistan", which relates to specific water delivery and removal structures. This will identify present designs of structures which can be upgraded. Mr. Khan will be transferring to Texas A & M to complete his studies for a doctoral degree. An abstract of this thesis is found in Appendix F.

3. Civil Engineering

Mr. Herbert G. Blank is working in the area of "Application of Mathematical Programming Techniques to the Planning of Water Resource Projects in a Developing Country" under the supervision of Dr. Maurice L. Albertson. The research has taken a two pronged attack; on one hand the research has concentrated on the "development" aspects and on the other, the "systems" and mathematical programming applications. Hopefully, the two combined will result in being a contribution to the planning process in developing countries.

On the "development" side research has been the collection of current development literature. In addition to the broad development field, there has been a focus on development in Africa with a particular emphasis on resource development and the need for water resource development in Botswana. Published and unpublished literature has been collected on Botswana,

current developments have been watched and in-country contracts have been made.

Several areas of needed research relating to water delivery and removal were suggested by officials of the Botswana government and work has continued on these, hampered however by the lack of funds to continue research in the country and the collection of needed data. Permission has been granted to engage in research in the country and various sources of funding were sought but the results have been unsuccessful.

On the other front, research has continued on relevant systems approaches to water supply and removal problems. Course work and literature reviews have concentrated on mathematical programming techniques which model the physical situations and attempt to determine optimal designs and/or operating procedures. Work has continued on an irrigation planning model and initial work has been done on a groundwater model incorporating the conjunctive use of surface water for irrigation. Work will continue on both of these models from available information. It is hoped that both models will be useful in planning for the development of the water resources of Botswana and other L.D.C.'s. However, for maximum use, use, familiarity with the Botswana situation and inclusion of actual data from the country obtained through fieldwork would be necessary.

The research is planned to continue through June 1975, the results being published in several papers and a Ph.D. dissertation. It is hoped that the research will not end there but will continue with the modeling of the economy of a developing country, including water as one of the key factors.

Mr. Janakiram Subramaniam carried out the following activities under the general supervision of Dr. Maurice L. Albertson.

1. Organized, edited and supervised transcription of tapes and typing for the conference, "Population and Development: Alternative Futures for the West," held at CSU, August 1-3, 1973.
2. Worked as an organizing secretary, rapporteur for the workshop on Water Delivery and Removal Systems and Related Institutional Structures from its initial conception in early 1973 to its completion in May/June 1973.

3. Rapporteur for the workshop on International Development sponsored by CAIE and CSU on March 29, 1974.

4. Conducted research on Water Resources Institutions. Progress is being made in the following areas:

a. Literature Review in the field of Institution Building with special reference to delivery and removal systems.

b. Finding the range of institutional mechanisms available for the development of water resources.

c. Development of a suitable framework for analyzing the complex interactions between and within water resources institutions.

A thesis on this research is being written and will be published as a technical report.

Last year Mr. Ata M. Nazar completed his M.S. degree under the direction of M.L. Albertson on "A Laboratory Study of Med Material Withdrawn in Farm Turnouts." An abstract of this thesis is included in Appendix F. Ata Nazar continued his course work for his Ph.D. and has returned to Afghanistan where he is working in the College of Engineering, University of Kabul. He will do his research on the planning of water delivery and removal systems in Afghanistan, for which he will continue to receive guidance from CSU faculty and will have a dissertation committee from both CSU and the University of Kabul. This is the kind of research which will be performed and apply directly to the problems of LDC's.

Dr. Mohammad Talib Chaudhry completed his doctoral program at CSU in March 1973 with Dr. Maurice L. Albertson as his advisor, and continued to serve on the staff of the university in expanding the research on conjunctive use for further funding from other agencies.

An abstract of Dr. Chaudhry's dissertation is found in Appendix F. A technical report based on this dissertation was written by Dr. Chaudhry and has been published as CUSUSWASH Technical Report No. 30. Other publications written by Dr. Chaudhry relating to Water Delivery and Removal Systems during his service at CSU are:

1. Rawal Dam Project (Technical record of planning, design and construction)

2. Research and Education for Development

faculty to maintain contact and to work with water delivery and removal systems and their associated institutional arrangements.

3. Water Resources Training and Information Dissemination Programs at CSU

4. Dynamic Optimization Model for Comprehensive River Basin Planning

Dr. M.T. Chaudhry has returned to Pakistan and has accepted a position with the National Engineering Services in Pakistan. This linkage will continue with CSU in assisting with research in Pakistan.

Dr. Alfred J. Tamburi completed his studies for his doctoral degree in June 1974. His dissertation on "Geology and the Water Resource System of the Indus Plains" is listed in Appendix F with an abstract of this report attached. This research involved experimental studies to help provide a rational basis for development of the surface water resources of the Indus Basin. This information has been furnished to the field team on the Water Management Research Contract and to USAID for their use and dissemination. Another way in which research performed under the grant is assisting the LDC's and an exchange of information has been established.

4. Economics

The future research of five Pakistani students in the Department of Economics will relate to the water resources program for less developed countries. This is a result of the 211(d) funding which allows Economics faculty to maintain contact and to work with water delivery and removal systems and their associated institutional arrangements. These students have not been funded under the grant.

Chris Dowsell, was funded under the grant during this reporting year and spent three months last summer in Peru under the Foreign Area Fellowship Program, dealing with Economic Approaches to Education Research and Planning. He completed a study entitled, "The National Agrarian University in Peru: A Political and Economic Appraisal of its Educational Contribution to Agricultural Development." Beginning in

September, he spent nine months in Guatemala conducting his M.A. thesis research. His efforts were devoted to conducting, "An Evaluation of the Irrigation Program for Small Farmers." This program is being financed by the Inter-American Development Bank. The effectiveness of this program is decidedly affected by political realities and bureaucratic institutions having charge of the program.

5. Political Science

One research assistant, Mr. Bailey Wharton, was supported by the 211(d) grant funds for FY 1974-1974. He completed his masters program on the lower Mekong River Basin development project, under the general supervision of Dr. Henry Caulfield. Mr. Wharton finished writing his thesis in June 1974. The study of "The Mekong Committee-An Organization of Synthesis" was designed to analyze the work of the Committee and to determine the successfulness of the committee (1) in maintaining its own organization by means of a compatible membership and (2) the Committee's program in terms of its goal contrasted to its accomplishments. An abstract of his thesis is part of this report in Appendix F.

6. Sociology

Forrest Deseran continued his bibliographic analysis, participated in the formulation and running of the Workshop on Water Delivery and Removal and is currently completing a document dealing with library resources and research techniques relative to the social aspects of natural resources (See Appendix I). The bibliography is a part of a proposed manuscript dealing with library resources and research material relevant to the study of development and planning. Because such a concern encompasses a broad range of disciplinary perspectives, it would be presumptuous to claim that the present bibliography is either complete or comprehensive. However, it is offered as an opportunity for generating feedback concerning both the adequacy and scope of the classification scheme proposed, as well as the range of the particular periodicals.

Two features of this publication justify its addition to bibliographical materials, especially the Serials Book Catalog, already available at CSU: 1) the periodicals are categorized according to major areas of interest, i.e., Economics, Geography, Political Science, etc. At the same time, periodicals which fall under more than one area, such as Social and Economic Studies, are cross-classified and appear under appropriate categories. 2) Some periodicals not available at CSU are available at nearby libraries of Colorado University, Denver University, University of Northern Colorado.

The selection of periodicals for this bibliography has been guided by the following criteria. The bibliography began as a personal collection generated during the course of a demographic research project. As the bibliography grew, several colleagues expressed an interest in obtaining a copy for their own files and consequently the idea emerged for a more complete manuscript dealing with library resources. Numerous individuals have been helpful in adding to the bibliography and suggesting categorical modifications. It is envisaged that a final manuscript incorporating revisions and further bibliographical references and explanatory essays as to resource materials in the area will serve as a valuable tool for further research in the area of water resources as it relates to the study of development and planning.

The bibliography is divided into two parts. The first section contains approximately 600 references and the second section is annotated selections of approximately 300 items which were selected by the faculty as being the most useful in the social sciences field as related to natural resources.

Even though support for this research was discontinued from grant funds, the publication will be printed and be available for distribution. Outside funding was generated as a result of an initial investment by the 211(d) grant funds.

C. Technical Publications

A number of publications in water management, as it relates to water delivery and removal systems, have been produced by the faculty and staff at CSU. These include:

(1) Small Farm Agricultural Development Problems, edited by Huntley H. Biggs and Ronald L. Tinnermeier. This book includes a collection of papers from many disciplines which were presented at the International Interdisciplinary Seminar on Water Resources Management. Partial funding of the book is from the 211(d) project. Drs. Biggs, Tinnermeier, and Wilken have prepared papers for this book.

(2) A paper by Ronald L. Tinnermeier, entitled "The Impact of Small-Farm Credit in Peru," will soon appear in a Praeger Book, Small Farm Agriculture Studies in Developing Nations. No 211(d) funding was used for this paper, but it is a direct result of the author's involvement in development as a consequence of the "seed money" from the grant.

(3) Two articles by Ronald L. Tinnermeier on agricultural credit resulting from work in the AID Spring Review for Small Farm Credit will soon appear, one in AID's Development Digest and the second in an edited book on Small Farm Development produced by the National Planning Association.

(4) Two reports have been produced during the 1973-1974 term by Dr. Radosevich that have received partial support from 211(d). The first is a paper entitled "Moslem Water Law and Its Influence on Spanish Water Law," presented at the Seminar on Legislation and Administration of Waters of the Andean Pact Countries in Quito, Ecuador, 18 January 1974 and published in the Seminar proceedings. The second report, entitled "Institutional Alternatives to Local Water Management," is contained in the proceedings of the Workshop on Water Delivery and Removal Systems, published in April 1974, Colorado State University.

(5) The thesis prepared by Mr. Qurban Ali Khan on "Irrigation Management in Pakistan", has led to important advances in the design technology of irrigation structures.

(6) Transfer of Water Resources Knowledge was published as a Water Resources Publication with Dr. Evan Vlachos serving as the editor of this publication.

(7) The Chapter, "Metaphors, Scenarios and the Planning of the Future" in Victor A. Koelzer et al. (eds.), Population and Development, was written by Dr. Evan Vlachos.

Other technical reports prepared during the reporting year that have been published as a CUSUSWASH report. These titles are as follows:

1. Conjunctive Use of Indus Basin Waters. Pakistan
2. Program for Computing Equilibrium Solution Composition in CaCO_3 and CaSO_4 Systems from Irrigation Water Compositions
3. Physical, Salinity, and Fertility Analyses of Selected Pakistan Soils
4. Practical Skimming Well Design
5. Informational Sources for Water Management for Agricultural Production in Pakistan

Copies of the title page and abstract are attached as part of this Appendix.

H22

**CONJUNCTIVE USE OF INDUS BASIN WATERS - PAKISTAN:
A GENERAL SUMMARY OF Ph. D. DISSERTATION**

Water Management Technical Report No. 30

by

Mohammad Talib Chaudhry

**Prepared under support of
United States Agency for International Development**

Contract No. AID/csd-2162

**"Water Management Research
in Arid and Sub-Humid Lands of the
Less Developed Countries"**



**Colorado State University
Civil Engineering Department
Fort Collins, Colorado**

March 1973

CER 73-74 MTC 24

Chaudhry, Mohammad Talib. Conjunctive Use of Indus Basin Waters - Pakistan. (Summary of Ph.D. Dissertation) Water Management Technical Report No. 30. Colorado State University, Fort Collins, October 1973.

ABSTRACT

This study is a part of the "Grow More Food" campaign of our civilization for world peace and prosperity. It provides a working mathematical model for analyzing and optimizing the conjunctive use of surface and ground water resources of West Pakistan. In specific terms, the objective of the study is to determine the size of the canal system, the surface reservoir, and the ground water pumping facilities, such that, when the system is operated optimally, the capital and operation and maintenance costs of meeting the given irrigation water requirements are minimized.

The results of this research indicate that by optimal conjunctive use management of the Indus Basin Irrigation System in Pakistan, the available water resources can be used more efficiently and at a lesser cost; the ground water aquifer can serve as a functional reservoir and a recycling facility, considerably increasing the usable water resources; and the present "use-when-available" supply system could be developed into a "supply-on-demand" system. This will make other technological, social, and economic inputs more effective and meaningful. As a result, the agricultural produce in the country could potentially be increased by 5 to 6 times. Continued research extension and development are necessary to explore this potential and determine its attainability.

The scope of this study is limited to only a relatively small subset of the overall conjunctive use problem in West Pakistan. Some other problems, however, are identified and suggested for future research.

H24

PROGRAM FOR COMPUTING EQUILIBRIUM SOLUTION
COMPOSITION IN CaCO_3 and CaSO_4 SYSTEMS FROM
IRRIGATION WATER COMPOSITIONS

Water Management Technical Report No. 29

by

Dhanpat Rai and W. T. Franklin

Supported by

United States Agency for International Development
Contract No. AID/csd-2162
Water Management Research in Arid and Subhumid
Lands of the Less Developed Countries

Agronomy Department
Colorado State University
Fort Collins, Colorado

October, 1973

ID 73-74 - 2

Rai, Dhanpat and W. T. Franklin. Program for Computing Equilibrium Composition of CaCO_3 and CaSO_4 Systems from Irrigation Water Compositions. Council of U. S. Universities for Soil and Water Development in Arid and Sub-Humid Areas, Water Management Technical Report No. . (Fort Collins: Colorado State University), October, 1973.

ABSTRACT

A computer program was developed to calculate equilibrium solution compositions in calcareous and gypsiferous systems. The calculations in the program are based upon published solubility products of calcite and gypsum and take into account ion-pair formation and the solubility enhancement of calcite resulting from the presence of Mg^{++} and $\text{SO}_4^{=}$ in the solution. For a given pre-equilibrium solution, the program predicts equilibrium ionic strength, ionic activity coefficients, dissociated (free) ions, ion-pairs, and total concentration of solution species, amount of CaCO_3 precipitated or dissolved at a specified partial CO_2 pressure, and the amount of gypsum precipitated. Lime and gypsum solubility results predicted with the computer closely agree with published experimental results. The program is suitable for assessing the sodium and salinity hazards of marginal quality waters using other independently developed parameters, such as the concentrating effects taking place in the soil solution due to evapotranspiration during the cropping cycle and partial CO_2 pressures developed under particular soil and cropping conditions.

H26

**PHYSICAL, SALINITY, AND FERTILITY ANALYSES
OF SELECTED PAKISTAN SOILS**

Water Management Technical Report No. 28

by

W. T. Franklin and W. R. Schmehl

Supported by

**United States Agency for International Development
Contract No. AID/csd-2162 ~
Water Management Research in Arid and
Subhumid Lands of the Less Developed Countries**

**Agronomy Department
Colorado State University
Fort Collins, Colorado
August 1973**

ID 73-74 - 3

Franklin, W. T. and W. R. Schmehl. Physical, Salinity, and Fertility Analyses of Selected Pakistan Soils. Council of U. S. Universities for Soil and Water Development in Arid and Sub-humid Areas, Basic Data Report No. . (Fort Collins: Colorado State University), August, 1973.

ABSTRACT

Textural, moisture retention, and salinity-related analyses are reported for 58 soil samples representing profiles from 11 sites in the Punjab. These alluvial soils contain more than 45% salt in surface layers at 9 sites and as much as 80% salt in subsoil layers. Thus, the high-silt soils are expected to be subject to weak aggregate stability, compaction, and low permeabilities. Soil moisture retention values can be estimated from textural analyses using the following regression equations: (1) $\text{Log } 1/3\text{-Bar Moisture \%} = 0.836 \text{ Log } C + \text{Si}(<50\mu)\% - 0.179$, (2) $15\text{-Bar Moisture \%} = 0.48 C + \text{FSi}(<5\mu)\% + 0.3$. Improved exchangeable sodium percentage (ESP) estimates from sodium-adsorption-ratio (SAR) measurements of saturation extracts can be obtained with the following regression equations: (1) $\text{ESP} = 0.90 \text{ SAR} + 1.94$, or (2) $\text{ESP} = \frac{100 (.0124 \text{ SAR} + .0063)}{1 + (.0124 \text{ SAR} + .0063)}$. The fertility status of 110 soil samples from 4 Pakistani Provinces was assessed. The low organic matter content (<1%) in the alluvial soils explains the large N response found for non-leguminous crops. Available P is deficient (<10 ppm) in most soil surface layers. Available K is generally adequate (>100 ppm) to very high. Available Zn may be inadequate (<1 ppm) for Zn-sensitive crops at about one-third of the sites tested. Iron, Mn, and Cu were generally adequate for the large majority of the samples.

H28

PRACTICAL SKIMMING WELL DESIGN

WATER MANAGEMENT TECHNICAL REPORT NO. 27

by

F. A. Zuberi

and

D. B. McWhorter

Prepared under support of

United States Agency for International Development

Contract No. AID/CSU

Water Management Research

in Arid and Sub-Humid Lands of the

Less Developed Countries

Colorado State University

Fort Collins, Colorado

CER 73-74 FAZ-BBM 23

F. A. Zuberi and D. B. McWhorter - Practical Skimming Well Design.
CUSUSWASH Water Management Technical Paper No. 27. (Fort Collins, Colorado
State University) December 4, 1973.

ABSTRACT

Well patterns and designs have been investigated in order to compare the technical performance and costs of several possible skimming facilities. It was established that, for aquifer properties typical in Pakistan, individual skimming wells can be expected to discharge in the range of 0.1 to 0.2 cfs. It is shown that several closely spaced wells can be pumped at a higher total discharge than a single isolated well, even though the individual wells in the battery are discharging at less than capacity. This results from the fact that distributed pumping produces a smaller maximum drawdown than does a single well pumping at the same rate. The discharge obtained by pumping in battery from closely spaced wells (i.e. 10 to 15 feet apart) is approximately 60 percent greater than for a single isolated well. The increased investment for the battery of wells is more than 60 percent higher than for a single well, however.

Costs estimates are contained in the report that indicate a single skimming well will cost approximately Rs. 2200. A typical private tubewell costs approximately Rs. 7000 for comparison. On a per unit discharge basis, the investment in a private tubewell is about Rs. 7000 per cfs and for a skimming well about Rs. 18,000 per cfs. Operating costs for electrically powered skimming wells is estimated to be about 15 percent of the operating cost for a typical private tubewell. On a per acre foot of water pumped, a skimming well will provide water at about Rs. 20 per acre foot compared with a cost of about Rs. 13 per acre foot for a private tubewell.

H30

Informational Sources for Water Management
for Agricultural Production in Pakistan:
With Special Reference to Institutional
and Human Factors

VOLUME II

by

Garth N. Jones, Ph.D.

M. Bashir Malik, Ph.D.

Abdur Rehman Rizwani, M.A., M.A.

Robert F. Schmidt, M.A., S.T.M.

Prepared under support of

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Contract No. AID/csd-2162
Water Management Research
in Arid and Sub-Humid Lands
of the Less Developed Countries

Colorado State University
Fort Collins, Colorado
April 1974

Abstract

The published and unpublished research on water management is overwhelming. Just a decade ago the literature was slight and the annual output relatively small. However, with the beginning of the 1960's there occurred a widespread interest in water management and a virtual avalanche of materials resulted. There is no easy way to deal with this problem. At several institutions, special collections have been started; new information retrieval systems are being developed, and numerous specialist bibliographies prepared.

For over one year we, along with others, struggled gamely with this problem. We tried to be selective and innovative. However, we accomplished neither. The problem was beyond our research resources. A computer information retrieval system is the only solution. We hope that we have offered some suggestions in this area.

Garth N. Jones assumed the primary responsibility for preparing the bibliographic section on Pakistan. Robert Schmidt did the same for the non-Pakistan bibliographic section as well as the compilation of journals and periodical literature. As indicated in the introduction to Volume I, Messrs. Jones and Schmidt were assisted by a number of persons. Again we wish to acknowledge their assistance, without which this undertaking would have never been completed.

Garth N. Jones
Robert Schmidt
February 1973

D. Seminars and Workshops

Dr. Evan Vlachos has been very active during this reporting year by participation in several Workshops. These are:

1. "Workshop on Water Delivery and Removal Systems" and actively participated for four days in April 30 - May 3, 1974.
2. Preparing a plan of a conference on "Global Water Law Systems" to be held in Valencia, Spain, with emphasis on irrigated agriculture, co-sponsored by AID, Rockefeller Foundation, U.N., and Ford Foundation.
3. Chairman, panel member and discussant in the following conferences only partly supported by 211(d):
 - (a) "Social Well Being/Quality of Life Dimension in Water Resources Planning," Logan, Utah
 - (b) "On-Farm Water Management and Implementation Symposium," Park City, Utah
 - (c) Presented in the above workshop a paper entitled: "Water and Society" at the "Workshop on International Development," Fort Collins, Colorado.
4. Actively worked in the Conference "Population and Development" in organizing the program and chairing a panel.

Dr. George Radosevich also participated in planning the conference on "Global Water Law Systems" to be held in Valencia, Spain in 1975.

Dr. M. L. Albertson, Evan Vlachos, Gaylord Skogerboe, Alan C. Early and Henry Caulfield met and organized a Workshop of Water Delivery and Removal Systems and Related Institutional Structures held at CSU on 30 April, 1, 2, 3 May 1974.

Drs. Evan Vlachos, M. L. Albertson and David Hendricks, prepared, organized a two-quarter faculty-student seminar on "Limits to Growth" with emphasis on population and water resources.

E. Library Acquisitions

During this reporting year, the library has expanded to include 88 new publications. These publications were not all purchased by 211(d) funds as there are other water management contracts which contribute publications to the library. Some publications are mailed

directly to Pakistan for use in the cooperating country. However, most of these publications will be added to the approximately 1400 publications in CSU Morgan Library as part of the total library collection in the field of water resource development. A list of these publications is as follows:

Publications purchased from grant funds:

1. Area Handbook of Thailand
2. Water Resource Systems Engineering
3. Pocket Flight Guide
4. Administrative Management
5. East Pakistan Land and Water Development as Related to Agriculture
6. Research and Development Directory
7. Future Water Demands
8. Metropolitan Water Management
9. Conditions of Agricultural Growth
10. Measuring Development - The Role and Adequacy of Development Indicators
11. Foreign Resources and Economic Development
12. Economic History of Tropical Africa: Colonial Period
13. Subscription to KIDMA
14. Subscription to Mahfil: A Quarterly of South Asian Literature
15. From Peasant to Farmer
16. Directory of Foreign Area Fellows 1952-1972
17. Water Supplies and Economic Growth in an Arid Environment: An Arizona Case Study
18. Economic Development of Agriculture
19. World Food Production
20. We Don't Know How
21. Subscription to Department of State Newsletter
22. Subscription to Ground Water Newsletter
23. Sophonboon Prasin (for Bailey Wharton)
24. Bridges to Understanding
25. Iran: Economic Development under Dualistic Conditions
26. The Theory of Share Tenancy

27. Research & Development Directory for 1972
28. International Organization: A Classified Bibliography
29. Sir Sayyid Ahmad Khan's History of the Bijnor Rebellion
30. Five Articles on Development Administration in Pakistan
31. Four Articles of Population and Family Life in Taiwan
32. Manual for Writers
33. Oxford World Atlas
34. 17 prints from Eros Data Center (Tamburi)
35. American's Water Resources for Economic Development
36. Reconnaissance Geology of Part of West Pakistan (Tamburi)
37. 3 Topographical maps of the I/M series (India) (Tamburi)

Publications purchased from outside funds:

1. Irrigation, Drainage and Salinity
2. Successful Irrigation - Planning, Development, Management (3 copies)
3. Measurement and Estimation of Evaporation and Evapotranspiration
4. Plant Water Relations, Irrigation Management and Crop Yield
5. Relations Between Drought and Corn Yields on Selected South Atlantic Coastal Plain Soils
6. Plan Puebla After Six Years
7. Effects of Irrigation Regime on Yield and Yield Components on a New Triple-Dwarf Wheat Variety
8. The Effect of Water Stress at Various States of Development on Yield Processes in Wheat
9. The Andosol or Humic Allophane Soils of South America
10. Arid Zone Irrigation
11. World Poverty and Development
12. Population and Affluence: Growing Pressures on World Food Resources
13. Scientific Allocation of Water Resources
14. Soybeans: Improvement, Production and Uses (2 copies)
15. Economics of Agricultural Production and Resource Use
16. 37.50 to US Committee on Irrigation, Drainage and Flood Control for payment on something (It does not say what the payment is for)

17. Economics of Irrigation
18. Role of Water in Agriculture
19. Subscription to Agronomy Journal
20. Subscription to Soil Science Society of America Proceedings
21. Economics of Land Forming in the Eastern United States
22. Transfer of Water Resources Knowledge
23. Psychrometry in Water Relations Research
24. Water Measurement Manual (4 copies)
25. Overcoming World Hunger
26. Advances in Procution and Utilization of Quality Cotton: Principles and Practices
27. Chemical and Physical Properties of the Alluvial Soils in South Vietnam
28. Research for the World Food Crisis (4 copies)
29. Subscription to the Pakistan Times
30. Interoffice Memo subscription
31. Irrigation Canal Lining
32. Farmer Water Management Seminar-Manila
33. Village Handbook
34. Irrigation and Drainage of Arid Lands in Relation to Salinity and Alkalinity
35. Water Deficits in Plant Growth, Volume II
36. Planning for An Irrigation System (2 copies)
37. Subscription to International Develop and Review
38. Survey of International Development (subscription)
39. Water Deficits in Plant Growth, Volume I
40. Water Deficits in Plant Growth, Volume III (3 volumes altogether)
41. Irrigation and Drainage papers #1,2,3,4,6,7,10
42. Research and Development Directory
43. R & D Contract Monthly
44. Development Policy II: The Pakistan Experience
45. Water Resources Engineering, Second Edition
46. Wastewater Engineering: Collection, Treatment and Disposal

- 47. Statistical Methods in Agricultural Research (11 copies)
- 48. Physical Edaphology (The Physics of Irrigated and Non-Irrigated Soils)
- 49. Drainage of Agricultural Land
- 50. Subscription to Bangladesh Economic Review
- 51. Farm Mechanization and Agricultural Development:
A Case Study of the Pakistan Punjab

F. Travel

1. International Travel

The only international travel which was supported by grant funds during the reporting year was Mr. Bailey Wharton, Research Assistant, who went to Bangkok, Thailand for three (3) months to do field research in connection with the study made on the Mekong Delta Committee which is an institution designed to develop water delivery and removal systems. This study is listed as a publication. The Abstract of this study is also included as a part of this report. The approximate total cost for this travel was \$2,000.

International travel that was performed during this reporting year without Grant funds is listed below. This travel is all related to the total water resources program being carried on at CSU. This interest and competence has been developed as a result of the grant funds:

1. Travel to Mexico to meet with Mexican officials regarding a cooperative program with Saltillo was performed by: Dr. J. W. N. Fead, Chairman, Department of Civil Engineering; Kristine Schneider, Research Associate; George L. Smith, Professor of Civil Engineering.

2. Professor Henry P. Caulfield attended the meeting of the Technical Committee under the OWRR Contract in Nevada and also the International Political Science Association in Montreal, Canada.

3. Dr. Daryl B. Simons attended the XVth Congress of the International Association of Hydraulic Research in Istanbul, Turkey.

4. The International Bio-Physics Grasslands Workshop held in Warsaw, Poland in July 1974 was attended by Dr. James H. Gibson, Director, Natural Resources Ecology Lab; Dr. James E. Ellis, Consumer Integrator, NREL; and Dr. Melvin I. Dyer, Director, Process Studies, NREL. This travel was supported by PL-480 funds.

5. Dr. Manuel Alers, Director, Center for Latin American Studies, presented a paper at the Arid Lands Conference "Science and Man in the Americas."

6. The Conference on Colorado River Salinity Problems sponsored by the American Society of International Law was held in Mexico City on 14-20 March 1974. Dr. Norman A. Evans, Director of Environmental Resources Center participated in this Conference.

7. International travel to Pakistan working with USAID and GOP performed during the reporting year was by: Dr. David McWhorter, Assistant Professor of Agricultural Engineering; Dr. A. G. Mercer, and Dr. Khalid Mahmood, Research Associate both in the Department of Civil Engineering.

8. Dr. W. D. Kemper, Project Director, Dr. David M. Freeman, Associate Professor of Sociology, and Professor Gaylord Skogerboe, Professor of Agricultural Engineering traveled to Pakistan in connection with the studies and research under the Water Management Research Contract.

9. In furthering CSU linkage and cooperation with AID/Washington, Dr. George Radosevich, Associate Professor, Department of Economics attended and presented a paper on Moslem water laws and their influence on the Spanish water law system at the Anden Group Water Law Conference in Quito, Equador in January 1974.

10. Dr. W. R. Schmehl was a member of a three-man CUSUSWASH team requested by USAID, Washington, for a water management study of the Bicol Basin in the Philippines. A report of the four-week review was prepared and submitted in September 1973--the title, "Water Management Team Report for the Bicol River Basin, Luzon Island, Philippines." Dr. Donald Drew and Dr. Norbert L. Ackermann, both CSU staff serving the AIT Project in Bangkok, Thailand served as consultants on the Bicol Basin Program.

11. Dr. William E. Hart of the Agricultural Engineering Department will be using his expertise and experience gained on the 211(d) grant on a two month special assignment in Pakistan. Here he will be working on water delivery systems improvement.

12. Dr. Alan Early will be participating in a special conference in Durbin, South Africa on the impact of water on sugar cane production.

13. Dr. Judson Harper's services were requested by the Bureau of Technical Assistance, AID/Washington to travel with Don Davis, AID

retired employee to serve as consultants looking at mechanization for small rice farms. This travel included discussions and cooperation with IRRI, Philippines, USAID, Vietnam, USAID & RED, Thailand and USAID, Korea.

14. CSU was represented by Professor Henry Caulfield at the United Nations Seminar on Water Administration in New Delhi, India.

2. U.S. Travel

U.S. travel by CSU faculty and staff was very minimal during this reporting period.

1. Dr. M. L. Albertson, Professor George L. Smith, Dr. Mohammad T. Chaudhry, Research Associate, Department of Civil Engineering, and Bonnie L. Frantz, Administrative Assistant, traveled to Logan, Utah via University car to attend the CUSUSWASH meeting on 10, 11, and 12 July 1973. Other CSU faculty who attended this meeting at no expense to the grant were: Dr. Evan Vlachos, Professor of Sociology; Dr. Daryl B. Simons, Dean, Engineering Research Center; Dr. W. D. Kemper, Project Director, Water Management Research Contract; and Dr. W. R. Schmehl, Professor, Department of Agronomy.

2. On 7 January 1974, M. L. Albertson, E. V. Richardson, and Bonnie L. Frantz attended the CUSUSWASH meetings in Tucson, Arizona. Dr. E. V. Richardson attended as a representative for Dr. D. B. Simons at no expense to grant funds.

Other travel performed in the U.S. by the Program Director which was paid in full or in part by grant funds is as follows:

3. Travel was made by M.L. Albertson to Kansas City on 24 July 1973 for discussion with Black & Veatch, International Consultant Engineers as a continued linkage program on water delivery and removal systems of mutual interest.

4. M.L. Albertson went to Washington, D.C. on 6 May 1974 to meet with AID officials and CUSUSWASH officials to discuss the Sahel Program.

5. On 19 January 1974, M.L. Albertson traveled to Los Angeles to hear and discuss papers at ASCE meeting on water resources systems.

6. The first week in October a Symposium was called by AID/Washington in Park City, Utah for all 211(d) Directors and others

to discuss all aspects of AID's Role in On-Farm Water Management Research and Implementation. Dr. M.L. Albertson attended this Symposium. Dr. Evan Vlachos and Dr. Daryl B. Simons also attended this Symposium but at no expense to the grant.

U.S. travel performed by research assistants under grant funds was as follows:

1. S. Janakiram attended the meeting of the First World Congress in Chicago from 23 through 29 September sponsored by the American Water Resources Association. The discussions were directly related to the research work Mr. Janakiram is doing with the multi-disciplinary nature of water resources in the area of water delivery and removal systems.

2. The latter part of August, Ata Nazar traveled to California, Washington, and Idaho to visit hydraulic laboratories in these state colleges. This travel was to further this student's knowledge of the research Mr. Nazar will be doing for his Ph.D. in Afghanistan.

U.S. Travel by the Program Director

Saturday, September 8, 1973 to Kansas City, Mo. - To discuss potential overseas positions at AIT with members of the International Division of American Society of Engineering Education

Sunday, November 25, 1973 to Washington, D.C. - To discuss National Academy of Engineering report.

December 21, 1973 to Philadelphia - To discuss NAE report.

January 11, 1974 to Chicago and Atlanta - To meet with NAW panel and to attend mid-year meeting of ASEE.

January 19, 1974 to San Diego and Los Angeles - To attend ASCE TCWRPM Executive Committee meeting and to attend ASCE conference.

February 13, 1974 to Atlanta and Washington, D.C. - To present a seminar on the Development Process and its work on the NAE report.

February 27, 1974 to San Francisco - To attend AAAS meeting and Program on Engineering Education for Foreign Students.

March 31, 1974 to St. Louis, Mo. - To serve as CSU Representative to the U.S. Committee for the United Nations University Meeting.

April 9, 1974 to Washington, D.C. - Attend OWRR meeting, discuss OWRR business, discuss AID Contract.

April 17, 1974 to Las Vegas - To meet with the Board of Trustees of CUSUSWASH.

Non-Grant Supported

July 1, 1973 to Memphis, Tenn. D. B. Simons	To review feasibility of research on response of Mississippi River to recent floods.
July 8, 1973 to Champaign-Urbana, Illinois-B. R. Sabey	To participate in a workshop on Recycling Municipal Sludges and Effluents on Land.
July 9, 1973 to Jefferson City, Mo. and Logan, Utah-D. B. Simons	To attend and participate in CUSUSWASH Meeting at Logan, Utah.
July 9, 1973 to Logan, Utah Evan Vlachos	To attend QOL Conference at Utah State University. To attend CUSUSWASH Meetings being held at Utah State University in Logan, Utah.
July 9, 1974 to Tulsa, Oklahoma Khalid Mahmood	Attend ASCE National Transportation Engineering Conference and present a paper, "The Variation of Regime Coefficient in Pakistan Canals."
July 11, 1973 to Omaha, Nebraska Delmer L. Brown	To meet with Corps of Engineers to work out details of the annual plan of work for Chatfield and Bear Creek Projects (Projects 2024 & 2010).
July 23, 1973 to Utah Robert Aukerman	Evaluation of wetland sites in Utah for National Park Service Research.
July 12, 1973 to Manhattan, Kansas-William S. Ball	To attend Great Plains Conservation Tillage Task Force committee meeting in Manhattan, Kansas to develop educational materials for Conservaton Tillage Handbook.
July 29, 1973 to Lubbock, Texas Robert A. Young	To attend UCOWR meeting and to participate in the Missouri River Basin Workshop.
July 29, 1973 to Lubbock, Texas Norman A. Evans	To attend Universities Council on Water Resources meeting and to participate in workshop of Missouri River Basin.
July 30, 1973 to Warsaw, Poland; Istanbul, Turkey; & West. Europe George S. Innis	IBP Grasslands workshop in Warsaw, Poland July 6-12 3-4 day meeting in Istanbul, Turkey; stop @ University in London.
August 15, 1973 to Bozeman, Montana-Morris M. Skinner	To attend Hydraulics Division Specialty Conference in Bozeman, Montana
August 20, 1973 to Washington, D.C.-Neil S. Grigg	Project Conference with OWRR research project sponsor.
August 23, 1973 to Pittsburgh, Pa. and Washington, D.C. John A. Spence	Field trip for Federal Water Project Recreation Act.
September 9, 1973 to Rolla, Mo. Willy A. Sadeh	To attend Third Biennial Symposium on Turbulence in Liquids.

September 10, 1973 to Corvallis, Oregon-Arthur T. Corey	Attend W-51 Western Regional Research Comm. on Drainage, represent Exp. Sta. of Colorado.
September 13, 1973 to Washington, D.C.-George L. Smith	Meet with Rohm and Haas officials to finalize research project on Water Harvesting and to meet with NSF of- ficials regarding international co- operative research programs.
September 13, 1973 to Washington, D.C.-John W. Labadie	To meet with Rohm and Haas officials to finalize research project on Water Harvesting and to meet with NSF of- ficials regarding international cooperative research programs.
September 20, 1973 to Sacramento, California-Khalid Mahmood	Attend Conference - U.S. Committee on Irrigation, Drainage and Flood Control.
September 23, 1973 to Logan, Utah Bert L. Bohmont	To attend meeting of CUSUSWASH Planning Group for Pest Control in Iran.
September 25, 1973 to Chicago, Illinois-H. L. Teller	To attend First World Congress on Water Resources and to present a paper.
September 25, 1974 to Tulsa, Oklahoma-Philip J. Hoefer	To attend meeting of Personnel in Corps Engineers Vegetation Management program to view & critique problems similar to our Chatfield and Pueblo Vegetation Management Projects.
September 27, 1973 to Tucson, Arizona-Henry P. Caulfield	To attend meeting of Technical Committee of OWRR Research Project on "Development of Techniques for Establishing Potential Water Resource Development."
September 30, 1973 to Salt Lake City, Utah-Carlos Seegmiller	To show Pakistan film to representatives of AID and CUSUSWASH.
October 21, 1973 to Seattle, Washington-Norman Wengert	To attend annual meeting of the American Water Resources Association as Associa- tion Editor and member of the Policy Committee.
October 23, 1973 to Lincoln, Nebraska-Norman A. Evans	To participate on panel at Nebraska Water Resources Research Institute on "The Role of Water in the Energy Crisis."
October 21, 1973 to Seattle, Washington-Norman A. Wengert	To attend annual meeting of the American Water Resources Association as Associate Editor and member of the Policy Committee
October 21, 1973 to Seattle, Washington-Wynn R. Walker	To attend 9th Annual Water Resources Conference sponsored by American Water Resources Association.
November 1, 1973 to Washington, D.C.-Henry P. Caulfield, Jr.	To confer with Director, Office of Water Resources Research and Director, Water Resources Council on utilization of results of current research.

November 26, 1973 to Las Vegas, Nevada-V. A. Koelzer	To attend the Joint Pacific-Southwest Management Agency Convention of Water Institutes and Centers Workshop, to assist CSU Environmental Resources Center.
December 14, 1973 to Logan, Utah D. B. Simons	Consultation on Council of Universities.
January 7, 1974 to Tucson, Arizona-Arnold Klute	To attend meeting of W-68 Regional Technical Committee on Soil Water in arid and semi-arid conditions. Discussion of research on soil water with other members of the committee.
January 10, 1974 to Phoenix, Arizona-David B. McWhorter	Attend meeting on Trickle Irrigation to Improve Crop Production & Water Management.
January 23, 1974 to Riverside, Robert E. Danielson	Attend planning meeting for CUSUSWASH Sponsored Research.
February 7, 1974 to Washington, Henry P. Caulfield, Jr.	To confer with the water resources council at the Office of Water Resources Research on proposed Colorado State University training program.
February 15, 1974 to Yuma, Arizona-Robert E. Danielson	Research Project Planning OWRR Sponsored Project through CUSUSWASH.
February 13, 1974 to Las Cruces, New Mexico-Norman A. Evans	To attend Western Soil and Water Research Annual Committee Meeting.
February 13, 1974 to El Paso, Texas & Las Cruces, New Mexico Robert S. Whitney	To attend Western Soil and Water Research Annual Committee Meeting as Colorado representative.
March 4, 1974 to Oklahoma City, Clarence A. Carlson	Attendance at conference on the use of wastewater in the production of food and fiber at Tradewinds Central, Oklahoma City.
March 5, 1974 to Yuma and Tucson, Arizona-Lawrence E. Mack	Attend meeting of Colorado River-Great Basin Consortium, of which CSU is a member and has research contacts in progress for the Consortium.
March 18, 1974 to Pacific Grove, John D. Nelson	To attend workshop conference, Foundations for Dams.
March 26, 1974 to Tucson George G. Olson	Attend Water Harvesting Conference and negotiate CUSUSWASH contract with Mexican representative.
March 31, 1974 to Washington, D.C.-Cleon V. Kimberling	To attend 2-week orientation of new staff personnel on Kenya Project, prior to their leaving for Nairobi, Kenya.
April 1, 1974 to Omaha, Nebraska D. B. Simons	Present lecture at Corps of Engineers Graduate Water Resources Program.

April 3, 1974 to Washington,
D.C.-Norman A. Evans

To attend 1974 Annual Water Resources
Research Conference and visit federal
agency personnel.

April 17, 1974 to Salt Lake City,
Utah-Norman A. Evans

To attend meeting of the Rocky Mountain
Environmental Research Group and to
conduct workshop on a regional research
project dealing with energy-related water
problems.

April 17, 1974 to Las Vegas,
Nevada-George G. Olson

To attend a meeting of the Associated
Western Universities.

April 17, 1974 to Las Vegas,
Nevada-E. V. Richardson

To attend CUSUSWASH Meeting.

April 21, 1974 to Washington,
D.C.-K. C. Nobe

Conference with OWRR officials and
attend Energy Conference, and conference
with USAID on Pakistan project.

April 10, 1974 to Washington,
D.C.-George E. Radosevich

Conference with USAID on Pakistan Project
and attend Energy Conference.

April 23, 1974 to Washington,
D.C.-Henry P. Caulfield, Jr.

To confer with officials of the Water
Resources Council relating to Water
Resources Training Program.

May 7, 1974 to Tucson, Arizona
W. D. Kemper

To evaluate, with personnel from U.S.U.
and other western universities, sources of
farm water management information and
their adequacy as guides for solving
water management problems in developing
countries.

Appendix I

Periodical Bibliography

Appendix I
Bibliography

PERIODICAL BIBLIOGRAPHY

F. ANDREW DESERAN
COLORADO STATE UNIVERSITY
November 9, 1973

PURPOSE

A preliminary bibliography to form part of a proposed manuscript dealing with library resources and research material relevant to the study of development and planning was developed. Because such a concern encompasses a broad range of disciplinary perspectives the bibliography is neither complete nor comprehensive. However, it was offered as an opportunity for generating feedback concerning both the adequacy and scope of a proposed classificatory scheme, as well as the range of particular periodicals.

FEATURES

Two features of this publication justified its addition to bibliographical materials, especially the Serials Book Catalog, already available at CSU: 1) the periodicals are categorized according to major areas of interest, i.e., Economics, Geography, Political Science, etc. At the same time, periodicals which fall under more than one area, such as Social and Economic Studies, are cross-classified and appear under appropriate categories; 2) Those periodicals not available at CSU but available at nearby libraries of Colorado University, Denver University, University of Northern Colorado are so indicated. Periodicals not available locally appear with no designations in the location/call number column.

METHOD OF SELECTION

The selection of periodicals for this bibliography was guided by very loose criteria. The bibliography began as a personal collection generated during the course of a demographic research project. As the bibliography grew, several colleagues expressed an interest in obtaining a copy for their own files and consequently the idea emerged for a more complete manuscript dealing with library resources. Numerous individuals have been helpful in adding to the bibliography and suggesting categorical modifications. Needless to say, further contributions,

suggestions, or comments will be greatly appreciated. It is envisaged that a final manuscript incorporating revisions and further bibliographical references and explanatory essays as to resource materials in the area will be available in the very near future.

CONTENTS

The Table of Contents and the first page are included in this appendix to indicate the scope of the bibliography. The total manuscript is 33 pages.

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Appendix J

Grant Document

(excluding Special Provisions)

DEPARTMENT OF STATE
AGENCY FOR INTERNATIONAL DEVELOPMENT
WASHINGTON, D. C. 20523

OFFICE OF
THE ADMINISTRATOR

CERTIFIED A TRUE COPY THIS
DAY OF
BY
MAY 23 1969

Mr. William E. Morgan
President
Colorado State University
Ligon, Colorado

Dear Mr. Morgan:

I am pleased to inform you that pursuant to the authority contained in Section 211(d) of the Foreign Assistance Act of 1961, as amended, Grant No. AID/ord-7460 in the amount of \$750,000 is made hereby to Colorado State University. This grant is for the purpose of implementing the project "Optimum Utilization of Water Resources with Emphasis on Water Delivery and Removal Systems", as set forth in the final proposal, dated April 23, 1969, and agreed to by A.I.D. and Colorado State University.

The grant funds are obligated as of the date of this letter, and shall apply to costs incurred in furtherance of the project for five years.

This grant is made by A.I.D. to Colorado State University on condition that the Grantee shall administer the funds provided under this grant in accordance with the terms and conditions set forth in the final proposal, Special Provisions and Administration of A.I.D. Grants attached hereto and made a part hereof.

Please acknowledge this grant by signing the original and six (6) copies of this letter and one copy of the Assurance of Compliance. Please return all documents to the Grant Officer.

Sincerely yours,

/s/ John A. Hannah
John A. Hannah

Attachments:

1. Final Proposal
2. Assurance of Compliance
3. Special Provisions
4. Administration of A.I.D. Grants
5. Budget

ACCEPTED

BY *(Signature)*
TITLE *President*

Final Proposal

For

AID Institutional Development Grant

- I. Title: Optimum Utilization of Water Resources:
with special emphasis on
Water Delivery and Removal Systems and Relevant Institutional
Development
- II. Name of Applicant: Colorado State University
- III. Program Director: Maurice L. Albertson
Linwood L. Hodgdon, Associate Director
- IV. Duration: Five years from date established by the Grant
- V. Amount of the Grant: \$750,000
- VI. Action Officer:

Summary:

This Proposal is one of three being submitted by each of three universities on different aspects of water resources utilization. This Grant will strengthen the already existing competence of Colorado State University in water delivery and removal systems and in development of institutions which are relevant to the various aspects of optimum utilization of water resources.

The competence of Colorado State University in these subjects exists in several departments whose staff members constitute the basic capability and interest. The Grant will be used to expand both the depth and breadth of this capability in its application to the less developed countries. Specifically, the grant would be used to support the salary of staff members and graduate students, and their travel and other expenses related to this activity.

As a Land Grant University, Colorado State University has a long tradition of research, education, and service for agricultural areas and their needs both in the United States and abroad. This Grant will help to expand these activities more effectively into and for the less developed countries.

Background

This proposal is one of three being submitted by each of three universities (University of Arizona, Colorado State University, and Utah State University), which are coordinating their efforts through the Council of U. S. Universities for Soil and Water Development in Arid and Sub-Humid areas -- later referred to as Council. These three universities are among the most competent in the field of water management in the United States.

Colorado State University will emphasize the development of its competence with special emphasis on "water delivery and removal systems and relevant institutional development", Utah State University in "on farm water management" and the University of Arizona, "water shed management". This division of emphasis reflects their respective current special competencies and major field of interest in United States' water management problems. In addition, each of these universities has special geographic experiences and interests in less developed countries. Utah State University is active in several Latin American countries; Arizona is working for AID in Brazil; and Colorado State University is active in Pakistan and Southeast Asia. All three of the universities have contacts and experience in several other locations throughout the less developed world and have general interests in water management problems in less developed countries.

Activities under the Grants to these three universities will be coordinated through the Council in order to maximize development of competencies under the Grants and to facilitate usefulness of these competencies to AID and other appropriate agencies.

Because irrigation agriculture is concentrated in relatively few states, special U.S. competence in irrigation water management is limited to relatively few U. S. universities. However, irrigation is of extreme importance to the agriculture of a large proportion of the less developed countries. Therefore, the increased competence in water management to be created through these Grants for conditions found in the less developed countries, will be of central importance to optimum agricultural development in many of the less developed countries of all the major continents of the world.

Capacity and Commitment

Shortly after the Land Grant Act was signed by President Lincoln, the Land Grant College for Colorado was created in Fort Collins to work with the people in the rural areas through its extension service programs, and to provide higher education for the common man. The Colorado Agricultural Experiment Station was also created at Fort Collins as an integral part of the college to conduct research and experiments on problems confronting the farmer. Colorado State University thus has a long-standing interest in and commitment to the problems of development--particularly in arid agricultural areas where water resources are in short supply or not yet fully developed.

This very practical beginning for what is now Colorado State University has continued to be the central theme, a strong program in research, education, and service. The primary aspect of this program is in Water Resources Development, including agriculture, engineering, watershed management, geology, and various aspects of biological and social sciences. The various water resources programs of research and education at Colorado State University constitute the largest such graduate programs in the world, and a number of these programs are heavily involved in various types of foreign activities, such as the Asian Institute of Technology in Bangkok, and a research program on Water Management in Pakistan.

Well over 100 faculty, and more than 300 graduate students from both the United States and abroad, are now involved in the foregoing programs in the various departments of Colorado State University.

Colorado State University has developed within its institutional structure a Center for Natural Resources, an Office of International Programs and a Center for Latin American Studies. Each of these centers and offices will assist in the development of this project and will be strengthened by their involvement in assisting in the addition of faculty, students, courses, and service activities to broaden the scope of the water resources program at the University as it relates to the less developed countries. These offices and centers have been and are now involved in projects or programs that focus on the professional and technical needs of the less developed countries including specific geographical areas; Latin America, South and Southeast Asia, and Africa.

Colorado State University also has a tradition of working on research, education, and service activities related to water resources with many different agencies of the United States Government and various state agencies, such as:

1. U.S. Geological Survey
2. U.S. Bureau of Public Roads
3. U.S. Agricultural Research Service
4. U.S. Economic Research Service
5. U.S. Soil Conservation Service
6. U.S. Forest Service
7. U.S. Rocky Mountain Forest and Range Experiment Station

8. U.S. Bureau of Reclamation
9. U.S. Bureau of Sport Fisheries and Wildlife
10. U.S. Public Health Service
11. Colorado Water Conservation Board
12. Colorado Cooperative Wildlife Research Unit
13. Colorado Game, Fish, and Parks Department
14. Colorado State Forest Service

Colorado State University has a large number of courses related directly or indirectly to water resources. These courses have been expanded steadily to meet additional requirements in each of the many departments which are interested in the optimum utilization of water resources.

When AID and SEATO were interested in establishing a graduate school in Southeast Asia ten years ago, with special emphasis on water resources, they came to Colorado State University which has taken the responsibility for the initial design of the School and the coordination of the United States contribution ever since that time. The School is located in Bangkok, Thailand and is now known as the Asian Institute of Technology with a continually expanding scope of activities.

Many of the Colorado State University faculty are serving periodically as consultants to various governments, agencies, and other organizations abroad with regard to water resources problems.

Colorado State University has been expanding, at an ever increasing rate, its level of support, both in breadth and in depth, in the various aspects of water resources. Furthermore, it expects to continue this expansion in the future. In addition, in support of this Grant, the University will provide:

1. The office, classroom, laboratory, and library space for faculty, students, and foreign visitors.
2. The basic facilities and equipment required for research, instruction, and service--such as analog and digital computers and certain basic laboratory equipment.
3. The usual administrative and technical supervision and counsel by the various administrators.
4. The advise and assistance of faculty and other staff throughout the University who have special competence which bears on the needs of the program.

Objectives and Scope of Proposed Program

With the funds from the Grant, Colorado State University will improve its level of excellence with respect to planning, development, management, and utilization of water resources with special emphasis on water delivery and removal systems and relevant institutional development related to the needs of the less developed countries. This will be accomplished through the following steps:

1. Expand its professional staff in the various departments of the University which are now involved, or which would like to be involved, in water resources activities related to the needs of the less developed countries.
2. Expand its number of graduate students in these departments from, or interested in, the less developed countries.
3. Expand its departmental research programs and activities related to the needs of the less developed countries.
4. Expand its course offerings in these departments --- including interdisciplinary courses --- which are related to the less developed countries.
5. Expand special activities, and initiate new ones, in the United States and abroad which are related to research, teaching, and service -- e.g. seminars, exchange programs, institutes, conferences, and publications which are concerned with the less developed countries.
6. Help to alleviate the critical shortage of qualified professional personnel with international interests, experience, and expertise, and with cross-cultural insights.
7. Expand its capability to serve in advisory and consulting capacity to various individuals, government agencies, industries, business, and other organizations who have an interest in activities abroad. It would be understood, however, that substantial specific services in this area will be funded by AID and any other sponsoring agencies under separate contractual arrangements.
8. Improve its understanding of the nature of the less developed societies, and find ways and means of assisting them to resolve crucial problems relating to water resources development and management.
9. Develop an exchange of personnel and publications, and other programs of interaction, which will help to establish steady and effective lines of communication between Colorado State University and the less developed countries.

The subject areas of specialization include the following as related to the needs of the less developed countries:

1. Development of water supplies from various sources.
2. Conveyance, delivery, and drainage of water in open and and closed conduits, including rivers, canals, irrigation ditches, tunnels, and pipelines.
3. Storage and use of water in reservoirs, both above and below ground.
4. Control and measurement of water in storage, and water being conveyed either for delivery or for drainage.
5. Control of erosion and sedimentation with respect to storage.
6. Use of wells as a source of water or for storage of water underground.
7. Use of systems engineering for development of optimum solutions to problems of water resources utilization.
8. Understanding social, economic, political, and cultural factors in technological change, and the processes of developmental change.
9. Analysis of prevailing social systems, their structural-functional characteristics within specific less developed countries to determine:
 - a. The kinds of structural changes necessary for maximizing water resource development and management, including the use of necessary new inputs.
 - b. The sources of resistance to these necessary changes, and
 - c. Effective ways of dealing with social resistance
10. To analyze specific organizational and administrative structures for agricultural development in specific less developed countries to determine needed changes for better water utilization in maximizing agricultural production.
11. To conduct economic analyses, including input response studies, and including the analysis of delivery and removal systems, to achieve efficient and economic allocation of water for agricultural purposes in selected areas of the less developed countries.

12. By use of systems analysis, develop case studies analyzing and documenting the above relationships in selected areas of the less developed countries for instructional research, and training purposes in a multidisciplinary setting.

Operational Plan

The details of the operational plan will be developed with the help of an interdisciplinary advisory committee from several departments and areas of administration. The broad aspects of the plan, however, are as follows:

1. Assemble and analyze existing information on water delivery and removal systems related to the less developed countries.
2. Assemble and analyze existing information on development of institutions relevant to optimum utilization of water resources in the less developed countries.
3. Prepare plans for additional research programs which will increase the knowledge of methods, techniques, and procedures for optimizing the utilization of water resources in the less developed countries.
4. Increase the breadth and depth of teaching and educational materials for the subjects of this proposal and for the situations in various less developed countries.
5. Solicit especially well qualified graduate research assistants, from both the United States and the less developed countries, who expect to work in some aspect of international development upon completion of their training.
6. Expand the library collection, especially with respect to the problems of the less developed countries.
7. Develop a program of student and faculty exchange with certain less developed countries.
8. Plan, initiate, and expand an interdisciplinary seminar on development and the interrelationship of the many factors involved in development--especially in the less developed countries.
9. Conduct short courses, institutes, seminars, and other activities to stimulate other personnel to become more deeply and actively involved, and to help in continuing education for those already involved in various aspects of international development.

The first year of this program will be devoted to analysing and developing the details of the total program, integration of on-going programs, selection and orientation of new staff and graduate students, and establishing the interdisciplinary components of courses, seminars, research projects, and service activities. It is expected that approximately 16% of the total grant will be spent the first year, and that this percentage will gradually increase to more than 20% the fourth and fifth years. Throughout the period of the grant the proportion spent for each line item will remain approximately the same from year to year.

Following the submission of the annual technical report, AID will initiate a review of the activities under the Grant. Such a review will include an evaluation of progress, administrative and financial considerations, and plans for the coming year. The discussion will include ways in which the accomplishment may be utilized in the AID program and other areas where technical assistance may be needed.

Date of Application: 21 April 1969

Appendix K

Workshop on International Development

Workshop on Water Delivery and Removal Systems and Related Institutional Structure

K-1
Appendix K

WORKSHOP ON INTERNATIONAL DEVELOPMENT

Sponsored by
Colorado Association for International Education
and
Colorado State University
Friday, March 29, 1974
Faculty Lounge

- 8: 30 a.m. Registration
- 9: 00 a.m. Chairman: Maurice Harari, Chairman, CAIE
Welcome by A.R. Chamberlain, President, Colorado
State University
- 9: 15 a.m. Speaker: Woods Thomas, Purdue University
Topic: "New Trends in University Participation in
International Development and Foreign Assistance"
- 10: 15 a.m. Coffee Break
- 10: 30 a.m. Chairman: Ruth Purkaple, Secretary, CAIE
Speaker: Maurice L. Albertson, Colorado State University
Topic: "The Development Process"
- 11: 15 a.m. Panel Discussion on above two topics
- 12: 00 Noon Luncheon - Longs Peak Dining Room
- 12: 45 p.m. Chairman: Nancy Harrington, Executive Director,
Institute of International Education, Denver
Speaker: Dale E. Hathaway, Ford Foundation
Topic: "Importance and Role of Manpower Resources
in International Development"
- 1: 30 p.m. Chairman: George H. Brooks, Director of International
Programs, University of Northern Colorado
Speaker: David Freeman, Colorado State University
Topic: "Importance and Role of Institutions
in International Development and Planning"
- 2: 30 p.m. Panel Discussion on last two topics
- 3: 00 p.m. Coffee Break
- 3: 15 p.m. Simultaneous Workshops - Discussion Groups
(Focus on Proper involvement of higher education in
Colorado. Distill priorities for the Colorado and Rocky
Mountain Region in higher education.)
- 5: 15 p.m. International-Intercultural Happy Hour
- 6: 30 p.m. Dinner (members and guests)
- 7: 30 p.m. Chairman: R. Curtis Johnson, Dean of International Education,
University of Colorado
Speaker: Samuel H. Butterfield, Associate Administrator,
AID/Washington
Topic: "New Directions for U.S. Government Involvement
in Foreign Assistance"

WORKSHOP ON INTERNATIONAL DEVELOPMENT
(CAIE)

March 29, 1974

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Appendix K

Workshop on Water Delivery and Removal Systems and Related
Institutional Structures

The workshop itself was an outgrowth of the 211(d) Grant that has been made to Colorado State University for five years to work in the area of water delivery and removal systems and related institutional structures as a part of the overall program of water management which the agricultural section of the Technical Assistance Bureau of AID has been staffing for the past few years. The specific objective of the workshop was:

1. To bring together some of the experts in the U.S., to assemble the information that is presently available on water delivery and removal systems, to develop analyses of these for practical application, and to indicate directions needed for future research.
2. Preparation of a publication which will provide a better understanding, and better planning and design information, for water delivery and removal systems and related institutional structures, especially in less developed countries.

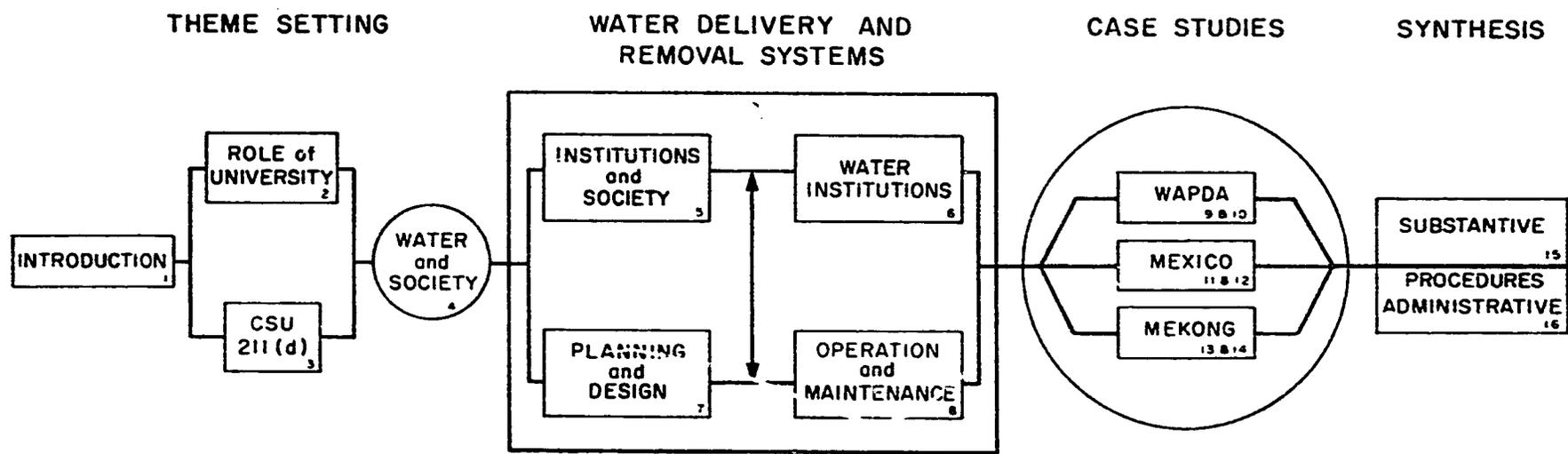
The specific detailed objectives which logically fall out of this stated purpose are to integrate the institutional and social sciences aspects of water delivery and removal systems with the physical planning and design aspects, by discussing these basic principles which are involved, discussing the general application of these basic principles and then making specific applications through case studies to illustrate the way in which these principles are useful. Out of all of this it is obvious that topics should become evident where research is needed to round out the information.

The workshop was built around a three-pronged attack or three basic directions. These are as follows:

1. The physical parameters
2. The human resources and institutions, and
3. The university as a change agent.

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Position papers were prepared under the leadership of those individuals indicated in the attached program, with other individuals helping to the extent that the primary authors needed the help, and then a series of disussants presented discussions of the position papers. The position paper itself gave the state of the art situation to the best of the knowledge of the author, and then much was gained by the additions provided through the discussions of each of the position papers.



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WORKSHOP ON WATER DELIVERY AND REMOVAL SYSTEMS
AND RELATED INSTITUTIONAL STRUCTURES

Program

Tuesday, 30 April, 1974

8:30 a.m. - 9:30 a.m.	Registration
9:30 a.m. - 10:00 a.m.	<u>Session 1</u> Welcome: A.R. Chamberlain Introduction: Opening Address Maurice L. Albertson
10:00 a.m. - 10:15 a.m.	Coffee Break
10:15 a.m. - 12:00 noon	<u>Session 2</u> Role of University: General A.R. Chamberlain
12:00 noon - 1:30 p.m.	Lunch
1:30 p.m. - 3:15 p.m.	<u>Session 3</u> Role of University: CSU Maurice L. Albertson
3:15 p.m. - 3:45 p.m.	Coffee Break
3:45 p.m. - 5:00 p.m.	<u>Session 4</u> Institutions and Society David M. Freeman

Wednesday, 1 May, 1974

8:30 a.m. - 10:15 a.m.	<u>Session 5</u> Water and Society Evan C. Vlachos
10:15 a.m. - 10:45 a.m.	Coffee Break
10:45 a.m. - 12:00 noon	<u>Session 6</u> Water Institutions - Organization and Development George E. Radosevich
12:00 noon - 1:30 p.m.	Lunch
1:30 p.m. - 3:15 p.m.	<u>Session 7</u> Physical Parameters: Planning, Design and Construction of Water Delivery and Removal Systems Gaylord V. Skogerboe
3:15 p.m. - 3:45 p.m.	Coffee Break
3:45 p.m. - 5:00 p.m.	<u>Session 8</u> Physical Parameters: Operation and Maintenance of Water Delivery and Removal Systems Charles W. Thomas

Thursday, 2 May, 1974

8:30 a.m. - 10:15 a.m.	<u>Session 9</u> Case Study 1: Presentation Alan C. Early
10:15 a.m. - 10:45 a.m.	Coffee Break
10:45 a.m. - 12:00 noon	<u>Session 10</u> Case Study 1: Discussion
12:00 noon - 1:30 p.m.	Lunch
1:30 p.m. - 3:15 p.m.	<u>Session 11</u> Case Study 2: Presentation Mexico Norman Illsley
3:15 p.m. - 3:45 p.m.	Coffee Break
3:45 p.m. - 5:00 p.m.	<u>Session 12</u> Case Study 2: Discussion

Friday, 3 May, 1974

8:30 a.m. - 10:15 a.m.	<u>Session 13</u> Case Study 3: Presentation on the Mekong Committee Henry P. Caulfield, Jr.
10:15 a.m. - 10:45 a.m.	Coffee Break
10:45 a.m. - 12:00 noon	<u>Session 14</u> Case Study 3: Discussion
12:00 noon - 1:30 p.m.	Lunch
1:30 p.m. - 3:30 p.m.	<u>Session 15</u> Synthesis A: Substantive Evan C. Vlachos
3:30 p.m. - 4:00 p.m.	Coffee Break
4:00 p.m. - 4:30 p.m.	<u>Session 16</u> Synthesis B: Procedures and Administration Maurice L. Albertson

**Titles of Papers presented at the Workshop on Water Delivery and Removal
Systems and Related Institutional Structures held at Colorado State University
30 April, 1,2,3 May, 1974**

1. **The Role of U.S. Universities in Development Assistance**
President A.R. Chamberlain
2. **Improving CSU Competence -- Optimum Utilization of Water Resources:
With Special Emphasis on Water Delivery and Removal Systems and Relevant
Institutional Development**
M.L. Albertson, Prof. Civil Engineering
3. **The Concept of Social Institutions and Technological Change**
David M. Freeman, Associate Prof. of Sociology
4. **Water and Society**
Evan Vlachos, Prof. of Sociology
5. **Institutional Alternatives to Local Water Management**
George E. Radosevich, Asst. Prof of Economics
6. **Planning, Design and Construction of Water Delivery and Removal Systems**
Gaylord V. Skogerboe, Prof. of Agricultural Engineering
Wynn R. Walker, Prof. of Agricultural Engineering
7. **Physical Parameters: Operation and Maintenance of Water Delivery and
Removal Systems**
Chalres W. Thomas, Prof. of Civil Engineering (retired)
8. **Water and Power Development Authority (WAPDA)of Pakistan**
Alan C. Early, Asst. Prof. of Agricultural Engineering
9. **Development in the Balsas River Basin in Michoacan**
Norman Illsley, Research Assistant
10. **The Mekong Committee**
Henry P. Caulfield, Jr., Prof. of Political Science
Bailey F. Wharton, Research Assistant in Political Science

APPENDIX L

U.S. STUDENTS WHO STUDIED UNDER THE GRANT

Appendix L

U.S. Students Who Studied Under the Grant

Agricultural Engineering

Ray S. Bennett

Cutthroat Flume Discharge Relations
Installation and Field Use of Cutthroat Flumes for Water
Management

James H. Barrett

Width Constriction in Open Channels
Comparison of Bridges Backwater Relations

Stephen W. Smith

Effect of Puddling for Reduced Seepage Losses

Agronomy

Jacob H. Dane

Effects of Soil Salinity on Hydraulic Conductivity

Civil Engineering

Philip A. Hosterman

Analysis of the Helmand-Arghandab River Basin Development

John T. Davenport

LDC/CSU Development Worker Program
Water Resource Project Evaluation
Water Resource Planning

Michael C. Shiefer

A Conceptual Framework for Analyzing Social Action
The Organization of Thai Irrigators

James H. Duke

Maximum Water Delivery in Irrigation

Herbert G. Blank

Optimal Use of Surface Water and Ground Water as Water
Delivery Systems in Botswana

Alfred J. Tamburi

A Bibliography and Literature Review of Groundwater Geology
Studies in the Indus Basin

Economics

Larry L. Caswell

Public Investments in Irrigated Agriculture Mexico's
Pacific Northwest.

Tiffin D. Harris

Cooperative Research with Dr. Biggs on problems of
technological change for agricultural development.

Christopher R. Doswell

An Evaluation of the Irrigation Project for Small Farmers

Political Science

Thomas J. Manninen

Political and Social Conflict in Development
Management of American Indian Irrigation Projects

John M. Fly

Comparative Political Characteristics of Developing Nations

Colin C. Webster

The Development of Institutions for Water Management
CSU Role in the Development Process

William L. Neal

N.E.S.A. Irrigation Practices Seminar Proceedings

Clifford W. Stockmeyer

N.E.S.A. Irrigation Practices Seminar Proceedings
Organization of Water Management for Agricultural Production

Robert Schmidt

Water Management in West Pakistan

Everett M. Myers

The Problem of Rural-Urban Water Competition

Robert B. Smith

Sources of Financial Assistance to Israel to Achieve Development

Bailey F. Wharton

Cooperation and Disagreement between the Nation Members of the
Mekong Committee

Sociology

Charles C. Brown

The Underground Church and Modern Systems Theory

Michael C. Brown

Change in Adaptive Organizations

Judith G. Ford

Socialization and Women's Roles

Patricia A. Madsen

The Residence Hall Community