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**FINAL REPORT**

**University Development Linkage Project**

**Improving the Management of Water and Natural Resources  
in Jordan and Washington State through Cooperation in  
Applied Research, Technology Transfer and Graduate Education**

**September 1997 - April 1999**



**University of Jordan  
Water and Environment Research  
and Study Center  
Amman, Jordan**

**Washington State University  
Pullman, Washington, U.S.A.**

with funding from  
United States Agency for International Development  
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This publication summarizes how an institutional partnership between the University of Jordan in Amman Jordan and Washington State University Pullman Washington is enabling the institutions to better serve the people of Jordan the Middle East Washington State and the United States The report focuses on the project entitled Improving the Management of Water and Natural Resources in Jordan and Washington State through Cooperation in Applied Research Technology Transfer and Graduate Education funded through the United States Agency for International Development (USAID) University Development Linkage Program



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Photographs by Muhammad Shatanawi Jan Noel Bill Funk & Mike Barber

# Executive Summary

The University Development Linkage Project (UDLP) cooperative agreement entitled *Improving the Management of Water and Natural Resources in Jordan and Washington State through Cooperation in Applied Research Technology Transfer and Graduate Education* has built upon and expanded the longstanding partnership between University of Jordan (UOJ) and Washington State University (WSU). Through the UDLP cooperative agreement, the UOJ Water and Environment Research and Study Center (WERSC) has established itself as a leader in Jordan, the Middle East, and North Africa in solving water and environmental problems. At the same time, Washington State University has capitalized on opportunities to develop and test solutions to water and environmental problems shared by the State of Washington and Jordan.

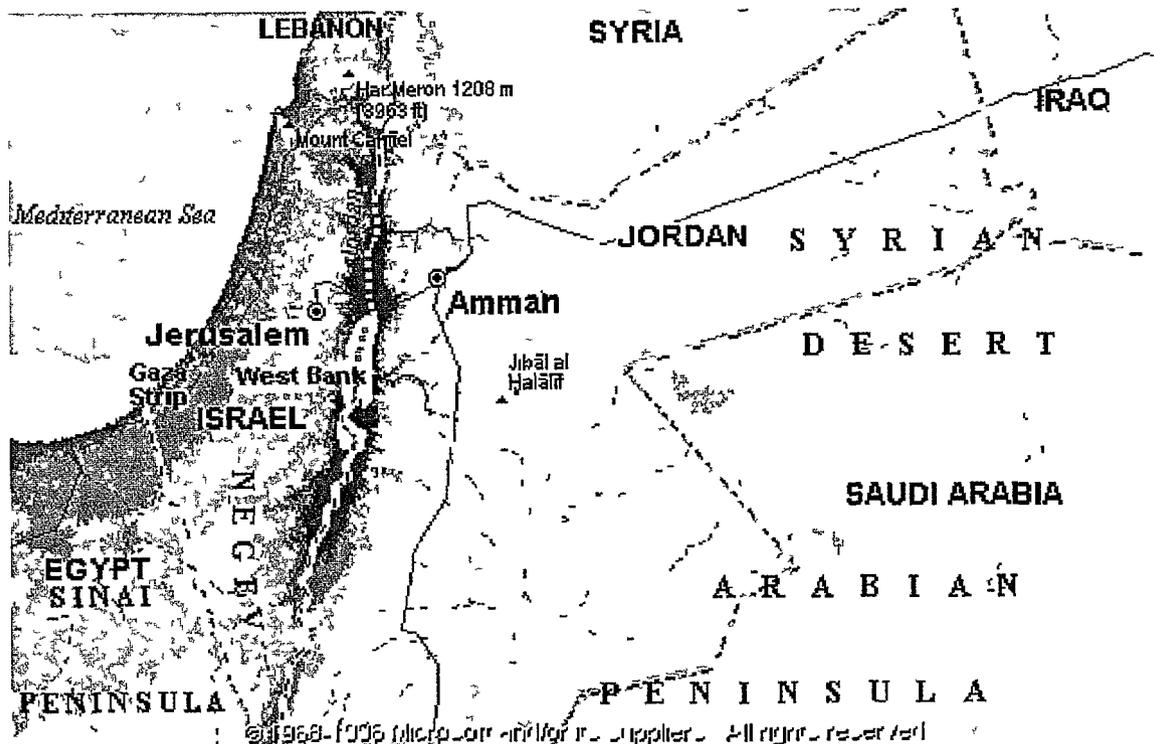
Both institutions have benefited technically, socially, and culturally from this relationship, and both are committed to sustaining and expanding their collaboration. WSU and UOJ have leveraged resources internal to their own institutions and from external sources in support of the achievements herein, at a rate exceeding U.S. \$3.00 for every UDLP grant dollar. This re-

port summarizes the results and impact of the project to date and the potential for the partnership to continue to generate benefits in the future.

## Background and Setting

Located in the heart of the Middle East, in south-western Asia, the Hashemite Kingdom of Jordan is bounded on the north by Syria, on the south by Saudi Arabia and the Gulf of Aqaba, on the east by Iraq, and on the west by the West Bank and Israel.

Jordan's varied topography covers about 89,500 square kilometers. Its central plateau runs from north to south and includes Jordan's principal cities and towns, as well as most of its rainfed agriculture. The Great Rift Valley arises in the west, forming a deep depression that runs the length of Jordan to Aqaba and the Red Sea, continuing on to Southern Africa. This basin includes the Jordan Valley, which is the largest agricultural irrigated area in the country, and the Dead Sea, which at 395 m (1,296 ft) below sea level is the world's lowest point. In the far east, the land slopes downwards from the plateau to the semi-arid steppe country of the Syrian Desert.



Jordan's Mediterranean climate is pleasant and is often compared to that of California. It has distinct seasons including warm summers and cool winters with some snow in the highlands. Rainfall is mostly during the winter months and ranges from 660 mm (26 in) in the northwest to less than 100 mm (4 in) in the east.

Jordan has a population of 4.8 million people (1998 estimate) with a growth rate that normally exceeds 3-5% per year. The Jordanian people have a high regard for education with literacy rates for Jordanians over the age of 18 exceeding 91% for men and nearing 80% for women.

Jordan faces significant challenges in meeting the needs of an expanding population in the country's dynamic socio-political setting. Paramount among these are the limited supplies and low quality of water, conflicting demands for its use, and a fragile environment under pressure from urban, agricultural, and industrial expansion. Jordan is considered among the world's poorest countries in water resources. The international poverty line for per capita share of water is considered to be 1,000 m<sup>3</sup>/year, and Jordan's per capita share is less than 200 m<sup>3</sup>/year. These conditions require that every possible effort be directed towards conserving and sustaining Jordan's natural resources without which economic and social development cannot be sustained.

## The Partners

The **University of Jordan** is the premier and oldest public institution of higher education and research in Jordan. Established by Royal Decree in 1962, its initial enrollment of 167 students and eight faculty members was limited to a single Faculty of Arts. Since then the University has witnessed distinctive and accelerated growth in every respect. Altogether there are 14 academic faculties including 65 academic departments/programs offering more than 3,500 courses a year. These faculties are Arts, Business Administration, Social and Human Sciences, Shari'a (Islamic Education), Educational Sciences, Physical Education, Law Sciences, Medicine, Agriculture, Engineering and Technology, Nursing, Pharmacy, and Dentistry.

The University has established a Faculty for Postgraduate Studies and entrusted it with the task of developing the academic standard and research capabilities of post-graduate students in their respective

areas of study. This is helping to meet Jordan's growing need for specialists. The Faculty offers more than 350 graduate courses in 60 master degree programs and 11 doctoral programs.

In line with its effort to better serve the student and local communities and respond to their evolving needs, the University has established nine training and research centers along with a Deanship of Student Affairs and a Deanship of Academic Research. The University Farm is located in the central area of the Jordan Valley. It serves as a station for conducting agricultural research and outreach, as well as providing a practical training site for students from the Faculty of Agriculture.

At present there are about 23,000 students registered at all levels of study at the UOJ, of whom about 2,000 students come from 50 Arab and Islamic countries. Over 3,500 students are enrolled for postgraduate degrees. The total number of faculty members of different academic ranks is about 950 full-time and another 100 part-time. The administrative staff exceeds 2,000, in addition to 1,700 staff members at the University Hospital.

The University of Jordan educational mission is based on the following pillars:

- \* The provision of quality education at both the undergraduate and postgraduate levels
- \* The adoption of the principle of democracy in educational decision-making
- \* Interaction amongst students at the local community and international levels
- \* Goal-oriented research, particularly research activities that support the national development plans

The University of Jordan has placed a high priority on communication with collaborators, universities, and research centers in other parts of the world. This helps to ensure the exchange of information and sharing of knowledge and expertise at the national and international levels. UOJ's international agreements with universities and academic institutions worldwide provide an umbrella for faculty and student exchanges, as well as for joint research and outreach.

Through its faculty institutional membership on governing bodies, and through faculty secondment, the UOJ is also closely linked with other bodies in Jordan.

The UOJ Water and Environment Research and Study Center (WERSC), established in 1982 is providing leadership for the design and implementation of national plans to develop and manage Jordan's water and other natural resources. The Center has close collaboration with the water authorities of Jordan as well as the Ministry of Water and Irrigation (MWI). It coordinates and facilitates water and environmental research and studies among the various disciplines and administrative units at UOJ. It also works closely with donors and other agencies internal and external to Jordan that fund and implement water and environmental-related activities in the country.



Its clients include the industrial and agricultural private sectors in Jordan. The Center's objectives include

- To conduct applied research to improve development and management of water resources and protection of the environment from degradation and pollution
- To provide services to the public and private sectors in such areas as water engineering design, environmental impact assessment, sustainable development management and laboratory and field analysis
- To identify problems and alternative solutions related to water and the environment

- To create official and public awareness for water environment and development issues
- To cooperate with national and international institutions, scientists and other clients

The WERSC accomplishes these objectives with a small core staff that serves to mobilize, catalyze, facilitate and support scientific and educational experts at UOJ, the wider university community in Jordan and from external organizations. This strategy allows the Center to focus on targeted results in a broad set of areas while continuing to build capacity in and bridges among sector stakeholders.

**Washington State University (WSU)** is the land grant university of the State of Washington. WSU's mission and legislative mandate is to increase knowledge through instruction and research and to extend this knowledge through outreach and public service to people in the state, nation and world. With nearly 20,000 undergraduate and graduate students statewide, WSU has a wide variety of prestigious academic programs, including more than 150 undergraduate majors, options and degree programs, and more than 100 graduate degrees.

WSU identifies itself as a Global Land Grant University and seeks out partners around the world with which to collaborate for mutual benefit. Areas of focus for WSU's international partnerships include water and the environment, food systems, biotechnology and sustainable economic development.

WSU has been involved in cooperative development activities in Jordan for over 27 years. The State of Washington shares many features with Jordan and this common ground has facilitated the long-term co-



operation Both have similar geographic diversity with fertile rainfed highland plateaus and warm irrigated valleys Contrary to the common perception of Washington as an exceptionally wet state Washington and Jordan share rainfall patterns with rain coming primarily in the winter months and ranging from 35 (900 mm) in much of western Washington to less than 6 (150 mm) in parts of the east These factors create similar agro-ecological conditions with many of the same commodities such as wheat barley fruits vegetables legumes and livestock produced under similar irrigated and dryland production systems

Both Washington and Jordan have seacoasts vital to trade and both share major rivers and regional watersheds with other nations and neighbors that compete for use and management of the water resources Both face major issues regarding prudent sustainable and equitable use of land water forest and wildlife resources In both cases decisions will affect a broad range of stakeholders within and outside their borders Declining soil and water quality disposal of industrial waste dam and reservoir development restoration and maintenance water pricing food safety – all are environmental issues of equal concern to Washington and Jordan

Competition is increasing for water resources for use in agriculture industry tourism and recreation and other economic enterprises (e.g. fishing) as well as to meet consumption needs of rapidly expanding municipal and rural populations Both Jordan and Washington are being challenged to identify technical management and policy options that balance economic development needs with those of sustaining and improving the natural resource base and quality of life Both are testing improved processes for conflict resolution and for more cost-effective means for measuring and monitoring the effects of decisions made In addition both need an educated and flexible workforce that is capable of functioning in a global economy and society

These similarities have allowed WSU and the State of Washington to contribute to Jordan's development while also benefiting from its involvement in Jordan This differentiates the partnership development approach from others that focus solely on delivery of development assistance services

## Project Goal

To strengthen the international partnership between the University of Jordan and Washington State University to improve their programs and enable both to better serve their respective clients' needs

## Project Purpose

To strengthen and further enhance education research and outreach performance and capacity of UOJ and WSU in the area of *water and the environment* through planning and management of sustainable collaborative programs and activities

## Project Objectives

This purpose was to be achieved through two major objectives that focused on the development of the new UOJ Water and Environment Research and Study Center while simultaneously providing opportunities for WSU to examine and improve its own programs and units

Objective 1 To strengthen the capacity of the University of Jordan (UOJ) and its Water and Environment Research and Study Center (WERSC) *to plan and manage research technology transfer and human resource development* in support of societal needs in the environment and natural resources

Objective 2 To strengthen the applied research and technology transfer capabilities of the UOJ and WERSC through the *planning and conduct of collaborative research and technology transfer activities*

## Approach

UOJ and WSU jointly planned specific activities in support of these objectives on an annual basis These activities were then implemented individually jointly or with other collaborators Input from collaborators and clients in Jordan and in the U.S. helped to shape the program over its 6 1/2-year lifespan For example water shortages and a progressive decline in water quality in Jordan became more critical as the project progressed Also the project was implemented prior to during and following significant re-engineering of

the USAID mission in Jordan. This re-engineering effort identified *improved management and use of water resources* as a major Strategic Objective of USAID programs in Jordan. Thus, water-related programs became increasingly the focus of the WSU-UOJ collaboration.

Water and environmental issues are exceedingly complex. Therefore, the partners emphasized interdisciplinary teams and involvement of multiple colleges and units, as well as linkages with other organizations — public, private, and non-governmental. This approach also promoted leveraging of resources and ownership by partners, both of which help to accelerate and sustain the achievement of results.

Solutions to water and environmental problems involve stakeholders from the levels of individual households, farms, and businesses to those of policy-makers at community, national, and international levels. The Linkage Project thus conducted activities that targeted multiple levels to enhance the probability that improvements would in fact be disseminated and adopted.

Further internationalization of UOJ and WSU programs was an integral part of the approach. Both partners used the Linkage project to expand professional and informational networks in the Middle East, the U.S., and around the globe. These expanded networks will serve both partners, as well as their respective constituencies, into the future.

## **Accomplishments of the UOJ/WSU Linkage Project**

The accomplishments of the UOJ/WSU Linkage Grant fit especially well within the context of the second Strategic Objective (SO2) of USAID in Jordan, which is to bring about *improved water resources management* in the country. The Government of Jordan (GOJ) shares these objectives and is working closely with USAID in the water sector. USAID now evaluates project performance in terms of progress made toward strategic objectives and intermediate results — a policy that WSU and UOJ strongly support. Therefore, this report will indicate accomplishments in terms of the specific intermediate results (IRs) or sub-objectives identified by USAID and GOJ for the water sector. It will also report additional accomplishments that fall outside this reporting framework.

### Intermediate results

*IR2.1 Stronger water institutions*

*IR2.2 Increased efficiency in use of water resources*

*IR2.3 Improved quality of wastewater*



### **IR2.1 Stronger water institutions**

The WERSC serves as Jordan's primary water research institution and also provides training and outreach services directly to the sector. Through their educational and research programs, the Center and UOJ provide researchers, teachers, administrators, businesses, and citizens with the tools, skills, and knowledge needed to deal with water and environmental issues. The Linkage project has broadened and deepened the capacity of UOJ and WERSC to serve these roles. Quantitative outputs include:

***A new Master's degree program was established and built up at the University of Jordan, which, through its graduates, is strengthening the human resource base of other institutions that serve the water and environmental sector in Jordan and the Region.***

- \* A new interdisciplinary program leading to a Master's of Science in Environmental Management was established. From the first class, 15 students have graduated; there are 45 in the new class. The program has drawn students from three faculties to date — Agriculture, Engineering, and Sciences.

- \* A survey of graduates demonstrated the impact that this new program is already having on water and environmental institutions and issues in Jordan and the Region. Graduates include
  - a public school teacher increasing water/environmental skills and awareness among school children
  - a WERSC research associate conducting research on water issues at UOJ
  - a faculty member at University of Hebron West Bank conducting Ph D research on water and the environment and engaged in dialogue on regional water issues
  - a individual employed in private sector company developing and producing water purification systems
  - a private school teacher increasing water/environmental skills and awareness among school children also engaged by the World Health Organization to provide training in the area of her thesis Hospital Waste Management
  - a research assistant in the area of water in the UOJ Geology Department
  - an individual employed by the General Corporation of Environmental Protection
  - an individual employed as a technical specialist by the Ministry of Water and Irrigation

***2 Ph D programs were established at UOJ, increasing sector human capacity and conducting research on priority water and environmental issues***

- \* Agriculture (Resources and the Environment) – 6 students enrolled
- \* Chemistry – 13 students enrolled
- \* Ph D students are also serving as teaching assistants at other Jordanian universities

***Research planning and management capacity in the UOJ and its WERSC was improved***

- \* Faculty training provided in proposal writing and grantsmanship resulted in at least 15 proposals of which 12 have been funded to date
- \* Research results from WERSC projects are being

produced on schedule and within budget as reported by various funding agencies

- \* Financial tracking and resource allocation for grants and contracts have been upgraded resulting in more efficient use of external funds
- \* Systems are in place and functioning well to encourage and reward interdisciplinary research and participation by multiple scientists and organizations
- \* Levels of faculty and staff and the amount of external funding have more than tripled since the onset of the project

***Facilities, technical equipment and laboratory procedures were upgraded at the UOJ/WERSC***

- \* A new building for the University of Jordan Water and Environment Research and Study Center (WERSC) was inaugurated on 17 April 1997. The new facilities consist of three laboratories, a conference room, training facilities, a library/computer facility and offices for faculty and graduate students. It is noteworthy that the design, construction and furnishing (apart from a small amount of equipment funded under the Linkage grant) were funded by a trust established for the Center and overseen by a board including private, public and non-governmental representatives. This illustrates the broad support generated by the Center over the first five years of the Linkage Project.



- \* Critical technical information and training equipment and supplies were identified procured installed and personnel trained in their maintenance and use. These are now in use by students and faculty in WERSC's research, training and outreach programs. Specifically
  - Four desktop computers with technical and office software and modems connected to the Internet
  - One laptop computer for field work with appropriate software
  - Four printers and one scanner for use in preparation of reports, publications and training materials
  - Two portable audio-visual projectors (slide and overhead) for use in training and educational programs and precision camera
  - One precision spectrophotometer for use in diagnostic and research analysis



- One high performance liquid chromatograph for use in diagnostic and research analysis
  - One trace analyzer for polarographic and voltametric trace analysis of organic and inorganic substances used in diagnostic and research analysis
  - A vehicle (double cab) was purchased through the project to serve various research activities
  - Field equipment such as water and sediment samplers, current flow meter and other small items
- \* UOJ's Water and Environment Research and Study Center laboratories have adopted, are using and

are providing training in Quality Assurance/Quality Controls (QA/QC) procedures. Clients of these training programs have strengthened their own institutions and businesses including

- Royal Scientific Society (RSS)
- food industries
- Ministry of Water and Irrigation
- paint industries
- cement industry
- private analytic laboratories
- phosphate industry
- pharmaceutical industries

***Capacity for Training and Training of Trainers in the UOJ and its WERSC was improved and used to strengthen others in the sector***

- \* An Environmental Impact Assessment (EIA) short course jointly conducted by UOJ/WERSC and WSU trained 25 participants from the Ministry of Water and Irrigation (MWI), Ministry of Health, Global Cooperation for Environmental Protection and university community
- \* EIA is now a required course in the UOJ Environmental Management graduate program

***UOJ has increased its input into water policy***

With its increased technical capacity and higher visibility, WERSC faculty have been taking the initiative to engage in policy dialog with the Jordanian government on water resources policy. For example

- \* WERSC activities in environmental impact assessment (EIA) helped to put in place the requirement for an EIA study as a prerequisite for business licensing and project approvals
- \* Documents from WERSC have raised issues and suggested actions to the Ministry of Water and Irrigation concerning water quality and other matters relating to the King Talal Dam
- \* WERSC leadership participated in a national technical panel to respond to the water quality emergency associated with contamination of the Amman water supply in 1998
- \* Documents from WERSC and editorial commentary by UOJ faculty have raised issues and en-

- hanced public awareness of water sector topics
- \* WFRSCs library and WERSC publications serve as major resources to others engaged in policy studies and in formulating policy recommendations
  - \* WERSC researchers participated formally and informally with the MWI in the formulation of the national water policy
  - \* WERSC research findings on the effects of the Russeifah Landfill on groundwater quality were disseminated to decision-makers

***Links with institutions outside Jordan have been established and strengthened***

- \* WERSC faculty have carried out research projects and training programs for or in collaboration with more than 20 Middle-Eastern U S and European institutions Examples include
  - National Research Institute of Egypt
  - Institute for Water and Forestry Tunisia
  - Suez Canal University Egypt
  - Water Management Department Syria
  - Cairo University Egypt
  - University of Sana a Yemen
  - Hassan II University Morocco
  - Wageningen Agriculture University Netherlands
  - University of Valadolid Spain
  - HR Wallingford Great Britain
  - Brigham Young University USA
  - University of Idaho USA
  - University of South Carolina USA
  - Ministry of Construction Portugal
  - Catania University Italy
  - Texas Tech University USA
  - Bari Institute Italy
  - University of Lisbon Portugal
  - Imperial College England
  - Beir Zeit University West Bank
  - University of Nice France
  - Hebron University West Bank
- \* WERSC/UOJ water scientists have been invited to serve as speakers or key resource persons in more than a dozen regional and international conferences or networks
- \* WERSC has received grants or contracts from over 10 international agencies



***Links with other Jordanian institutions have been strengthened***

The UOJ/WERSC has carried out studies for or in collaboration with numerous Jordanian organizations institutions and businesses including

- Jordan University of Science and Technology (JUST)
- National Center for Agricultural Research and Technology Transfer (NCARTT)
- Ministry of Water and Irrigation (MWI)
- Ministry of Agriculture
- Jordan Valley Authority (JVA)
- Ministry of Planning
- Water Authority of Jordan (WAJ)
- Different water bottling companies
- Royal Scientific Society (RSS)
- National Cement Company
- Higher Council for Science and Technology
- Royal Society for Conservation of Nature
- Royal Jordanian Geographic Center
- Jordan Environmental Society
- Jordan Phosphate Company
- Jordan Society for Combating Desertification
- Badia Research and Development Program
- General Corporation of Environmental Protection (GCEP)
- Hashemite University
- Applied Science University

These studies have yielded multiple impacts They have provided specific information and recommendations for the clients strengthened communication channels with partners and clients and study results have been fed back into UOJ's teaching research and outreach programs

## **IR2.2 Increased efficiency in use of water resources**

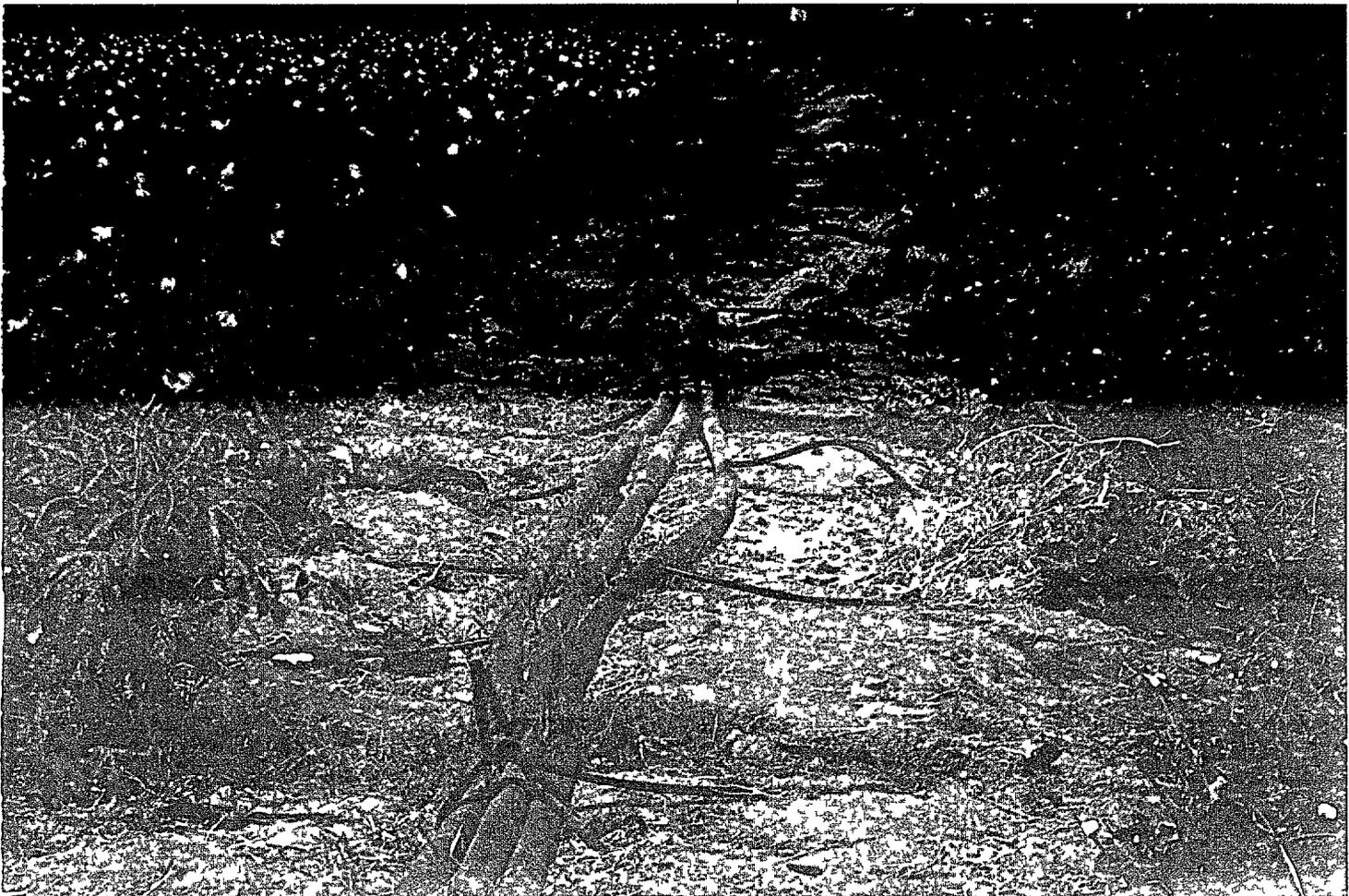
The Linkage Project has promoted increased efficiency in water use through UOJ academic degree programs research and technical training and outreach programs Specific outputs are as follows

### ***An International Workshop on wadi hydrology is held by WERSC on annual basis in cooperation with the International Hydrological Programme (IHP)/ UNESCO***

This recognition was made based on WERSC research and training in hydrological modeling and monitoring rainfall harvesting the artificial recharge of aquifers and use of brackish water In this capacity WERSC will serve as a prime regional and international resource in these key technical areas

### ***Farmers and extension agents have been trained in and are using more efficient irrigation techniques***

- \* WERSC has produced a bulletin entitled *Water Consumption Models for Major Crops in Jordan*
- \* WERSC has produced a bulletin entitled *Waste-water Reuse in Irrigation* which is in great demand
- \* The Center has conducted training courses for 30 farmer-leaders on irrigation water management As a result an expanded set of farmers in the Jordan Valley is now using improved methods of drip irrigation instead of less efficient methods Farmers and agents also have greater awareness of the effect fertilizers have on water quality and how water use efficiency affects the choice of crops grown



- \* Training programs in hydroponics optimal crop choices for different water qualities fertilizer/water use and others have helped to promote adoption of more efficient practices

***UOJ/WERSC research has promoted increased water use efficiency***

Among the research projects carried out alone or in collaboration with other institutions several have been on water use efficiency Results of these studies have been disseminated to a variety of end-users Examples include

- \* Improvement of irrigation efficiency under protected agriculture by 30% through proper irrigation scheduling and management 30 farmer leaders are helping to further disseminate these practices
- \* Demonstrated decreases in irrigation water demand through incorporating rainfall water into irrigation management in the Jordan Valley
- \* Demonstrated improved natural vegetation and barley production through better utilization of water resources and an integrated management plan for Marab Suweid
- \* Identified optimum sites for enhancing natural recharge and artificial recharge of groundwater including upper Yarmouk basin sites



**IR2.3 Improved quality of wastewater**

Research and service activities have focused on identification and characterization of wastewater quality testing cost-effective methods to improve its quality and using wastewater more efficiently especially for agricultural purposes



***Water quality monitoring services were and are being provided for public and private institutions***

- \* WERSC has provided and continues to provide water quality monitoring services to other national institutions and companies
- \* A study on the impact of the wastewater treatment plant on the water quality of springs in the Kuferanjeh Basin has been completed (with GCEP)
- \* WERSC collaborated with NCARTT in a database study for the Jordan Valley and with the Water Authority of Jordan (WAJ) on wastewater treatment and reuse These results will assist in monitoring progress and impact of interventions to improve wastewater treatment and reuse
- \* Training courses are in place and being used to improve wastewater reuse and quality control/quality assurance in water analysis

***Water quality issues were identified and characterized through collaborative UOJ/WSU research***

- \* Potential uranium contamination of soils amended with phosphate fertilizer Responding to concerns that uranium was leaching into soil and water from phosphate fertilizer WSU and UOJ researchers

carried out initial characterization studies. Results showed that due to highly alkaline soils this probably does not pose a major hazard to soil and water quality in the sample area studied.

- \* Under the Al-Azraq Oasis Conservation Project WERSC is assessing the effect of the Khirbet As-Samra treatment plant on ground water quality.

***Water quality improvements have been achieved through UOJ research***

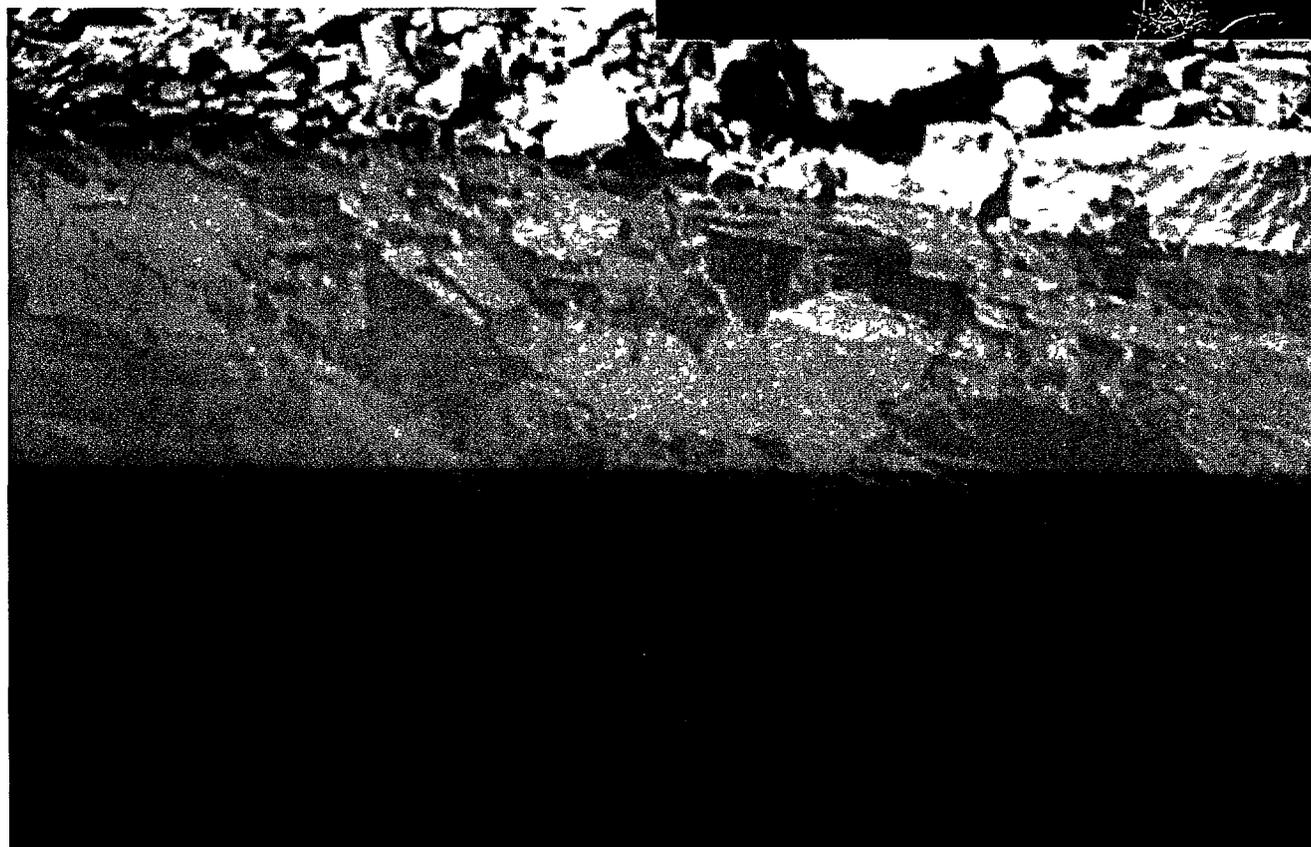
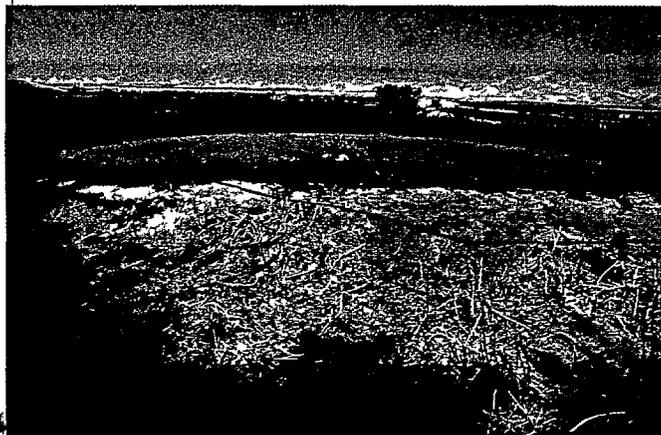
Among the research projects that are providing promising results to improve water quality are

- \* *Purification and re-use of domestic wastewater using low cost eco-bio technological methods* – European Union (EU) funded. The purpose was to improve the design and construction of low cost upflow anaerobic sludge blankets.
- \* *Removing pathogens from wastewater by using solar radiation* - EU funded and carried out with the Wallingford Institute (Great Britain), the Portuguese Ministry of Construction and the Tunisian Center for Water and Forestry.
- \* *The use of duckweed for wastewater treatment* – Funded by CIDA (Canadian International Development Agency). This was carried out on

newly constructed pilot ponds at Khirbet As-Samra and initial results suggest that follow-up is merited in the Jordan Valley.

- \* Substantial improvements in water and environmental quality at Azraq Oasis were achieved through a WERSC-UNDP-Royal Society for Conservation program.
- \* Based on findings from a comprehensive study of wastewater effluents from 25 industries in Jordan, WERSC provided recommendations for improved treatment to the participating companies.

WERSC provided or is providing leadership to these research efforts, with WSU providing consultation or assisting to access information sources as needed.



## **Additional Results Contributing to Increased Water Use Efficiency and Improved Water Quality**

- \* In the summer of 1998 the Director of WERSC aided by faculty from UOJ and WSU assisted the Jordanian government to respond to a problem that developed with the quality of water delivered to Amman. The investigators tracked down the cause to an algae bloom that developed in the prolonged warm weather. They provided information on how to deal with the existing difficulty and proposed establishment of an early warning system for possible future occurrences.
- \* A University of Jordan faculty member has completed his Ph.D. at WSU in collaboration with the University of South Carolina. He is developing an improved system for monitoring water use and quality in municipal water systems through inverse modeling.

### ***Other Benefits to Jordan and to Washington from the Linkage Project***

- \* WERSC and WSU provided leadership to the University of Jordan in the installation and testing of Internet access and e-mail. UOJ faculty is now well connected to the global information highway.

Communications with WSU as well as partners around the world is far easier and more economical than in the past. WERSC graduate students and faculty were among the first at UOJ to use this tool to access global research information.

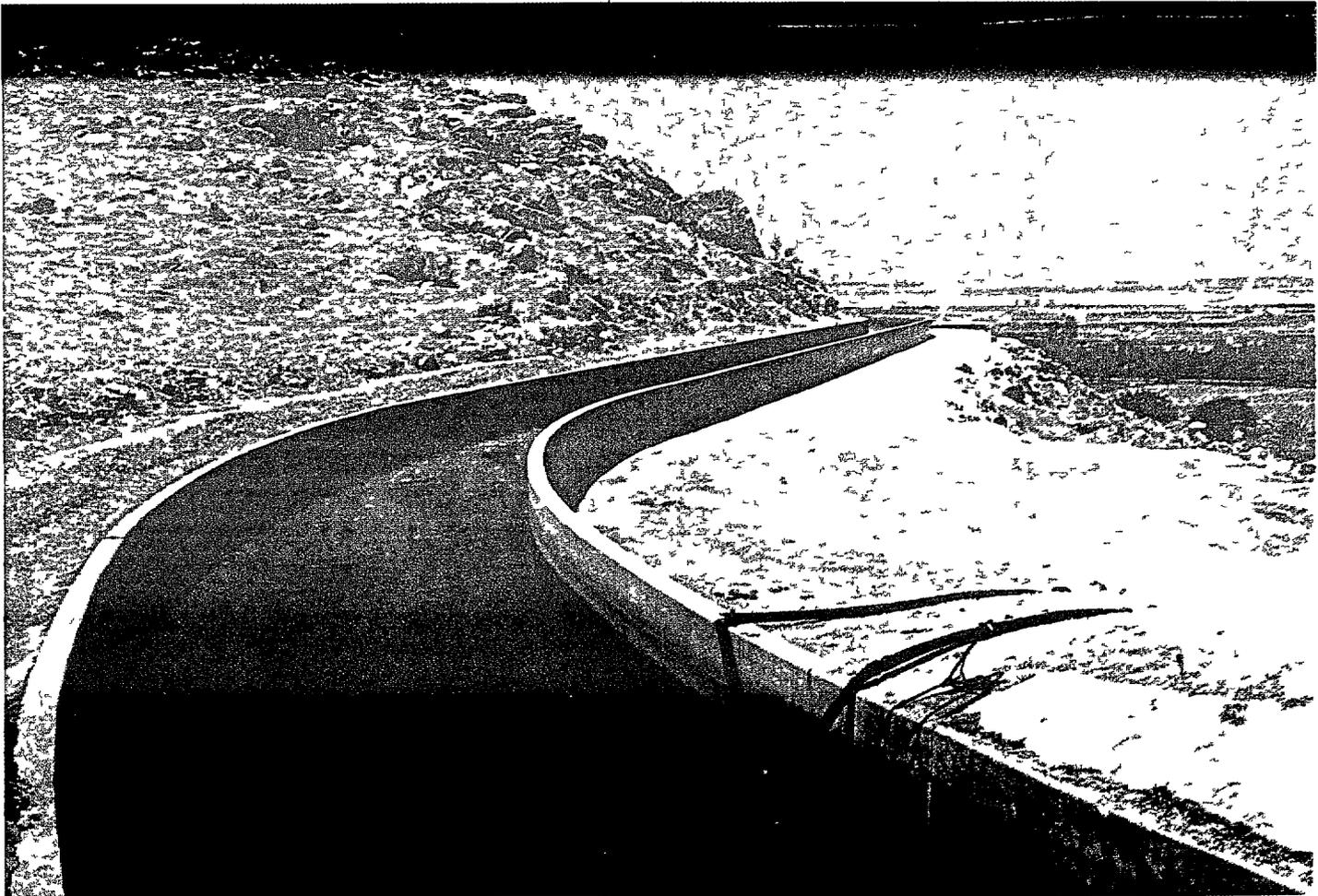
- \* UOJ faculty visitations to WSU and WSU faculty visits to Jordan provided opportunities for student and faculty seminars as well as for ongoing discussions on a broad range of water and environmental issues of mutual interest. For both WSU and UOJ this has resulted in curricular improvements and incorporation of broader international dimensions into their respective educational programs.
- \* Visits to WSU by senior UOJ administrators including the President, Vice-President and multiple deans were used as opportunities for UOJ and WSU leadership to exchange information and strategies on a number of topics. These included higher education's role in the next century, strategic planning and management of university programs, distributed learning, globalizing programs, funding and many others. Both WSU and UOJ reported that these sessions had a positive impact on their own planning processes. Subsequent movement of some of these administrators to other universities has expanded the impact to other institutions in the U.S. and Jordan.



- \* University of Jordan and the WERSC serve as the Middle East core institution for a *Global Environmental Research Education and Economic Development Network* that WSU is coordinating through its Interdisciplinary Environmental Science and Regional Planning Program. Along with core institutions in other regions (Latin America, Africa, Europe, Russia, Southeast Asia, and North America) this network is providing both WSU and UOJ expanded opportunities for funding collaborative and comparative research and education at both undergraduate and graduate levels. The use of distance delivery technologies (distance education) is a component of the latter.
- \* In part through activities associated with the UOJ-WSU Linkage Project, several U.S. and Jordanian institutions have increased collaboration in the U.S. and in Jordan. This collaboration spans a number of different areas and disciplines including water and the environment. In addition to UOJ

and WSU these include the Jordan University of Science and Technology, the Hashemite University, Yarmouk University, Purdue University, University of South Carolina, Brigham Young University, Texas Tech University, and others. These U.S.-Jordan university linkages serve as a strong basis from which the results and impact of the Linkage Program can be continued and expanded into the future.

- \* The Linkage has played a major role in increasing interest and effectiveness in planning and implementing interdisciplinary educational, research, and outreach programs in water and the environment. This has spanned faculty, administrators, and students in multiple faculties and departments at both WSU and UOJ, including engineering, soils, and irrigation, chemistry, environmental sciences, geology, biology, law, and others. This approach is recognized as adding strength and value to the universities' programs.



## Resources Used and Leveraged

- \* The USAID grant provided a total of U S \$500 00 which was fully expended during the grant period
- \* WSU and UOJ provided officially reported matching funds from non-U S federal sources in the amount of \$1 361 207
- \* UOJ WSU and collaborators in the U S and Jordan provided additional resources outside the USAID grant in support of this program These resources exceeded \$140 000 and were not reported as part of the formal match due to accounting procedures at WSU and UOJ

Thus USAID funds were leveraged at a level of greater than 3 1

The partners have also substantially invested in planning for additional collaborative activities that build upon the successes to date As a result WSU and UOJ have had some success in accessing funding that will help to sustain the partnership as well as the benefits it generates into the future However resources available to universities in Jordan and in the U S for participation in social and economic development programs remain limited The partners believe that universities in both countries remain valuable and underutilized resources for such development programs

## Postscript: Higher Education Partnerships for Social and Economic Development Conference

As a result of the success of this partnership program the University of Jordan and WSU were invited by USAID's Center for Human Capacity Development to organize a working conference entitled *Results of Higher Education Partnerships for Economic and Social Development* This conference was carried out in Amman Jordan from 18-20 April 1999 Seventy-six registered conference participants from a dozen countries gathered to exchange information on higher education development partnerships involving U S and Asia/Near East Russian and Northern African institutions Issues addressed included an examination of higher education's past present and future role in development and factors that influence the success of development partnerships The conference developed a set of best practices gleaned from partner experience and identified actions that members from the higher education community can take to participate more effectively in social and economic development Participants also developed a draft Action Plan for follow-up activities Over 90% of the respondents to the conference evaluation rated the conference as highly successful in meeting its objectives Proceedings of this conference are available through the Internet at the following address [http // www ip wsu edu/ipdc/jordan](http://www.ip.wsu.edu/ipdc/jordan)





## Selected Project Contributors

More than 400 persons internal and external to WSU and UOJ have participated in the Linkage Program and its associated activities. This list is too extensive to include in its entirety. The following illustrates some of these for the three primary UDLP partners.

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