

Panel on
Science and Technology
in Jordanian Development

Amman, Jordan
July 27-August 4, 1979

NATIONAL ACADEMY OF SCIENCES
Washington, D.C. 1979

972241 PB83-174201

79-0118

Summary Report of the National Academy of Sciences Panel on
Science and Technology in Jordanian Development, Amman,
Jordan, July 27 - August 4, 1979

National Research Council, Washington, DC.

Corp. Source Codes: O19026000

Sponsor: Agency for International Development, Washington,
DC.

1979 54p

Languages: English

NTIS Prices: PC A04/MF A01

Country of Publication: United States

Journal Announcement: GRAI8313

Contract No.: AID/ta-C-1433

A six-member National Academy of Sciences team visited Jordan July 27 - August 4, 1979 to outline priority needs in science and technology for development and consider areas for cooperation between the Jordanian and U.S. scientific communities. This report seeks to do the following: (1) To define ways by which enhanced collaboration between Jordan and the United States can make use of the scientific and technological resources in Jordan, the United States, and elsewhere in the world to improve the quality of life for the Jordanian people; (2) To define an organizational framework for the formulation and implementation of policies that will strengthen the links between science and technology and the development process; and (3) To suggest ways by which joint activities between the National Planning Council of Jordan and the U.S. National Academy of Sciences, and between the NPC and other agencies and institutions, both public and private, can make better use of science and technology to solve critical problems in the areas of water, energy, agriculture, environment, industry, and manpower.

Descriptors: *Technology transfer; *Jordan; Cooperation; Policies; Quality of life; Organizations; Developing countries

Identifiers: NTISNASNRC; NTISAIDOST

Section Headings: 5A (Behavioral and Social Sciences--Administration and Management); 70E (Administration and Management--Research Program Administration and Technology Transfer)

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NATIONAL ACADEMY OF SCIENCES PANEL
ON SCIENCE AND TECHNOLOGY IN JORDANIAN DEVELOPMENT

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This is a report on the activities of the Panel on Science and Technology in Jordanian Development. The panel, which performed its mission under the auspices of the National Academy of Sciences (Board on Science and Technology for International Development), visited Jordan during the period July 27 - August 4, 1979. The observations and recommendations of the panel were conveyed to Jordanian and U.S. AID and Embassy officials at meetings held in Amman. This report is submitted to the Agency for International Development under contract AID/ta-C-1433, for AID use and further distribution, if any.

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CHAPTER 1

INTRODUCTION

During a visit to Jordan in early 1979, Ambassador Thomas Pickering, Assistant Secretary of State for Oceans and International Environmental and Scientific Affairs, held a series of meetings with Jordanian government officials involved with national planning, science, and education to explore possible U.S.-Jordanian cooperation in the broad area of science and technology related to national development. It was agreed that as a first step a small group of U.S. experts, representing disciplines of major interest to the Jordanians, would be sent to Jordan to meet with counterparts to discuss this possibility. In response to this agreement, the U.S. Agency for International Development (AID) in Jordan asked the National Academy of Sciences (NAS) to select the U.S. group and organize its visit to Jordan. The specific purpose of their meetings with local officials would be to outline priority needs in science and technology for development and consider areas for cooperation between the Jordanian and U.S. scientific communities.

A six-member team, through financial assistance by AID, visited Jordan July 27 - August 4, 1979.

Members of the panel were:

- Robert N. Kreidler (Chairman), Executive Vice President, Alfred P. Sloan Foundation, New York, New York
- William A. W. Krebs, Vice President, Arthur D. Little, Inc., Cambridge, Massachusetts
- Daniel A. Okun, Kenan Professor of Environmental Engineering, Department of Environmental Sciences and Engineering, School of Public Health, University of North Carolina, Chapel Hill, North Carolina.
- Philip F. Palmedo, President, Energy Development International, Stony Brook, New York
- David Pimentel, Professor, Department of Entomology and Section of Ecology and Systematics, Cornell University, Ithaca, New York

NAS Staff:

- Rose Bannigan, Board on Science and Technology for International Development, Commission on International Relations, National Academy of Sciences, Washington, D.C.

Mrs. Bannigan arrived a week in advance of the team to assist Mustafa A. Zahran and Omar Zuqash of the National Planning Council in scheduling appointments for the NAS panel. During this initial week, James Cassanos of the AID mission in Amman accompanied Mrs. Bannigan on the preliminary visits.

The visit of the panel was well timed because the responsibility for formulating science and technology policy in Jordan's national development had recently been vested in the National Planning Council. Prior to this, science and technology policy was not the clear responsibility of any government agency, although the creation of the Royal Scientific Society (RSS) and its patronage by H.R.H. Crown Prince

Hassan had given that organization a significant role in science and technology coordination. An important step toward the development of Jordanian science policy was taken early in 1978 when the RSS organized a conference on the subject of UNESCO support and invited participants from a large number of countries and organizations, including the NAS. The need for integrating science and technology into Jordanian economic and social development planning was emphasized by the conference and provided a basis for U.S./Jordanian cooperation.

Discussions between the NAS panelists and their Jordanian counterparts concentrated on possible areas of collaboration and assistance which the Jordanians viewed as central to their institutions. This underscores the fundamental approach of the BOSTID program: The NAS panelists are not technical consultants, bringing solutions to technical problems or ready-made concepts of policy formulation for the host country to adopt. Rather, they bring a wide variety of talents and experience, which, taken together with the understanding of local priorities and constraints provided by the host counterparts, aid in analysis of possible areas of future collaboration. The goal is joint recommendations for improving the utilization of science and technology to reach national development objectives. The sections of this report that follow reflect the understanding reached in these joint discussions. The NAS panel, however, bears full responsibility for all the recommendations.

A number of suggestions and ideas raised during the discussions are not listed in detail in the report. Some problem areas, such as

scientific and technological information needs, were mentioned by several individuals and are encompassed in one major recommendation. A few specific suggestions were not individually included because the panel did not feel competent to make recommendations outside their specific areas of expertise. However, these requests have been conveyed to AID informally by letter.

The comments and recommendations of the panel were expressed to H.R.H. Crown Prince Hassan ibn Talal and to Hanna Odeh, President of the National Planning Council, during final meetings in Amman. The panel kept the U.S. Embassy and the AID Mission informed of their observations by informal reports and through the participation of the U.S. Ambassador and senior State Department and AID officials at the briefing sessions.

The National Academy of Sciences and the panel would like to express their appreciation to the AID Mission in Amman for its invaluable assistance in helping the Academy staff and panel to carry out this activity, with special thanks to James Cassanos, Senior Engineer and AID Project Officer for the NAS visit. Further, the panel, on behalf of the Academy, would like to thank Hanna Odeh and the staff of the National Planning Council for their assistance in setting up the program and for their illuminating discussions of policy issues regarding science, technology, and national development. Their colleagues at the various ministries and other institutions were all extremely helpful in frank discussions.

The panel would also like to express its thanks to H.R.H. Crown Prince Hassan ibn Talal, H.E. Sharif Abdul Hamid Sharaf and Dr. Abdullah Touqan for taking time for discussions from their very busy schedules.

CHAPTER 2

REPORT OBJECTIVES

This report is concerned with the use of science and technology for the economic and social development of Jordan. It seeks to do the following:

1. To define ways by which enhanced collaboration between Jordan and the United States can make use of the scientific and technological resources in Jordan, the United States, and elsewhere in the world to improve the quality of life for the Jordanian people.
2. To define an organizational framework for the formulation and implementation of policies that will strengthen the links between science and technology and the development process; and
3. To suggest ways by which joint activities between the National Planning Council of Jordan and the U.S. National Academy of Sciences, and between the NPC and other agencies and institutions, both public and private, can make better use of science and technology to solve critical problems in the areas of water, energy, agriculture, environment, industry, and manpower.

The panel has reviewed the Five-Year Plan for the Economic and Social Development of Jordan for the years 1976-1980, which was prepared by the NPC. It is clear from that review the main problems of development had been clearly identified by the NPC. It is also clear that steps have been taken to implement the objectives of the Five-Year Plan. But it is recognized by all concerned with Jordanian development that much remains to be done. Since the NPC is now at work on a new plan for the post-1980 period, a set of joint activities between Jordan and the United States, if promptly initiated, could be of timely significance.

The single most important resource in Jordanian development is its people. The panel was impressed at every turn in the course of its visit with the competence and dedication of individuals carrying out large responsibilities. Indeed, the degree to which Jordanians are being called upon to contribute their talents and skills to the development of the Middle East not only testifies to their capabilities, but also threatens to impair Jordan's own development. This is recognized as a serious problem and can only be addressed by training more people and by better utilization of those already well trained.

But it is also recognized that the solution of this problem is not simply to expand the educational system at all levels and redeploy manpower to the critical areas, difficult tasks in themselves. It is also a matter of putting in place the kinds of incentives that will encourage the redeployment of those already well trained and of establishing in the technical schools and, principally in the universities, the kinds of programs that will contribute to national development.

Jordan has considerable resources for training and research in its two major universities and in the Royal Scientific Society. However, these resources need to be strengthened and better related to the needs of development. The University of Jordan, for example, has much to contribute to development, but an inhibiting factor (as is frequently the case in the United States) is the organization of the university along classical departmental lines. While development problems depend for their solution on multidisciplinary approaches in both research and training, universities are largely structured according to academic disciplines. Difficult though it may be, it is imperative to establish programs and institutes in the University of Jordan, in the Royal Scientific Society, and in Yarmouk University to draw together individuals from many disciplines in order to address critical national problems in such areas as water, energy, and agriculture.

The planning and early stages of growth of Yarmouk University provide an unusual opportunity to relate relevant academic programs in research and training to important national needs. But if Yarmouk University also becomes organized along conventional departmental lines, its full potential to contribute to the solution of development problems will not be realized.

The capability of the Royal Scientific Society to undertake research and to analyze major policy issues in the development field will likewise not be realized unless its structure is multidisciplinary and task-oriented, so that its capacities for addressing priority problems can be utilized by the NPC and the relevant government agencies.

Similarly, strong links need to be forged among government agencies and between government agencies and the private sector--not only at the top but at all levels--to maximize their contributions towards meeting overall national development needs.

In the recommendations that follow, the panel has dealt with sectoral and cross-sectoral areas: water, energy, agriculture, and industry on the sectoral side; technical manpower and technical information on the cross-sectoral side. This has been done for the purpose of analytical description. The panel would like to emphasize, moreover, that the workshops and studies which are recommended in this report are designed to support developmental activities in Jordan. They are not suggested as academic exercises but rather as a means for developing specific programs and policies. The interdependence of each problem with the others and the interrelationships inherent in the proposed solutions should be well understood. The values of an integrated approach can not be underestimated. The fact that science and technology infuse all these areas should be viewed as a considerable resource to be drawn upon.

CHAPTER 3

RECOMMENDATIONS

This chapter summarizes the conclusions and recommendations stemming from discussions on science policy, water, energy, industry, manpower, and scientific and technical information. It is followed by a more detailed discussion of these topics.

Science Policy

The use of science and technology for economic and social development requires an organizational structure--and a set of activities--which can closely link science and technology to the development process through the formulation and implementation of policy.

Accordingly, it is recommended as a first priority that there be established within the National Planning Council a staff capability in science and technology so as to integrate science and technology into the formulation and implementation of national development policy.

The science and technology staff should be selected by the president of the Council and should be part of the general organ-

izational structure of the NPC, which includes economists and other development specialists. This is necessary in order to define at the outset how science and technology can contribute to the solution of the problems of development.

The science and technology staff should be a principal resource for the president of the National Planning Council and the Council itself in the fulfillment of their missions and responsibilities.

The science and technology staff should be relatively small, comprised of highly qualified technical people experienced in dealing with the problems of development. This staff should enlist additional technical support from R&D units in the relevant ministries, in the universities, in the Royal Scientific Society, and from expatriate sources.

To assist the president of the NPC in establishing the science and technology staff capability, it is recommended that a small group of advisors from the United States, appointed by the NAS, be sent to Jordan to help the NPC with this task. The advisory group should be made up of a senior policy analyst and two organizational development specialists with practical experience in science and technology in developing countries at the operational level.

It is further recommended that a collaborative effort between the NPC and the NAS be undertaken to help plan, organize, and implement a program of activities by which the resources in science and technology can be mobilized and utilized for Jordanian development.

As a first step, a joint Steering Committee of up to five individuals appointed by the president of the Council and five appoint-

ed by the president of the Academy should be established to oversee the planning and implementation of a collaborative program in science and technology and to review other proposed programs and the results of established programs in science and technology. The Steering Committee should meet annually (initially, perhaps semi-annually) to evaluate progress and review proposed activities.

Under the Joint Steering Committee, a number of joint workshops or study groups would be organized to focus on a specific topic or set of topics to arrive at recommendations for policies and programs that will promote science and effect development in the subject area or resolve particular problems. These efforts could focus on sectoral problems such as water, energy, agriculture, environment, and industry, or on problems that cut across all sectors, such as manpower training and scientific and technological information systems. From these activities will emerge programs and projects that might be undertaken by various U.S. institutions to assist Jordanian development and establish long-term collaboration between U.S. and Jordanian institutions.

Parallel to the NPC-NAS collaborative efforts, it is proposed that there be other forms of technical assistance between individuals and organizations in the United States to advise and assist the NPC itself and, through the NPC, Jordanian counterparts, in undertaking several activities of immediate importance to Jordanian development.

In the recommendations that follow, both forms of assistance are considered:

Water

The establishment of the recently approved National Water Authority is urgent and it should be constituted without delay so that water can be allocated to serve the overall national interest.

The first order of business for this authority should be the initiation of a national water assessment that would draw upon the many individual studies that already have been done. However, the assessment should concentrate on national needs, as contrasted with the earlier studies, which tended to serve more specialized constituencies. The services of a multidisciplinary team would be essential to such an assessment.

Since efficient use of water is vital to the national interest, it is recommended that a Water Conservation Technology Workshop be organized jointly by the NPC (or the National Water Authority) and the NAS. The workshop would address the technology and other factors, such as pricing policy, that will help optimize the use of water.

With water so important to Jordan's development, the shortage of qualified professional and technical personnel constitutes a major constraint on efficient water management. Immediate steps should be taken to develop expertise in the water management field, both by training students abroad and by adding faculty in the water management field at the two universities. The universities and other training establishments must be brought more fully into action in the water sector.

In addition, in any manpower development efforts strong emphasis should be given to training Jordanians as water management specialists.

Energy

Jordan faces serious problems in energy supply; its virtually total dependence on imported oil is already having major national economic consequences. Since meeting Jordan's future energy needs requires a much more effective and integrated use of its considerable technical, scientific, natural, and managerial resources, it is recommended that a national energy assessment be undertaken as soon as possible to consider all energy sources and uses. The objectives of the assessment should be:

- To establish an overall energy policy that can stand as part of the national development plan;
- To define a consistent set of national energy strategies and programs in areas such as energy resource development, technology development and demonstration, energy conservation, and energy pricing; and
- To establish a continuing institutional capability for the analysis and formulation of national energy policy.

The assessment should be carried out primarily by Jordanian personnel representing the relevant institutions, in collaboration with U.S. energy planners and appropriate technical specialists.

An important product of the national energy assessment will be a set of R&D priorities and programs. However, in view of the urgency of the energy problems facing the country, careful consideration should be given to the funding of sound proposals for technical or financial assistance in promising energy R&D areas such as solar energy, wind

energy for pumping, shale oil development, and utilization, geothermal energy, and energy conservation.

Agriculture

Food production continues to be vital to the economy of Jordan. Since evidence suggests that significant advances could be made in the food system through the application of new technologies, it is recommended that a joint NAS-Jordanian panel be established to study the food system in order to assess the priorities for research and development. The Jordanian participants should include scientists and investigators from the public and private sectors appropriate to the mission of this R&D assessment.

Environment

Jordan has serious environmental problems in the Gulf of Aqaba, and others associated with land use and soil erosion, water use, and pesticide use, which are affecting its economic development. Therefore, it is recommended that a series of joint study panels be formed to assess the management of environmental resources for development.

Separate study panels should focus on:

- Pollution and degradation of the Gulf of Aqaba;
- Land use and soil erosion;
- Water pollution by disease organisms and chemicals; and
- Environmental and public health impact of pesticides.

Industry

Because of the importance of the industrial sector to Jordan's future economic growth, it is recommended that a strategy for expanding science and technology capabilities in support of industrial activity be developed as part of the next five-year plan. A recommended first step in this direction is a joint workshop sponsored by the NPC and the NAS on industrial development strategy for Jordan. The agenda of this workshop should focus on the role of S&T in optimizing the country's comparative advantages of technologically competent manpower and a dynamic private sector.

Manpower

Since qualified S&T manpower is a basic resource for all development, a long-term manpower development strategy is of vital importance. It is recommended that a joint workshop be sponsored by the NPC and the NAS to focus on the special manpower needs for the development of Jordan and the region, including the potential for engaging overseas Jordanians in the technological development of Jordan during their overseas residence.

Scientific and Technological Information

Access to current scientific and technological information is vital to any developing country to ensure that scarce resources are not

wasted in duplicated effort. As a first step, a brief survey should be made of needs and possibilities in the S&T information area, probably carried out by an expatriate specialist or small team, with the objective of identifying options consistent with worldwide trends and resources while strongly focusing on Jordan's special requirements and capacities.

CHAPTER 4

SUMMARY SECTORAL REPORTS

Water

The availability of water is the chief constraint in the future development of Jordan. Few countries at its stage of development are as limited in water resources. The problem is exacerbated by the fact that Jordan is predominantly urban and will become increasingly urban and industrialized in the future. The adequacy of the water supply will determine the pace and quality of urban and industrial development.

The problem of water scarcity is accentuated by the fact that water management, including wastewater management, is highly fragmented among conflicting and competing agencies: the National Resources Authority (NRA), the Jordan Valley Authority (JVA), the Amman Water and Sewerage Authority (AWSA), and the Water Supply Corporation (WSC), with the individual municipalities also playing a role. Some of the agencies are new, and the laws and policies governing their powers are only vaguely defined. This results in haphazard and often wasteful investment in the water sector, resulting in uncertainty that clouds the potential for economic development.

The need for a centralized National Water Authority has long been recognized and recently decreed, but until now final action toward its formation has not been taken and decisions as to its powers have not been made. Establishing this Authority is an urgent need. Every effort should be made to ensure that the Authority be constituted so as to facilitate independent and objective policymaking, free of pressures from the major water-interest constituencies, so that this scarce resource can be allocated to serve the overall national interest.

The need for a national policy, and an authority to implement that policy, is urgent. Many water studies have been made, and massive projects are now in various stages of planning, design, and construction. Each of these has been based upon use concepts that are more or less parochial, focusing on water for urban or agricultural use. Studies and projects have not been designed for optimizing the national use of water resources, in good part because there has been no single agency charged with that responsibility.

The management structure can take any of several forms. An excellent model is the Water Authority in England, which plans, builds, owns, operates, charges for, and finances all water-related facilities in its area, based on hydrologic boundaries. There are ten such water authorities, several of which would be similar in size and population to Jordan. (The National Water Council in Britain, as distinct from the Water Authorities, has little authority and would not be a useful model.)

Following the creation of a Jordanian National Water Authority, there needs to be a national water assessment to help establish criteria for water allocation so that individual water projects will serve a national plan. The assessment should build upon the many studies that have already been done. However, it should concentrate on national needs in contrast to earlier studies that tended to serve specialized constituencies. Rather than taking the stated needs of the several water-using agencies as a starting point, the study would assess the value of water in each of its uses, to provide a guide for the long-term allocation of water resources.

The paragraphs that follow discuss additional issues that affect Jordan's water sector and offer suggestions for employing science and technology in their solution.

Water and Health

Water supply in Amman and other urban areas is intermittent, often being available only one day per week. Many households depend upon water from tank trucks or private vendors. The situation promises to get worse in the years ahead unless additional resources are made available. Furthermore, most households are not served by sewers, the wastewater being discharged into the ground. The consequences of this situation, discussed below, are serious.

Of greatest concern is the fact that the water is not safe to drink. When water pipes are not under pressure, underground water enters the pipes. Inasmuch as the underground water is polluted by cesspools,

the distribution system is contaminated. This has been demonstrated by the high percentage of samples with excessive bacteria.

Those who are obliged to buy water from tank trucks, often the urban poor, pay exorbitant prices and hence have limited amounts of water for sanitation and general cleanliness. The effect is evident in that diseases arising from poor sanitation are the leading cause of illness and death in Jordan. Further, Jordan suffers a high infant mortality rate, about 100 deaths per 1,000 live births, a rate at odds with its level of development. Only the most impoverished and least developed countries of the world have higher infant mortality rates.

The water supply for Amman and other urban areas is drawn from underground sources. The rates of withdrawal exceed the rates of recharge, threatening supply.

The absence of adequate water and sewerage services interferes with sound urban planning, acting as a constraint on optimum land use planning and industrial and commercial development.

The inadequate unsafe water supply and the improper waste disposal interfere with the development of large-scale tourism. Not only is the water not safe to drink, but the excellent vegetables in Jordan are not safe to eat.

Water and sewerage infrastructure for urban communities is being given a high priority, but without adequate water resources this will not correct the problems.

Sewerage

Sewerage is necessary for proper sanitation and protection of water supplies. In arid areas, in addition, sewerage becomes important as a means for conserving a water resource. A sound sewerage system, with appropriate treatment facilities, can enable direct reuse of the water for a myriad of nonpotable purposes. Such reclaimed water is particularly valuable for irrigation because it is rich in nutrients. Ample uses for this reclaimed water are available on the plateau. It is senseless to allow the wastewater to dribble down to the Jordan Valley while plans are afoot to pump water from the Jordan Valley, at great cost in money and energy, up to Amman.

Reuse of wastewaters for nonpotable purposes in urban areas, with dual distribution systems, is developing rapidly in the United States, particularly in the arid areas of the West. This is an approach deserving far more study in Jordan than it has been given to date. (Circumstances that call for water reuse are not found in Britain or Europe.)

Water Policy

Many individual studies of water resources and use in Jordan have been made by consultants from Britain, Germany, the United States, and other countries. The failure to consider water management in the context of the needs of the country as a whole can be made clear from a few examples:

- Water is sold in the Jordan Valley by JVA at 3 fils per cubic meter, by NRA on the plateau for 40 fils per cubic meter, and in

Amman at prices up to and exceeding 1,000 fils per cubic meter. Thus, there is little incentive for conservation in the Jordan Valley but much in Amman. Most of the potential for conservation, however, is in the Jordan Valley.

- Groundwater can be tapped by an industry or other large user without charge.

- The plan for using water from Maqarin reservoir would allow the water to flow down the East Ghor Canal, with Amman to be served--at the pleasure of JVA--by pumping up from the canal to Amman, rather than direct pumping to the city from the reservoir. This involves an additional head of some 400 meters, or well over 300 meters considering the additional friction loss of transmitting water some 110 km from Maqarin to Amman, as contrasted with 35 km from the canal to Amman. With energy costs continuously increasing, this approach will be a heavy financial burden on the people of Amman and will draw excessively from limited energy resources. In addition, flow in the East Ghor Canal will result in deterioration in water quality as well as in greater loss of water through evaporation than would direct pumping from the reservoir. The only advantage of the projected plan is that it assures the primary availability of water for agriculture in the Jordan Valley.

The construction of King Talal Dam and the many changes in plans for utilization of water in the reservoir have been costly. Because the efficient use of water is in the national interest, it is recommended that a Water Conservation Technology Workshop be organized jointly by the NPC (or the projected National Water Authority) and the NAS. The workshop would address the technology, and the pricing policy, that would help

optimize the use of water. The workshop might include panels on:

- Conservation in agricultural use, including discussion of the various methods of irrigation;
- Conservation in urban and residential use, such as the use of water-saving devices, pressure regulation, and leak prevention;
- Conservation in industrial use, including the potential for process modification and water recycling within a plant; and
- Reuse of wastewaters for nonpotable purposes such as urban irrigation, agriculture, industrial processing and cooling, and toilet flushing.

As noted, the United States has begun to implement reuse and conservation technology on a large scale, offering excellent opportunities for technology transfer.

Manpower

With major investment soon to be made in water projects, the need for qualified personnel at all levels should be clear. However, there appears to be no integrated effort to prepare the necessary training programs. Neither of the two universities has faculty in the water management field.

The universities and other training establishments must be brought into more active participation in the water sector. This would increase the number of qualified people available to the nation and improve the ability of these institutions to address problems in the water sector. A particularly fine opportunity exists at Yarmouk University which, as a new institution, has the potential for organizing its

academic, research, and service programs along multidisciplinary lines relevant to the pressing needs of the region and the country. Yarmouk University would thus seem to be in an excellent position to develop a program in all aspects of water management. A multidisciplinary teaching, research, and service unit, made up of engineers, chemists, biologists, economists, political scientists, geologists, lawyers, and other professionals, would be an excellent resource for training at all levels, as well as for undertaking the studies that will be increasingly necessary in the future.

Energy

Background

Jordan's current energy situation is characterized both by serious problems and potentially significant, if highly uncertain, opportunities. Few countries in the world are so completely dependent on imported oil. There is virtually no use of indigenous fuels -- either "commercial" energy sources (oil, coal, hydropower) or "noncommercial" energy sources (wood, agricultural wastes, etc.) so widely used in the developing world. This dependence on imported oil results in serious economic impacts, both on balance of payments and on the national budget through the internal subsidies for most fuels. The roughly \$120 million dollars paid in 1978 for imported oil amounted to 1.2 times the total value of Jordan's commodity exports in that year.

It is difficult to see how the country can continue its rapid economic and social development with its current energy dependence. Energy consumption is increasing rapidly; the use of electricity, for example, has grown at an annual rate of 17-20 percent in the last several years. Moreover, oil prices are increasing more rapidly than the value of Jordan's exports. The world oil situation appears even more menacing to Jordan's long-term economic health. Most analysts anticipate severe pressures on world oil production within about 15 years, with further upward pressure on oil prices.

Jordan does have significant human and natural resources that can be brought to bear on this critical national problem. Many of the intellectual resources of Jordan and Yarmouk Universities and the Royal Scientific Society; the technical and managerial resources of institutions such as the Natural Resources Authority, the Ministry of Industry and Trade and the Jordan Electricity Authority; and the entrepreneurial capabilities of the private sector are all relevant to solving the energy problems of the country. Furthermore, Jordan's natural resources appear to offer the possibility of much greater energy self reliance. There is at least the possibility that conventional petroleum resources, oil shale, and geothermal energy can help meet the nation's growing energy requirements. Jordan should be an ideal nation for the use of solar energy, and the energy in the winds may also be an economically exploitable resource in some parts of the kingdom.

A number of valuable programs have been undertaken that may eventually contribute to Jordan's energy supply picture. The preliminary evaluation that the panel was able to perform, however, suggests that the extent of these efforts is not consistent with the urgency and seriousness of the immediate problem. A basic difficulty is a lack of institutional and policy focus for a national energy effort. Our recommendations in the energy area are intended to help remedy this situation and to provide a basis for a more concerted set of programs and institutions to address this critical national issue.

A national energy assessment should be made to consider all energy sources and uses. The objectives of the assessment should be:

- To establish an overall national energy policy that can stand as part of the national development plan;
- To define a consistent set of national energy strategies and programs in areas such as resource development, technology development and demonstration, energy conservation and pricing; and
- To establish a continuing institutional capability for the analysis and formulation of national energy policy.

Among the issues that should be addressed in the assessment is the energy implication of various industrial development options. The current direction of industrial growth appears to be quite energy-intensive. Another issue is the relationship between agricultural and water policies on the one hand, and the energy situation on the other.

The assessment should be carried out primarily by Jordanian scientists, economists, social scientists and planners, with the support and collaboration of U.S. experts in relevant technical areas and in energy planning. All the appropriate Jordanian institutions should be represented in some way in the assessment. The National Energy Commission could play an important role in the assessment in assuring interest in its conception and in the eventual implementation of its recommendations. The agency responsible for the assessment could be the National Planning Commission.

One important product of the national energy assessment will be a set of priority program areas in energy research, development, and demonstration. It is evident that several areas are quite promising and that at least some of these are receiving inadequate attention. Given the urgency of the energy situation, careful consideration should be given to well-founded Jordanian proposals for technical or financial assistance in energy research, development, and demonstration, particularly in the following areas:

- Wind power, which, despite its apparent potential, at least for irrigation pumping, has received minimal attention.
- Solar energy, particularly the more straightforward approaches to water heating for industrial, commercial, and domestic applications, and simple approaches to desalination and water pumping.
- The acquisition of basic data on the extent of petroleum, oil shale, and geothermal resources.

Energy conservation in all sectors: industry, agriculture, transportation, government, commercial activities, and households.

Further Comments

Science and technology can contribute a great deal to the resolution of problems in energy. But these problems are basically interdisciplinary, and for science and technology to be used effectively in their resolution, the conventional boundaries between various technical areas and the physical and social sciences must be broken down. This is true at the planning level, the functional level, in designing and carrying out research, and in the development of manpower. As part of the energy assessment or of the new science and technology emphasis recommended above by the National Planning Council, the question of the overall institutional structure of energy research and implementation should be addressed.

One opportunity in this area exists in connection with the current evolution of Yarmouk University. The university is being built with the laudable goal of relevance to national developmental needs. But it is questionable whether that goal can be realized with the very traditional disciplinary structure that is anticipated. It might be well to consider a multidisciplinary institute or program at the university in the area of energy. This would provide a mechanism for bringing together faculty members and students to address energy problems in an interdisciplinary framework. As noted earlier, a

similar institutional arrangement could also be of great value in the area of water resources. The problems of energy and water will continue to be critical to the development of Jordan.

If the universities are to fulfill their national responsibilities in energy and other critical areas, they should be producing graduates with education that reaches beyond narrow technical specialties, and whose professional competence is complemented by an understanding of major national issues.

Agriculture

Agriculture and the food system in general dominates the economy and social system of Jordan, utilizing the largest share of land and water resources as well as large quantities of energy. Under normal conditions, agriculture provides most of the food required by the nation, and agricultural products make up more than half of all exports. Increasing the productivity and efficiency of agricultural resources, therefore, would directly serve development.

Science and technology have contributed to increasing crop and livestock yield during past years, and significant potential exists for R&D to further increase these yields. This is especially true of irrigated crops; estimates obtained during the panel's review were that the yields of some crops could be increased by 200-500 percent.

Maximum use of land, water, energy (for fertilizers, pesticides, machinery, etc.), and labor resources for crop production depends

directly upon technology because of the immense complexity of the agricultural system. The mismanagement of a single factor in the production system will result in low yields and waste of all the other resource inputs.

Based on a conservative estimate, it is projected that food production could be doubled, perhaps in the next five years, through the effective use of science and technology in agricultural development. There is tremendous potential for increased food production in Jordan if resources are effectively managed and utilized. With this potential in mind, it is recommended that a joint study be made of the food system of Jordan, including nutrition aspects. This study should cover the following aspects of food production.

1. Agricultural Development Policy

An overall assessment and plan is needed to determine the food production priorities of Jordan for the next 5-10 years. This would include an assessment of the land, water, energy, and manpower resources available for crop and livestock production and other components of the food system. The types of crops and livestock production systems that would best supply the nutritional needs of Jordan also should be determined in the study.

2. Irrigated Crop Culture Technology

Tremendous potential exists for improving crop yields from irrigated crop lands by applying scientific concepts to the management and use of resources available to agriculture.

3. Dry Land Crop Culture Technology

One of the major problems in producing dry land crops for effective commercial production is the small size of land holdings. However, the opportunity exists to increase dry land crop culture through the use of improved crop varieties and better land and water resource management.

4. Livestock Production Systems

Three major improvements for livestock production include increased forage production, reduced grazing pressure, and more productive livestock types. All of these improvements are possible through appropriate R&D.

5. Nutritional Systems

Available evidence suggests that about 20 percent of the Jordanian population suffers from some type of malnourishment. Most of the problem exists with children. More should be known about the prime causes of this malnourishment.

Improved nutrition for the people of Jordan is extremely important. It is related to increased agricultural production, better food processing and distribution, reduced food losses, better nutrition information, effective disease control, and economic development. These interdependencies should be investigated to determine ways and means of improving the overall national diet. Better nutrition will result in a healthier nation and more productive manpower.

To identify the research priorities that will improve the food system of Jordan, a joint study panel made up of scientists from Jordan and the United States should be established. The Jordanian scientists and technologists for this study should be drawn from the Ministry of Agriculture, Jordan University, Yarmouk University, Jordan Valley Authority, National Resources Authority, the food processing industry, marketing groups in the private sector, and any other interested organizations in the public and private sectors that would contribute to the work of the study panel.

Although the report of the study panel should be directed toward the total food system, some of the investigations could be conducted by subpanels. The study should take into account the interdependence of the food system with water, energy, land, and manpower resources.

Environment

Concern is being expressed about rapidly increasing environmental problems that are directly affecting economic and social development in Jordan. These problems include water use, land use and soil erosion, pesticide use, and pollution in the Gulf of Aqaba.

One of the main difficulties in dealing with these problems in Jordan is the lack of any group or agency responsible for environmental concerns. In addition, environmental problems are usually complex, since they degrade land and water resources and affect public health in many ways. This makes control of such problems difficult.

Since environmental problems are complex, they require interdisciplinary efforts for their solution or control. Clearly, appropriate technology should be employed to reduce the seriousness of environmental impacts.

Joint Jordanian-NAS study panels, each concerned with one of the major environmental problems, are needed to identify research priorities and to develop programs that can deal effectively with these problems. Ideally, the studies should recommend strategies to deal with both short- and long-term environmental problems.

The major environmental problems are pollution and degradation of the Gulf of Aqaba, land use and soil erosion, water pollution, and pesticide pollution.

1. Pollution and Degradation of the Gulf of Aqaba

Phosphate is being released into the Gulf of Aqaba by the potash mining and export operation. Nitrogen and phosphorous levels are also increasing from the release of sewage effluent into the water. Perhaps the most serious problem is the release of ballast from ships using the bay as a port. In any case, deterioration of the gulf, as indicated by the death of some of the coral growth, appears to be taking place.

The Jordanian panel dealing with this problem should include investigators and managers from Jordan University, Yarmouk University, Aqaba municipality, the appropriate tourism authority, the Royal Jordanian Navy, the potash mining industry, the Royal Scientific Society, and other organizations appropriate to the mission of this R&D assessment.

2. Land Use and Soil Erosion

Soil erosion is occurring primarily from crop and livestock production. It is degrading the productivity of the agricultural land as well as rapidly rendering some of the reservoirs ineffective. For example, it is projected that Zerka Reservoir will be filled with sediment in about 8 years.

Jordanian membership on this panel should include investigators from the Ministry of Agriculture, Jordan University, Yarmouk University, Jordan Valley Authority, Natural Resources Authority, and the Urban Planning Unit of Amman, among others.

3. Water Pollution

Water is being polluted with disease organisms and chemicals, which affect public health as well as crop and livestock production.

Among the Jordanians participating in this study panel, there should be individuals from the Environmental Unit of the Ministry of Health, Royal Scientific Society, Jordan University, Yarmouk University, Ministry of Agriculture, Jordan Valley Authority, Natural Resources Authority, and Amman Municipality.

4. Pesticide Pollution

The use of pesticides for agriculture and public health is reported to be having an impact on the health of the people of Jordan.

Participation on this panel should include investigators from the Royal Scientific Society, Ministry of Agriculture, Jordan University, Yarmouk University, Jordan Valley Authority, Environmental Unit of the Ministry of Health, Malaria Control Group, Food Processing Industry, and private voluntary organizations.

Science and Technology in Industry

Jordan's long-term economic development will be highly dependent on the pace and quality of its industrialization efforts, in which S&T may well be the critical element. The panel noted that, from a small base, Jordan's industrial sector has been growing consistently over recent years at an annual rate of over 25 percent. Technology needed for the large-scale, resource-based industries--for example, phosphate, potash and fertilizers--seems to be supplied from abroad by experienced multinational firms in joint ventures. Technology employed in the dynamic small- and medium-industry private sector appears, at this stage, to also be obtained largely from abroad by joint venture or license, with relatively little indigenous S&T activity, aside from quality control and technical trouble-shooting services offered by the RSS and the universities or by individual faculty members in a consulting role.

These technical resources seem consistent with Jordan's short-term development strategy and resources. Over the next 5 or 10 years, however, it would be desirable to encourage the growth of indigenous S&T capabilities for industrial research, both within the large-scale industries themselves and within RSS and the universities, in support of the cost-effectiveness and export marketing of the light industry sector. There is also a need for strengthening technical support in the development of government policies aimed at improving the appropriateness of technology imported from abroad.

Technical support is also needed in the formulation and administration of standards for manufactured goods, processes, and industrial wastes.

Over the next several years, the contribution of S&T to industrial development is likely to be most significant indirectly, that is, through efforts to relieve the serious constraints on industrial expansion that are created by the energy and water resource problems.

Because of the importance of the industrial sector to Jordan's future economic growth and the leverage that a healthy indigenous research capability can supply, it is recommended that a strategy be developed for expanding S&T capabilities in support of industrial activity, and that it be made explicit as a part of the next five-year plan. A useful step in this direction would be a workshop jointly sponsored by the NPC and the NAS on industrial development strategy for Jordan. The agenda of this workshop should focus on the role of S&T in optimizing the country's comparative advantages in technologically competent manpower and a dynamic private sector. To take account of the long-term implications for industrial development strategy of the constraints implicit in rising energy and water costs and of the opportunities that exist in the area of human resources, this workshop should build on the national energy and water assessments and the findings of the manpower development workshop.

Central themes to be addressed by the workshop should include:

- The potential of industrial research, both in the large-scale extractive and processing industries and in the small-scale manufacturing and services sectors, for increasing profits and contributing to the achievement of national development goals.

- Means for encouraging greater use by the private sector of the technological resources of the science and technology community in the RSS and the universities.

- Opportunities presented by regional markets in the Arab countries, and cooperation with other Arab countries in regional industrialization.

- The role of the S&T community in assuring that acquisitions of technology from abroad are appropriate in light of development strategies.

- The role of industrial standards in supporting the penetration of export markets by Jordanian products and in protecting the interests of consumers of both imported and domestic items.

CHAPTER V

SUMMARY CROSS-SECTORAL REPORTS

Science and Technology Manpower for Development

A country's stock of qualified science and technology manpower is a basic resource for development with implications for the effectiveness of programs in all sectors. Jordan is a developing country relatively rich in human resources and relatively constrained by natural resources. The fullest use of its talented and skilled manpower should therefore be a major development objective. A manpower development strategy, necessarily long term in its goals and execution, is of central importance.

As a first step toward the development of such a strategy, a manpower development workshop should be jointly sponsored by the NPC and the NAS. Central themes of this workshop should include:

- Special science and technology manpower problems flowing from the emigration of a significant portion of Jordan's human resources, especially talented engineers and managers.
- Potentials for engaging the talents of overseas Jordanian scientists, technologists, and managers in Jordan's technological development activities during their overseas

residence, thus strengthening short- and medium-term science and technology infrastructure to induce repatriation of overseas manpower.

- The elements of a long-term science and technology manpower development strategy, closely linked to a vision of Jordan's future role as one of the leading countries in science and technology in the Middle East.
- The specific educational and training activities, both in Jordan and abroad that will be needed to meet the country's science and technology manpower requirements, including those at the technical and paraprofessional level.
- The special opportunities present in large-scale joint ventures with multinational companies for utilizing the presence of such companies in Jordan to build indigenous science and technology capacity through training, both in their operations and by linking their resources with the universities and RSS.

Scientific and Technological Information

A developing country of Jordan's size, endowed with a technologically alert and active--albeit small--cadre of engineers and technologists, should have a very special interest in taking advantage of rapidly expanding worldwide systems and facilities for accessing

non-proprietary science and technology information. At the policy level this requires that research projects begin with an energetic search of the world's relevant knowledge, to assure that scarce resources are not wasted in redundant effort. Making such a policy effective will depend, however, on the availability of adequate professional and technical capability for obtaining such access, with close links within the country to the user organizations.

The panel was not able, in its brief reconnaissance, to gain more than a brief impression of existing capabilities and needs in this important area. It seems likely, for example, that the national standards operations of the Ministry of Industry and Commerce would benefit from rapid, interactive electronic linkage with world science and technology resources over a wide range of technologies. This also might be the case for the Royal Scientific Society, the Natural Resources Authority, and the proposed National Geographic Center, as well as for the universities. Of specific interest, in view of Jordan's needs in the natural resource area, might be a closer working relationship with remote-sensing satellite systems.

The possibilities for strengthening the science and technology information system range from the establishment of some kind of national scientific and technological information center to simply strengthening the library and the conventional information service activities of the science and technology institutions. What appears to be needed as a brief survey of needs and possibilities in the science and technology information area, probably carried out by an expatriate specialist or small team. The objective should be to identify options that are

consistent with worldwide trends and resources, while strongly focusing on Jordan's special requirements and capacities.

PANEL ON SCIENCE AND TECHNOLOGY
IN JORDANIAN DEVELOPMENT

SCHEDULE

Saturday, July 28

9:30 a.m. American Embassy
Nicholas Veliotes, Ambassador

10:30 a.m. National Planning Council
Hanna Odeh, President

12:00-03:00 Royal Scientific Society
Albert Butros, Director-General
Fakhruddin Daghestani, Deputy Director-General

Sunday, July 29

9:00 a.m. Yarmouk University (Amman Liaison Office)
Adnan Badran, President

12:00 noon University of Jordan
Marwan R. Kamal, Dean, Faculty of Sciences

4:00 p.m. Jordan Valley Authority
Munther J. Haddadin, Senior Vice-President

Monday, July 30

10:15 a.m. Chief of Royal Court
H.E. Sharif Abdul Hamid Sharaf
Science Advisor to His Majesty
Abdullah Touqan

12:00 noon Ministry of Agriculture (Pimentel & Okun)
Hassan Gharaybeh, Undersecretary

12:00 noon Ministry of Industries (Krebs & Palmedo)
Hasham Dabbas, Undersecretary

LATE P.M. Visit to King Talal Dam

Tuesday, July 31

8:30 a.m. Amman Water & Sewerage Authority (Okun & Pimentel)
Usama H. Mudallal, Deputy General Manager

9:00 a.m. Jordan Electricity Authority (to include energy)
Ali Ensour, Director-General (Palmedo * Krebs)

10:00 a.m. Ministry of Education (Kreidler)
Ahmad Al-Aqaileh, Secretary General

10:00 a.m. Ministry of Health (Okun & Pimentel)
Aram Yaghlian, Director, Planning and Foreign
Relations

12:30 p.m. National Resources Authority (Okun, Pimentel &
Palmedo)
Yousef Nimry, Director-General

6:00-7:30 American Ambassador's Residence - Reception (Informal)

Wednesday, August 1

7:00 a.m. Leave Amman via RJ 300

7:40 a.m. Arrive Aqaba
(USAID car and driver met team at airport)

In Aqaba, visit:
Marine Science Section (under University of Jordan)
Desalination Plant (under Royal Scientific Society)

Return Aqaba to Amman by USAID car

Thursday, August 2

9:00 a.m. National Planning Council
Hanna Odeh, President

11:15 a.m. American Embassy
Nicholas Veliotos, Ambassador

12:00 noon H.R.H. Crown Prince Hassan

Friday, August 3

No appointments - preparation of report

Saturday, August 4

9:00 a.m.	U.S. Agency for International Development for final informal discussions.
12:00 noon	Ammah Urban Regional Planning Group (Okun) Ghalib Bagaeen, Director

JORDANIAN OFFICIALS INVOLVED IN PANEL DISCUSSIONS

Ahmad Al-Aqaileh, Secretary-General, Ministry of Education
Izzat Azizi, Director, Administration and Services, Yarmouk University

Adnan Badran, President, Yarmouk University
Ibrahim Badran, Planning Manager and Director of R & D, Jordan
Electricity Authority

Ghalib Bagaeen, Amman Urban Region Planning Group
Victor Billeh, Acting Dean, Faculty of Science and Arts, and
Director, School of Education, Yarmouk University
Albert Butros, Director-General, Royal Scientific Society

Hasham Dabbas, Undersecretary, Ministry of Industries
Fakhruddin Daghestani, Deputy Director General, Royal Scientific
Society

Mohammad H. Dajani, Director of Environmental Health, Ministry of
Health

Omar Abdullah Dokhgan, President Jordan Valley Authority

Ali Ensour, Director-General, Jordan Electricity Authority
Abed Naqoula Sahhar, Director, Sewage Treatment Plant, Amman
Water and Sewerage Authority
Hassan Gharaybeh, Undersecretary, Ministry of Agriculture

Munther J. Haddadin, Senior Vice-President, Jordan Valley Authority
Muhammad Halawa, Director, President's Office, Yarmouk University
Ribhi Hamdan, Transmission and Distribution Manager, Jordan
Electricity Authority
Faraj Al-Hashimi, Ministry of Industries
H.R.H. Crown Prince Hassan Ibn Talal

Basil Jardaneh, Secretary-General, National Planning Council
Marwan R. Kamal, Dean, Faculty of Sciences, Jordan University
Robert Kemper, Sewerage Advisor, Amman Water & Sewerage Authority
Carl Madin, Water Advisor, Amman Water & Sewerage Authority
Usama H. Mudallah, Deputy General Manager, Amman Water and Sewerage
Authority

Waddah Nabusli, Generation Manager, Jordan Electricity Authority
Raif Najem, Director, Engineering Office, Yarmouk University
Fahed Natour, Vice President for Irrigation, Jordan Valley Authority
Bassam Nimry, Director, Department of Public Relations, Ministry of
Agriculture
Yousef Nimry, Director-General, National Resources Authority

Hanna Odeh, President, National Planning Council
Khalid Omari, Director, Planning and Development, Yarmouk University

Jamil Quhaiwi, Director, Research Department, Ministry of Agriculture

Sadallah Saadallah, Amman Urban Region Planning Group
Naser Sa'don, Project Manager, Jordan Electricity Authority
Bassam Saket, Economic Advisor to H.R.H. Crown Prince Hassan
Farid Samarh, RSS Solar Desalination Station, Aqaba
H.E. Sharif Abdul Hamid Sharaf, Chief of the Royal Court
Nabil Sweis, National Planning Council

Abdullah Touqan, Science Advisor to His Majesty King Hussein

Mohammad Wahbeh, Marin Science Station, Aqaba

Aram Yaghlian, Director, Planning and Foreign Relations, Ministry of
Health.

Mustafa A. Zahran, National Planning Council

Omar Zuqash, National Planning Council

Background Material

Reviewed by

Panel on Science and Technology in Jordanian Development

1. General Report on Jordan's Science and Technology Conference, 1978.
2. Jordan Country Paper - prepared for United Nations Conference on Science and Technology for Development.
3. Jordan - Travel Description from PANAM Travel Book.
4. Background Notes - Issued by Department of State
5. Jordan - Information from EUROPA Publications: The Middle East & North Africa, 1978-79.
6. Jordan: Foreign Economic Trends and Their Implications for the United States, June 1978.
7. The Economic Realities, Jordan, 1976-77 by Bassam J. Asfour.
8. A National Policy-Making Body for Science and Technology in Jordan, from June 1978 Science and Public Policy.
9. Survey of Scientific and Technological Potential for Jordan in 1976 - prepared and submitted by the National Preparatory Committee for the Conference on Science and Technology Policy for Jordan.
10. Laws and Measures Dealing with the Encouragement of Scientific Research and Scientific and Technological Activities in Jordan, prepared by same conference as above.
11. Science and Technology for Development - Institutions and Policy Formulation, January 21, 1977 - by Royal Scientific Society of Jordan.
12. Synthesis: The Dynamics of Health, An Analytic Series on the Interactions of Health and Socioeconomic Development - by the U.S. Public Health Service.
13. USAID/Jordan Program Activities
14. Five-Year Plan for the Economic and Social Development of Jordan, 1976 - 1980.



