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Advancing Environmental Education and Training for Sustainable Management of Environmental Resources in Palestine

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This article describes the various capacity-building activities at the Institute of Environmental and Water Studies of Birzeit University during the past 10 years. It highlights the gained experience in advancing environmental science and engineering education and training programs as components of sustainable water and environmental management schemes. Furthermore, the major constraints faced, and future plans to sustain and enhance the capacity-building activities, are also introduced and discussed. Critical analysis of the past and ongoing educational and training programs provided clear evidence that environmental education and research capacity building in Palestine is still underutilized and threatened by a persistent lack of financial resources. The data presented should also be of interest to international agencies engaged in strengthening higher education.

PROBLEM DEFINITION AND BACKGROUND

Water and the natural environment in Palestine are important resources and crucial regional stability elements as witnessed by the historical and political conflict with Israel. The water supply and sanitation services in Palestine are very poor, so that the quality of the limited water resources is deteriorating annually. It is estimated that about 35% of the total popula-

tion in the West Bank are connected to a centralized sewerage network, whereas only 17% of the collected urban sewage is either partially treated or discharged uncontrolled into receiving water bodies. The prevailing intolerable local and regional political situation has affected the socioeconomic and health aspects of the Palestinian people as well as inhibited the education and research at the Palestinian institutions. The existing water and sanitation facilities are suffering from weak management and lack of financial resources. In addition, the negative influence of donor-driven-projects and narrow local and regional environmental visions exacerbate the problem (Al-Sa'ed & Mubarak, 2006; Al-Sa'ed, 2007).

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Although considerable progress has been made, Palestine is faced with multiple water

and environmental concerns and the need for significant human and financial investments. Much of the water and sanitation infrastructures in Palestine have approached the end of its operational life cycle, and the resulting infrastructure deficit is estimated to be approaching \$1 billion (World Bank, 1993). Protecting Palestine's environmental resources is crucial and demands financial resources and effective capacity-building efforts to sustain environmental resources and reduce environmental irreparable damage.

The development of human and physical resources for a long-term sustainable management of water and environmental resources requires capacity building. The capacity-building term is defined as the sum of efforts to enhance and effectively utilize the existing skills and capacities of both people and institutions at all levels and domains in order to achieve an adequate progress toward sustainable development (UNDP, 1998). The principal objective of capacity building for sustainable water and environmental resources management is to improve the quality of decision-making, sector efficiency, and managerial performance in the planning and implementation of programs and projects. Gutierrez-Martin and Dahab (1998) reported that environmental education and training are essential elements in the dynamics of environmental pollution prevention. On the other hand, education and training ensures that consistency about the value and the need for sustainable management of water and wastewater treatment systems is achieved to protect and improve the quality of the scarce water and environmental resources in Palestine. Worldwide, there is an increasing demand for engineering- and science-based environmental decision-making at the local, regional, national, and international levels. Natural scientists and environmental engineers are being faced with three main challenges: (1) to estimate the probability, magnitude, and impacts of natural and human-made environmental impacts, (2) to analyze and identify major environmental processes within water and sanitation unit operations, surface

and groundwater watersheds, and freshwater and marine ecosystems, and (3) to interpret scientific findings for better policy, management, and engineering decisions (Derrickson et al., 2002; Steel & Weber, 2001).

To approach and solve these challenges, the interests and needs at various Palestinian educational and research institutions are growing. In order to support and cope with these interests and needs, Birzeit University (BZU) began in 1994 cooperative professional training programs in water and sanitation and created M.Sc. programs in 1997. In response to increased national demand for qualified professionals in water science and engineering, BZU has established the Institute of Environmental and Water Studies (IEWS).

This article presents the various activities being accomplished at Birzeit University in promoting environmental education and training in the past 10 years and discusses the major constraints faced in achieving these activities. The upgrading and development attempts of new courses combining sound science and applied engineering concepts to graduate high-quality professionals are presented. Furthermore, a problem-solving approach and future plans to sustain and enhance the activities of the IEWS are also introduced and discussed.

CAPACITY BUILDING IN WATER AND ENVIRONMENTAL EDUCATION

Past Capacity-Building Efforts and Old M.Sc. Programs

In order to support and cope with increased national demand on capacity building, BZU began in 1994 cooperative professional training programs in water and sanitation and created M.Sc. programs in 1997. In response to increased national demand for highly qualified professionals in water science and engineering

BZU has established the Institute of Environmental and Water Studies (IEWS), formerly called Institute for Water Studies (IWS), as a regional knowledge center. The burden of the Israeli occupation and building of the security wall resulted in roads' blockage with restrictions in staff/student movement and led to potential reduction of research funding opportunities and intolerable working conditions. Among the 11 Palestinian universities, BZU is the only Palestinian university still offering M.Sc. degrees in Environmental Science and Engineering.

Capacity building in water and environmental management has a 10-year history at BZU (Table 1). Several specialized local training programs and cooperative agreements were made in an effort to promote sustainable water and sanitation infrastructures.

The IEWS, has emerged from the M.Sc. program in water engineering, as a part of a water sector capacity-building program in Palestine (WASCAPAL, 1996) funded and technically supported by the Dutch government. WASCAPAL has educational, capacity-building, and research components. The educational component entitled the establishment of a M.Sc. program in water engineering. This program granted a M.Sc. degree in two specializations: sanitary engineering and hydrology. The IEWS mission was to educate, train, and inform Palestinian professionals and the public about the most current technologies and methods to minimize pollution loads, reduce health risks, and enhance water quality excellence through sustainable water and wastewater treatment facilities.

Local instructors and foreign professionals from The Netherlands shared the education responsibility. In accordance with the Faculty of Higher Education policy, the head of the M.Sc. council, comprised of six staff members, is responsible for advising students, planning semester courses offered, coordinating the courses contents and the teachers involved in the course, and for logistics management.

At program's start, about 20 students of engineering background were accepted from all districts in the West Bank and Gaza Strip. Although donated by The Netherlands government, Al-Sa'ed (1997) reported that capacity building of Palestinians abroad caused heavy financial burdens (about 45,000 US\$ per participant). Hence, and due to pressing market demand and the multidisciplinary nature of the water and sanitation services, the water experts and management level at BZU decided to open another program in water science and technology. The number of students enrolled and those graduated in various M.Sc. programs offered by the IEWS at BZU are summarized in Table 2.

At present 52 students are registered in both programs. Within the two offered M.Sc. programs (three specializations), the ratios of registered students in each specialization were 10%, 27%, and 63% in hydrology, water science and technology, and sanitary engineering, respectively. During the last 10 years 67 M.Sc. students have graduated from the M.Sc. programs in the specializations mentioned. Due to the political situation during the academic year 2000–2001 about 44% (eight students) of total accepted students had withdrawn from

Table 1
Historical development of environmental capacity building at Birzeit University

Year	Education, training, and research development activities
1994	Cooperation between BZU and IHE* -Delft, The Netherlands
1995	Short courses on water supply and environment
1996	Water Sector Capacity Building in Palestine (WASCAPAL) project
2001	Establishment of the Institute for Water Studies (now Water Studies Institute)
2002	IEWS-POWER Partnership (Partnership for Water Education and Research) Collaborative Center of UNESCO-IHE Institute for Water Education
2004	TEMPUS** project on Environmental Capacity Building at Birzeit University

*IHE: Institute of Hydraulic Engineering; **TEMPUS: Trans-European Mobility Scheme for University Studies.

Table 2
Students' numbers and graduates from current M.Sc. programs

Academic year	Enrolled	Graduated	Dismissed	Female/Male Percentage (%)
1997/1998	10	—	1	20
1998/1999	9	2	2	33
1999/2000	20	4	1	15
2000/2001	10	11	1	20
2001/2002	15	10	2	33
2002/2003	16	5	3	22
2003/2004	25	13	—	40
2004/2005	14	8	—	30
2005/2006	12	6	1	50
2006/2007	10	8	—	33
Total number	141	67	11	

the program. Also, the female to male ratio has fluctuated between 15–40% during the academic years 1997–2004. Despite political and financial constraints, the quality of graduating students is of international standards reflected in enrolment of seven graduates in Ph.D. programs in Europe and Japan.

Upgrading Current M.Sc. Programs

Building on the experience gained from the past WASCAPAL project and in response to the acute demand for well-trained Palestinian professionals in the fields of environmental science and technology, BZU has managed successfully to upgrade the existing Master Programs with environmental subjects. As a part of the new strategic direction, the Water Studies Institute has rationalized its educational policy and research and development. The strategic priorities were identified as critical for water and environmental education, training, and innovation needed to ensure sustainable water and sanitation infrastructures, reduce public health risks, and protect environmental resources. These changes are tackled within an EU-funded Tempus Program (TEMPUS, 2004), where the existing M.Sc. programs are upgraded by incorporating environmental core and elective courses. This program (2005–2006) was implemented in cooperation with the Royal Institute of Technol-

ogy (KTH) and the UNESCO-IHE Institute for Water Education.

In response to the increased demand for engineering- and science-based environmental decision-making at the local, regional, national, and international levels, Palestinian natural scientists and environmental engineers are forced to interact and work across disciplines. Developing tools and bio-monitoring methodologies, estimation of fate and magnitude of natural and man-made environmental impacts, understanding of key environmental processes, protecting surface and groundwater, and developing science-engineering-based decisions call for upgrading and new courses development of the current M.Sc. course offered. All courses offered incorporate advances in science and engineering for a sustainable management of water and environmental infrastructures. Developed M.Sc. thesis works entail fundamental and applied research and bio-monitoring to increase the understanding of impacts, fate, design parameters of treatment technologies and enhancing public acceptance, and a widespread implementation of developed innovative technological solutions. In close cooperation with project partners (KTH and UNESCO-IHE), the IEWS staff members and adjunct inter-departmental members were involved in the development of eight new courses (four environmental engineering and four environmental sciences) as well as upgrading and updating the lecturing materials of two other existing M.Sc. courses.

Collaborative Partnerships and Development of M.Sc. Research

Partnerships and collaborative networks for sustainable environmental management are increasing worldwide, where effective integration of scientific input in co-operative research depends on the role of science and the stakeholders and decision-makers involved (Gutrich et al., 2005). Sustainable development has become a key issue in environmental policy and today's environmental protection aims not just

at clean-up of past-times pollution or wastewater treatment facilities' erection but also pollution prevention at the source (e.g., through application of cleaner production principles to optimize industrial production and attain a reasonable profit). Enrolled environmental scientists or environmental engineers will become active participants in recognizing pollutants; characterizing the level, fate, and consequences of pollution in the environment; identifying and evaluating alternatives for prevention, remediation, and treatment; and evaluating the economic and political viability of these alternatives to achieve adequate solutions to these problems. The M.Sc. programs at BZU aimed at giving them the knowledge and tools to do so. Problem-based research learning is in focus, studies are project oriented, and students work in groups of 3–5 persons on a particular project. The existing water and wastewater infrastructures in Palestine are inefficient and deteriorated. The majority of the local experts and operational staff lack the solid practical knowledge and technology know-how in planning, design, and management of these infrastructures. At the M.Sc. level, professional education is based on promoting critical thinking skills to satisfy the needs of stakeholders in both applied environmental science and engineering. Ernst-Athman and Monroe (2004) have examined the relationship between environment-based education and high-school students' critical thinking skills. They found that critical thinking was a purposeful process that enhanced problem-solving and decision-making using interpretation, evaluation, and analysis.

In a changing world, water knowledge and partnership are major elements of any capacity development aiming at sustainable management in water and environmental sectors (Gibson, 2001; Luijendijk & Arriens, 2007). In this context, the outcome of a 10-year partnership between the IEWS and UNESCO-IHE is presented briefly. One major milestone achieved is the unique publication series focused on exchange of research results and dissemination of knowledge in water and envi-

ronmental engineering. Financial support for this joint Netherlands–Palestinian co-operation has been obtained from The Netherlands government within several joint projects (PoWER, WASCAPAL, WASTIVAL, and SWITCH). The best benefit of research activity is its feasible application with practical impacts. This applies to environmental engineering sciences, where the PoWER project (PoWER, 2004) being described in this article included joint research projects among partners to provide practical solutions related to water and wastewater treatment, cleaner production, and climate change. Figure 1 illustrates the key elements and outcomes of the PoWER partnership. The partnership initially started with building capacity for all faculty, staff, lab technicians, and key community personnel, as well as M.Sc., and Ph.D. students. Funds for capacity-building efforts were controlled locally by the UNESCO-IHE and a respective partner. Additional funds were secured from foundations, the private sector, and governments. At the same time, capacity-building programs usually require a high level of voluntary commitment and committed leadership. Members of the Technical Committee met regularly to specifically identify tangible skills with impacts that can be integrated into the economy after the project was completed. Locally defined goals by the respective partners were more likely to build on existing capacity and strengths.

Sustainable long-term planning for how technical skills will be integrated into the local, regional, or national economy was emphasized at the outset of the PoWER program. Evaluation of programs was a key element in determining whether skills have been incorporated. As indicated earlier, the new Ph.D. graduate within the previous joint projects was fully integrated in the IEWS and Civil Engineering Department. Rybicki and Plaza (2006) reported on a similar successful cooperative network between the Royal University of Technology and a group of Polish universities as well as local communities and water utilities, which led to a sustainable network of knowledge in the field of wastewater treatment technologies.

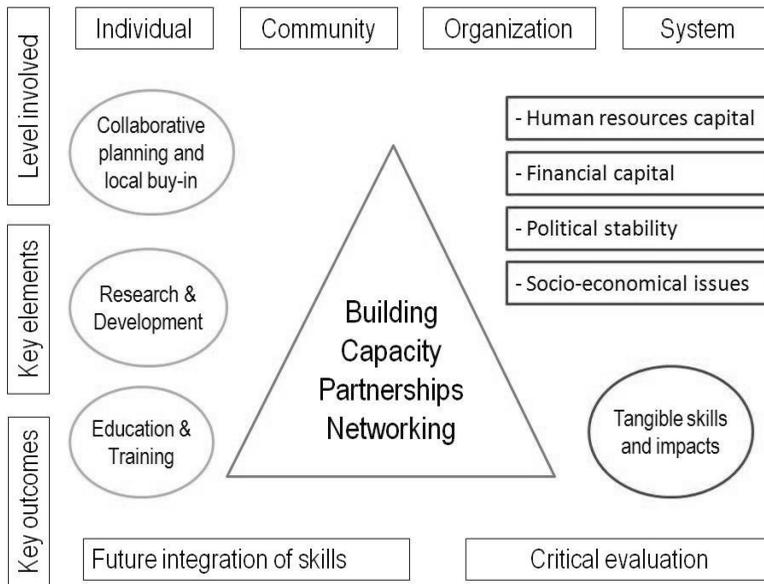


Fig. 1. PoWER model of capacity building, partnership, and networking.

As the drive toward sustainable management of water and environmental resources increases the demand for information, the Internet and related technologies are useful tools in research dissemination, e-learning modules, and knowledge transfer. Under the Partnership framework for Water Education and Research (PoWER), UNESCO-IHE and its partners are currently developing innovative e-learning programs resulting in products such as joint modules and joint degree programs (PoWER, 2004). Figure 2 shows the "Delft Cluster" located in the city of Delft, where UNESCO-IHE plays a key role in national- and international-oriented knowledge centers. IEWS is one member of 18 PoWER partners involved in an I-Learning Module on Activated Sludge Process Design and Engineering (Brdjanovic & Ramsundersingh, 2004).

This module is an innovative post-graduate educational tool for wastewater professionals and other members of the world's wastewater science and engineering professionals. Within the PoWER project, the convergence of intensifying educational needs and changing teaching capabilities present a unique opportunity for IEWS professionals to examine their present

educational techniques and practices on the World Wide Web. The Inter-American Water Resources Network (IWRN) is a similar Web-based network whose purpose was to build and strengthen water resources partnerships in the Americas including technical cooperation and information sharing, developing opportunities for education and training, and forming partnerships to investigate and manage water resources (Anderson, 1999).

PROMOTION OF WATER AND ENVIRONMENTAL TRAINING PROGRAMS

Well-informed water-related decisions based on scientific support will lead to more demand-driven and policy-relevant environmental training programs. Therefore, local government experts in water and environmental management institutions and professionals from nongovernmental organizations and the private sector are increasingly targeted in all IEWS training programs and capacity-building

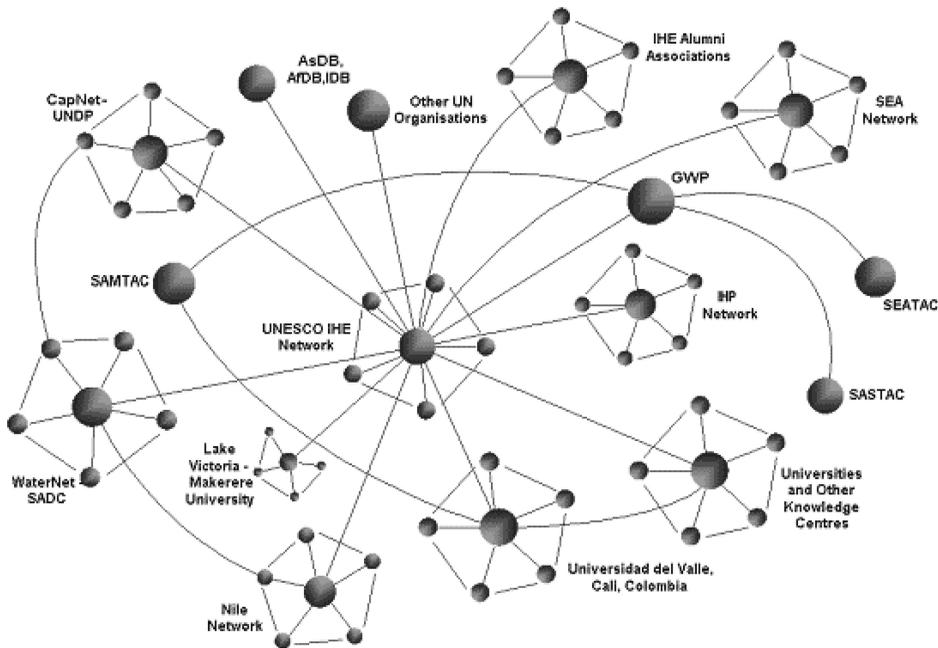


Fig. 2. UNESCO-IHE global networks for water capacity building.

efforts. The IEWS water and environmental experts have recognized early that sustainable water and sanitation infrastructures can only be achieved through continuous and proper facility management. Special emphasis was made with regard to proper operation, regular maintenance, and repair of the various unit operations of these facilities. This can only be fulfilled through regular offering of specialized training programs in the field of water and sanitation. Within the MEDA project (2004–2005), IEWS has offered 10 specialized training programs in various water and sanitation fields. Around 200 trainees successfully completed these programs and gained new knowledge and enhanced their capacity related to their careers.

ENVIRONMENTAL SCIENCE AND ENGINEERING EDUCATION CONSTRAINTS

To learn about the state of science and research in Africa and the working conditions of

the researchers, Gaillard and Tullberg (2001) reported that lack of funding was identified as the main constraint to scientific research. The second largest constraint was identified to be the limited access to scientific equipment, and the third constraint was poor library facilities or lack of access to scientific literature. These findings coincide with those results published by Yahya and Salamin (1997). During the political instability, the IEWS education and research activities have been affected by several factors, which had negative impacts on all BZU institutions. Resignation of a number of IEWS staff members, successive reduction in M.Sc. students, and mismanagement of available financial resources were among the main negative impacts. Despite all Israeli military actions, IEWS staff members succeeded in continuing to offer their courses and maintained high educational standards as achieved by other institutes like Institute of Community and Public Health (Halileh & Giacaman, 2002). Both institutes offered lecturing materials on RITAJ, a website developed by BZU to overcome the Israeli siege to Palestinian communities. Achieving internationally

recognized standards of quality requires an investment in faculty, programs, and support services. While accomplishing this major goal, major constraints faced the IEWS while conducting the capacity-building activities, which are more complex and variable in nature. The major constraints faced by IEWS during implementation of capacity-building activities include managerial, financial, physical, and human resources, and political issues. Ghadban (1998) reported on various difficulties prevalent in institutional management and organization at Palestinian universities. In addition to the aforementioned constraints he found major deficiencies in modern administrative techniques within the engineering college at BZU, no consideration of experienced academic and administrative staff, and lack of flexible academic and administrative policies.

The political situation in Palestine during the last two years was intolerable for all IEWS staff members at all living levels. According to Relief Web of the OCHA (2005), hundreds of Israeli military checkpoints were installed around the Palestinian communities in the West Bank, including about 93 checkpoints and road blocks around Ramallah city, where BZU is situated. Despite this political situation, IEWS, like many other BZU institutes, has offered online course materials. Despite successful ways of minding the Israeli siege's negative impacts, Halileh and Giacaman (2002) have reported on their experiences gained by using a distance learning method at the Institute of Community and Public Health.

PROPOSED PROBLEM-SOLVING APPROACH

Based on the gained experience from the past years in education and training in the field of water and sanitation, the IEWS has achieved most of the objectives and tasks set regarding sustainable management of water and san-

itation facilities in Palestine. However, several strategic steps must be undertaken at levels governing the process of education and training at the IEWS. The following problem-solving approach is suggested:

- Found a national education and training council for water and environmental resources.
- Endorse post-training programs for conventional scientists and engineers to accept the needs for change in their educational and managerial skills to cope with problems requiring multidisciplinary know-how and knowledge.
- Activate international and regional networking and join scientific projects.
- Encourage industrial leadership participation in teaching and training activities.
- Support cross-departmental interactions and foster multidisciplinary collaborations to strengthen individual capacity for solving research problems that require interdisciplinary solutions.

FUTURE PLANS AND SUGGESTIONS

The IEWS has played a key role in capacity building of local Palestinian water and sanitation through its M.Sc. programs and promoting ecological sanitation via education, training, and research projects conducted. In the absence of a stipend or research honorarium, scientists' basic salaries are not sufficient to support their families, and force them to perform extra consultancies or business. More external financial and political involvement and pressures will smooth the present intolerable local and regional political repressions on the Palestinian communities and academic and research institutes. This will enhance research opportunities and create better future careers for new graduate and undergraduate students.

Finally, this study also raises important practical questions that should be answered with additional multidisciplinary research:

- What are the impacts of programs upgrading on the sustainability of offered M.Sc. programs?
- What makes a teacher able and motivated to continue work under uncertain conditions with regard to unstable local and regional political situations, low salaries, and lack of incentives for additional research and projects acquisition activities?
- How can the quality of professional education be enhanced through course evaluation procedures, lecturing materials updating, and use of innovative educational and applied research approaches?

CONCLUSIONS

The relative wealth of physical research facilities and the strong core of well-trained researchers at the IEWS are a valuable resource for the country that can be used to foster applied environmental education and promote adequate training programs. The tangible experience gained by the projects implemented provide clear evidence that environmental education and research capacity building in Palestine is still underutilized and is threatened by a persistent lack of financial resources. The inadequacy of national funding and absence of research incentives affected the Palestinian scientific community and caused changes in the scientific production rate and scientific professions types.

Partnerships should be practiced to understand and prioritize the most acute water and sanitation problems and to realize sustainable management of their facilities. Overall, capacity building for the management of environmental resources in Palestine can only be sustainable under continuous efforts that

maintain the current highly qualified scientists and engineers with well-established infrastructures and tolerable environmental working conditions.

Although this article has focused on a specific educational sector with a limited sample of developmental research projects, it is a good guiding resource for the promotion of further research and analysis. It is also believed that information presented and experience gained should be of interest not only to Birzeit University but to international agencies interested in strengthening higher education, promotion of continuous training, and scientific research development in Palestine, in particular, and in the developing world in general.

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