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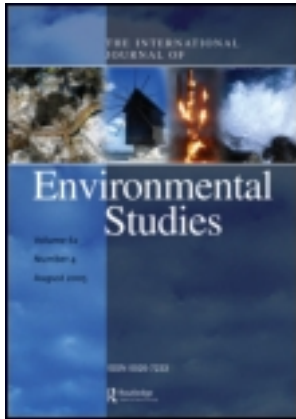
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The role of partnerships in water-related research in Palestine

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This study analyses the good effect of science and engineering inputs from partnerships and applied research in promoting sustainable management of water and environmental resources in Palestine. The capacity building achieved during the past 10 years at the Institute of Environmental and Water Studies (IEWS) is reviewed. Palestine faces major constraints, and these affect everyone and everything. A problem-solving approach can be beneficial.

Keywords: Capacity building; Environmental resources management; Partnership and networking; Research and development; Sustainable development

1. Introduction

Water and the natural environment in Palestine are both resources and elements in the historical and political conflict with Israel. The water supply and sanitation services in Palestine are very poor. The quality of the limited water resources is deteriorating annually. It is estimated that about 35% of the total population in the West Bank are connected to a centralised sewerage network, whereas only 17% of the collected urban sewage is either partially treated or discharged uncontrolled into receiving water bodies [1]. The prevailing intolerable political situation has affected the socio-economic life and health of the Palestinian people. The situation has also inhibited education and research at scientific institutions. While considerable progress has been made, Palestine faces multiple concerns about water and other environmental resources. Palestine needs significant human and financial investments. Much of the water and sanitation infrastructure in Palestine is near the end of its operational life cycle. The infrastructure deficit is estimated to be approaching US\$1 billion [2,3]. In Palestine, as with the state of sanitation reported by Bakir [4] in other Mediterranean zones, the current water and sanitation facilities suffer from weak management and lack of financial resources. The negative influence of donor driven projects and narrow local and regional environmental visions exacerbate the problem [1].

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The development of human and physical resources for a long-term sustainable management of water and environmental resources requires capacity building. This term means the sum of efforts to enhance and effectively use the existing skills and capacities of both people and institutions at all levels in order to achieve adequate progress towards sustainable development [5]. 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 [6]. Protecting Palestine's environmental resources is of equal importance, and effective capacity building is needed to sustain environmental resources and mitigate damage. Martinez *et al.* [7] reported that the most effective means to achieve sustainable development is to integrate local knowledge of the problems with scientific knowledge generated through research and development.

It is particularly important to have technologies and policies that are adapted to local needs and conditions. The real challenge is to develop the capacity to protect the environment under current constraints [8]. Various Palestinian water related research institutions work on this. For example, Birzeit University (BZU) has established the Institute of Environmental and Water Studies Institute (IEWS) as a regional knowledge centre. The IEWS provides interdisciplinary education, research and training in water and environmental fields. Figure 1 shows the location of Birzeit University in Ramallah-Albireh district and the Israeli separation wall being implemented. The IEWS gives the MSc programs in water and environmental fields a national and international visibility and integrates the water and environment related programs at Birzeit University.

Among the 11 Palestinian universities, BZU is the only one offering MSc degrees in Water Science and Engineering specialisations. How does the IEWS encourage intellectual debate on water and environmental management and provide leadership?

This paper presents the various activities of the IEWS with regard to environmental research and networking in the past 10 years and discusses the major constraints faced in achieving these activities. We highlight a problem-solving approach and future plans to sustain and enhance the activities of the IEWS.

2. The role of EU projects in the IEWS history and building capacity

Substantial reduction of poverty by 2015 is among the greatest challenges set by the Millennium Development Goals [5–7]. The management leadership and research professionals at Birzeit University have realized that a changing world calls for a flexible and co-operative development. The aim is to help create conditions enabling improvement in the Palestinian water and environmental sectors through effective and efficient development co-operation in research and training. The IEWS takes advantage of the diversity and breadth of learning and skill by close interactions with six faculties involved in water and environment related activities: Engineering, Science, Community and Public Health, Commerce and Economics, Law and Public Administration, and Geography. Figure 2 shows some of these activities. The BZU strongly supports this co-operation. The IEWS staff members seek to eliminate barriers and create research facilities for interdisciplinary interaction.

As part of BZU's new strategic direction this year, the IEWS has rationalised its educational policy and research and development to four Water and Environment Themes: Protecting Watersheds and Environmental Resources; Pollution Prevention and Protecting Public Health;

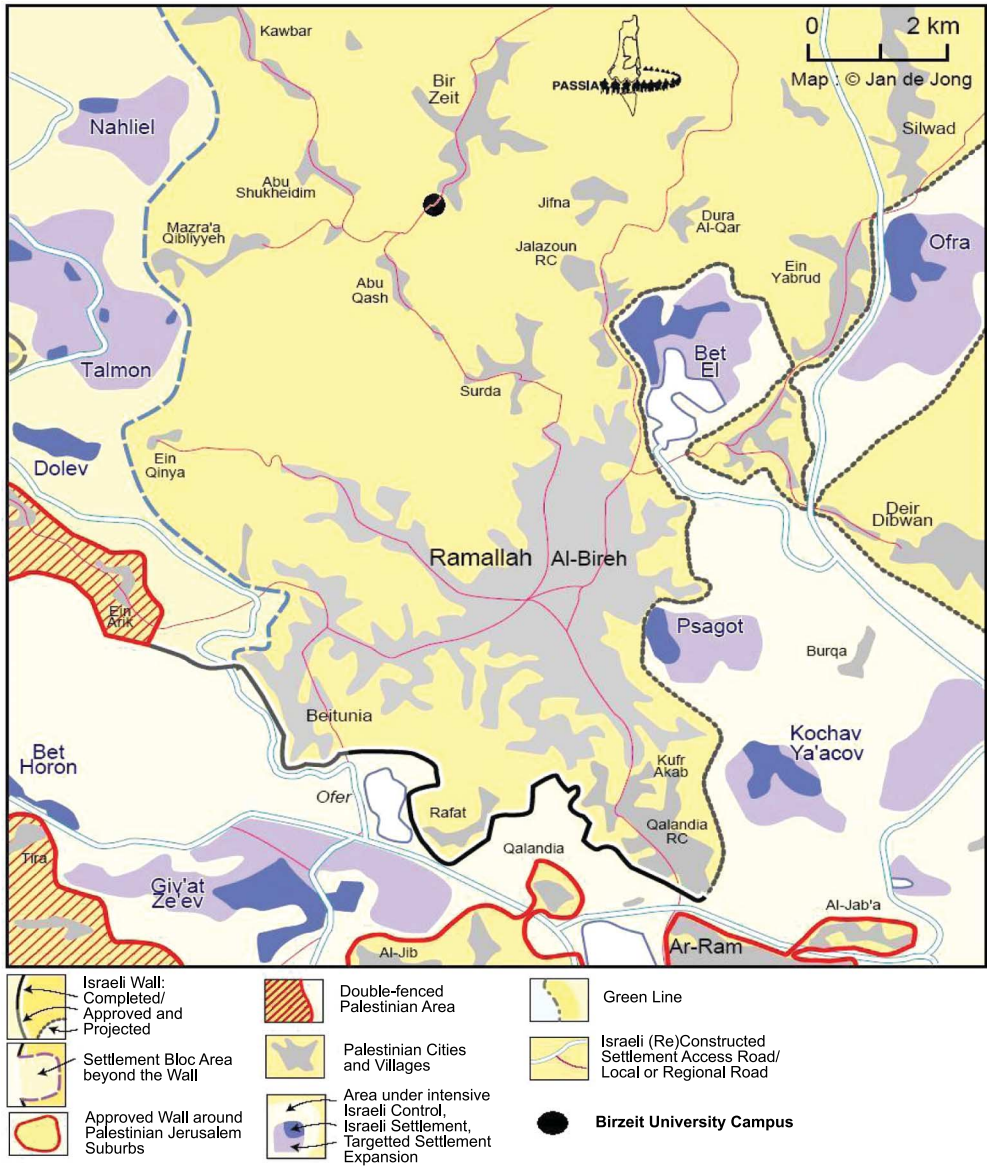


Figure 1. Campus location of Birzeit University in the West Bank, Palestine.

Ensuring Sustainable Water and Sanitation Facilities; and Innovations in Low-Cost Sanitation Technologies. These reflect crucial strategic priorities [9].

2.1. Building capacity in research and development

The existing water and wastewater infrastructures in Palestine are inefficient and deteriorating. The majority of the local experts and operational staff lack the solid practical knowledge and technology know-how to plan, design and manage these infrastructures. At the MSC

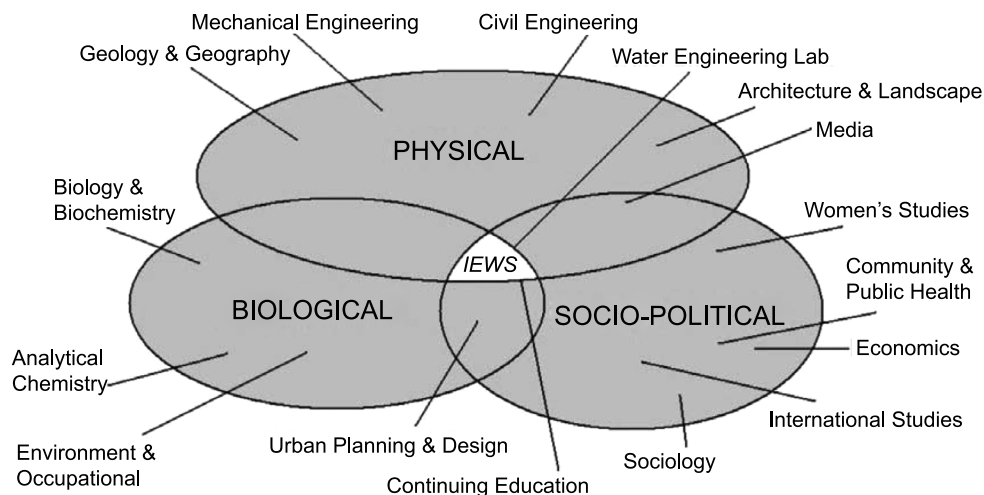


Figure 2. Faculties and programs contributing to the IEWS interdisciplinary activities.

level, most of the research concerns solving Palestinian oriented problems in the water and sanitation infrastructures. Within the framework of EU funded projects (CORETECH, WASTEVAL II), research priorities during the last four years concentrated on ecological sanitation. These include evaluation of rural water and sanitation systems, development of low-cost natural treatment technologies, wastewater analysis, methods development to minimise industrial pollution, and the development of pre- and post-treatment technologies using UASB and biofilters.

Besides one local PhD holder in water and sanitation, IEWS has gained three new PhD holders in the field of water and environmental engineering as a result of the research and development projects (WASCAPAL and WASTEVAL). The major research themes of the local IEWS staff are:

- Planning and design of rural and municipal wastewater treatment facilities;
- Low-cost and advanced wastewater treatment technologies;
- Enhanced pre-treatment technology using UASB technology;
- Socio-economical and health aspects of biosolids and effluent reuse;
- Hydrology and water resources management;
- Water science technology and pollution control;
- Waste management and cleaner production;
- Bioremediation and pollution monitoring.

In the planning and design of sanitation facilities it is important to demonstrate sustainability; new low-cost solutions should focus on ecological sanitation. Development of cost-effective reclamation techniques stimulates effluent reuse as a potential nutrient resource. CORETECH aimed to develop such techniques, and made a direct link between wastewater treatment and agricultural production. Within CORETEC and WASTEVAL projects, the up-flow anaerobic sludge blanket-septic system was developed and installed at pilot scale as an enhanced pre-treatment stage for rural wastewater management [10–12]. Recently, Al-Sa`ed and Mubarak [13] reported that most of the installed onsite rural sanitation systems were

unsustainable in the context of socio-cultural, technical, environmental and economic aspects. Most of the investigated onsite treatment systems derived from donor agencies and suffered from misconception, failure in design and construction with no maintenance, process monitoring and control. Muga and Mihelcic developed a set of sustainability indicators [14] to evaluate the sustainability of mechanised and natural systems for wastewater treatment. Muga and Mihelcic realised that the overall sustainability is governed by economic, environmental and social dimensions, where the geographic and demographic situation influences the selection and interpretation of indicators. Current research focuses on developing alternative post-treatment systems using local fixed film media in biofilters and compares their treatment efficacy with the conventional oxidation ditch system (Figure 3).

Research into the efficient use of stabilised biosolids and reclaimed effluent was conducted through EU funded projects [15,16]. The research into hygienic aspects of reclaimed municipal effluent at Albireh wastewater treatment plant (WWTP) revealed a safe non-conventional water source for industrial crops irrigation (Figure 4). Although non-disinfected effluent was pathogen free, because potential pathogens were found in raw wastewater of the Albireh WWTP, it was recommended that UV disinfecting units should be put into operation if planned restricted agricultural irrigation was envisaged. Treated domestic effluent from UASB septic tanks as an enhanced pre-treatment stage for rural onsite treatment systems as biofilters must be disinfected if the purpose is to use it for restricted agricultural purposes [17].

The German Adelphi Consult implemented a four-year project (2003–2007) on efficient wastewater management in the Mediterranean Region under the Euro-Mediterranean Partnership [18] of the EC. Undertaken with four local MEDA partners including IEWS in Palestine, the project provides technical assistance in the area of wastewater treatment and reuse. Recent reports published by the Palestinian Water Authority [19] revealed about 172 training



Figure 3. Post-treatment of anaerobically treated effluent using biofilters.



Figure 4. Industrial crops irrigation with reclaimed effluent at Albireh WWTP.

modules reflected by the feedback of respondents on their training needs in the water and sanitation facilities. Two major tasks implemented by the IEWS were capacity building programs. Another major task entailed the design and implementation of an onsite treatment system to serve about 100 inhabitants including a wastewater reuse scheme.

Recently, several joint research grants [20,21] were obtained to carry out research and development in various fields such as urban water management via nesting and development of capacity of learning alliances at different levels. Other projects tackle the use of membrane technologies for water and wastewater treatment and reclamation, biofilm formation in water networks, health aspects of water roof tanks, use of local fixed media in polishing anaerobically treated wastewater, and the development of low-coast onsite sanitation systems using biofilters. The funding agencies include EU, USAID, UNESCO-Flanders, and WHO with a total funding sum equivalent to about US\$120,000 for research projects lasting between six and 18 months. A few assistantships grants were allocated to high quality students willing to conduct thesis research studies. Unfortunately, late approval of funds and lengthy procedures for money transfer have delayed the mobilisation of resources and progress of the work.

2.2. Networking and partnerships with local and foreign organisations

Networking and partnerships are increasing worldwide with greater community involvement in the choice of technology for public health and protection of natural resources [22,23]. The exchange of information between members and networks allows for the development of joint research programs that build on the strengths of the members while promoting multi-disciplinary and multi-sector research [24–26]. The IEWS facilitated such national and international partnerships to integrate initiatives that maximise value and impact. These partnerships have accelerated the exchange of knowledge and technology by organisations that can harness them for Palestinian, and regional social and economic benefits. To help the

Palestinian communities improve their water and sanitation, and reduce environmental pollution, the IEWS has played its part in full. The IEWS acquires scientific knowledge and develops scientific tools and technical methods with international partners including the following:

- Arab integrated water resources management network (AWARENET) – a knowledge map development and research promotion network.
- Partnership for water, education and research (POWER) – a network of 17 collaborating centres (worldwide) aiming at conducting and disseminating research in sustainable water and environmental resources management.
- Mediterranean Network on Wastewater Reclamation and Reuse (MED-REUNET) – a support program for capacity building for professionals in wastewater reclamation and reuse.

‘Engaged and effective research’ in water and environment implies inter- and multi-disciplinary approaches but also more co-operation and partnership in executing applied research programs at the IEWS; and also close relations between the governmental institutions of the Palestinian Autonomy and non-governmental organisations (NGOs).

A program for co-supervision of MSc and PhD students was identified as a capacity building activity [26]. Mentorship will be used to establish relationships between scientists among project partners. The hosting of young researchers in successful laboratories or universities will enhance capacity building [27]. Finally, many bilateral partnership agreements have been established with several national and international agencies. The IEWS innovative research projects are having positive impacts on Palestinian public health, surface and groundwater, as well as water and sanitation facilities across the country.

Research and development projects at the IEWS aim to reduce the impact of land septage disposal, guaranteeing greater protection for receiving water bodies, while partnerships with local NGOs are improving decision-making processes that reduce contamination of vulnerable groundwater [28,29]. Many municipalities have applied the results of innovative IEWS research to develop policies that improve the management of water and wastewater treatment facilities. At the same time, new technologies are being developed to improve water and wastewater treatment and use stabilised biosolids and reclaimed effluent in partnership with the Palestinian Water Authority and the local municipalities.

3. Factors affecting research and development capacities

Gaillard and Tullberg [30] reported that lack of funding was identified as the main constraint to scientific research in Africa. The second largest constraint was the limited access to scientific equipment, and the third constraint was poor library facilities or lack of access to scientific literature. Recently, Lindgren *et al.* [6] applied the Meadows list to identify and make recommendations of ways to overcome the barriers that hinder the incorporation of sustainability issues into education and research at Lund University. They concluded that sustainable development with multidisciplinary concepts, relevant and adequate to various curricula and research fields is overwhelmed by uncertainty. In Palestine, during continual political instability, the IEWS research activities have been affected by several factors. The major constraints upon the IEWS while conducting capacity building activities are more complex, variable, and unpredictable in duration and effect. These are mainly caused by the Israeli

Table 1. Summary of constraints faced during projects implementation at the IEWS

Factor	Constraint description
Managerial	<ul style="list-style-type: none"> - Limited experience in project management - Obscure rules as to incentives for project acquisition and conduction - Management too centralised and poor decision-making quality - Little acknowledgement of technical staff achievements - Responsive actions instead of strategy-based research projects
Human and physical	<ul style="list-style-type: none"> - Loss of initiative and deep psychological depression - Few interactions among faculty members from different institutions - Limited opportunities to publish and disseminate research findings - Lack of specialised lab equipment and chemicals - Minimal updating in scientific and engineering software
Financial	<ul style="list-style-type: none"> - Weak internal financial resources for research and training activities - Scarce availability of national funds for research and development - Low salaries and inconsistency in salary matters - Dependency on limited financial aid from allocated research projects - Absence of financial assistance from local NGOs and private sector
Political	<ul style="list-style-type: none"> - Israeli occupation, siege, curfews and separation wall construction - Purchasing and installation delay of newly purchased equipment - Loss of opportunities for conferences attendance and participation - Systematic dehumanisation at Israeli military checkpoints

abridgement of Palestinian autonomy, of which the 'protective wall' is the current worst symbol. Table 1 summarises all factors with associated constraints descriptions.

Although IEWS projects are intended to strengthen human resources and enhance the infrastructure for research and education, these constraints are a severe trial. They have a generally discouraging effect which militates against the necessary calm and continued, stable emotional effort which any student should experience. Highly qualified staff in academic, financial and administration departments are crucial elements to maintaining competent education and research institutions. Ghadban [31] reported on various difficulties in institutional management and organisation at Palestinian universities. He found a major deficiency in modern administrative techniques within the engineering college at BZU, no consideration for experienced academic and administrative staff, and lack of flexible academic and administrative policies.

Recent and accurate estimates on national research expenditures are lacking. Yahya and Salamin [32] reported that annual research grants made by the Palestinian Higher Education did not exceed a meagre US\$300 per faculty member. Annually variable research funds have led to unstable acquisition of resources and created problems in library and equipment upgrades. Hence, without external financial donations or any Palestinian reforms of the Palestinian systems of government and administration, the situation of Palestinian research institutions will remain unsatisfactory. They will continue to have weak internal financial resources, insufficient scientific equipment, a limited or reduced number of scholarships, no active recruitment policy, and under-paid professional staff. As water is essential to life, so is capacity building to the future of Palestine. But the forces preventing this are enormous and unjust.

The political situation in Palestine during the last two years was intolerable for all IEWS staff members. According to Relief Web of the UNOCHA [33], hundreds of Israeli military checkpoints were installed around the Palestinian communities in the West Bank; including checkpoints and road blocks about 93 of these were around Ramallah city, where BZU is situated (figure 1). No teacher or student in Makerere University or Tehran, London or Dublin, Canberra or New York has to experience this menace and humiliation.

4. Proposed problem-solving approach

Recent data reported by Shobeiri and Prahallada [34] showed that knowledge, skills, and participation in environmental challenges cannot be realised by governmental agencies alone but can be enhanced through integration of environmental sustainability concepts in the curricula of schools. Just as it is important to expose engineering students to real world projects in their educational program, it is important to relate the social and environmental issues to the problem solving process, to achieve sustainable sanitation facilities and reduce degradation of environmental resources [35,36]. Although IEWS has achieved most of the objectives and tasks set for the promotion of ecological sanitation in Palestine, several strategic steps must be taken at levels governing the process of research development at the IEWS. Al-Sa`ed *et al.* [9] suggested the following problem-solving approach:

- Foundation of a national research fund and national research council for environmental, water and sanitation sectors.
- Establishing creative consultation mechanisms between education and research communities and policy-makers.
- Knowledge sharing and industrial leadership participation in teaching and training activities.
- Provision of fellowships and financial incentives to acknowledge research efforts and encourage new prospective students with limited financial resources.
- Support for intradepartmental and multidisciplinary collaborations to strengthen individual capacity to solve research problems that require interdisciplinary solutions.

Given the scarcity of national funding for research, it is probable that the survival of a robust and sustainable Palestinian scientific research community will continue to depend heavily during the coming years on foreign-based programs. A sombre warning comes from Sagar [8], who has pointed out that different gaps (perception and relevance) dominate national and international R&D efforts, and that very few successful joint papers have been published as a result of partnerships established between developed and low-income countries.

To promote data publications from joint research projects and close the gap in research perceptions among project partners, an EU funded project has offered financial support to young scientists and MSc students. This financial support helps to retain scientific communities and effectively contributes to national research capacity building needs [37]. It is a sign that Palestine is not completely isolated, that there is a world community of knowledge in which she takes part. Despite lacking access to scientific journals, prohibitively expensive for all low-income countries, the IEWS has made exclusive use of the free access to about 70% of the world's most refereed journals provided by the online Access to Research in the Environment, OARE [38]. The OARE initiative is crucial.

5. Future plans and suggestions

Within the last four years IEWS has played a key role in capacity building for local Palestinian water supply and sanitation. Clear rules governing the research activities by staff members will enhance productivity and concentrate efforts. In the absence of a stipend or research honorarium, a scientist's basic salary is not sufficient to support a family, and forces

one to perform extra consultancies or maintain a business. Ironically, this poverty unites Palestine with Ukraine or Russia where similar restricted opportunities and low salaries exist. To maximise research productivity, the IEWS should consider providing a small honorarium to researchers for the length of their agreed projects.

More external financial and political involvement and pressures should reduce the present intolerable Israeli political repression on the Palestinian communities, academic and research institutes. This may seem extraordinary to a distant observer, but it is only too unbelievable – *and believable* – to us who live with it day by day! Ideally, the vast knowledge of water and sanitation matters within Israel should be offered to Palestine as one of many benefits which should be offered to make peace. This would enhance research opportunities and create better future careers for new graduates and undergraduates. It would also be a very fitting response to the criticism that Israel profits by taking Palestine's land and water. The Palestinian Ministry of Education and Higher Education should develop a policy statement including national research priorities. But co-operation from the Israel side would be an enormous benefit.

On integrating research and education, Avila [39] has suggested that strengthening interdepartmental interactions is an important element in enhancing capacity building even at the undergraduate level. In this context, individual initial attempts were made towards interdepartmental interactions, but these are still not enough. These attempts and efforts should be mainstreamed to maintain and strengthen the co-operation among faculty members from different departments and institutes with regard to research projects development and implementation, and effective use of research equipment. There should also be more effort at networking, knowledge transfer and making consortia of similar departments from different local universities [40,41]. Another option to secure financial sustainability might be the establishment of a technology park where consultancy services are provided. The point is the efficient use of scarce financial, technical and human resources for better outcomes in R&D. This is not something which happens without remarkable effort. Sharp [42] investigated environmental R&D programs at 30 universities in Europe and USA, and found various groups (faculty, administration and student unions) with diverse decision-making practices, time constraints, priorities, threats and opportunities, which led to tension in the delegation of and struggle for power among these three groups. Similar findings have been reported by Mekkelsen *et al.* [35].

Most research projects of the IEWS in water and environmental resources focus on establishing sustainable water and sanitation facilities in Palestinian communities and the environmental impacts of development activities on water quality and quantity. Most of the research attempts concern the development of technical solutions using pilot-scale studies and efforts to establish available water resources and future demand [43–47]. There has been very little research on socio-economic issues related to water and sanitation facilities [13,48,49]. In a sense, the answers are obvious: the inequitable control by Israel of the water and land which Palestinians believe to be theirs. Limited access to available water and environmental resources, water development and conservation cannot solely be solved through technical alternatives. Israel must give; Israel needs to trade land and water for peace. Socio-cultural, economic and gender issues have a considerable impact on sustainable management of water and environmental resources. This coincides with arguments by Sarkar *et al.* [50] about environmental education, community participation and industry input as effective management tools for water resources with intricate and complex problems in the interaction between nature, technology and human beings. Sustainable water and environmental resources can only be achieved by establishing sustainable sanitation technologies for

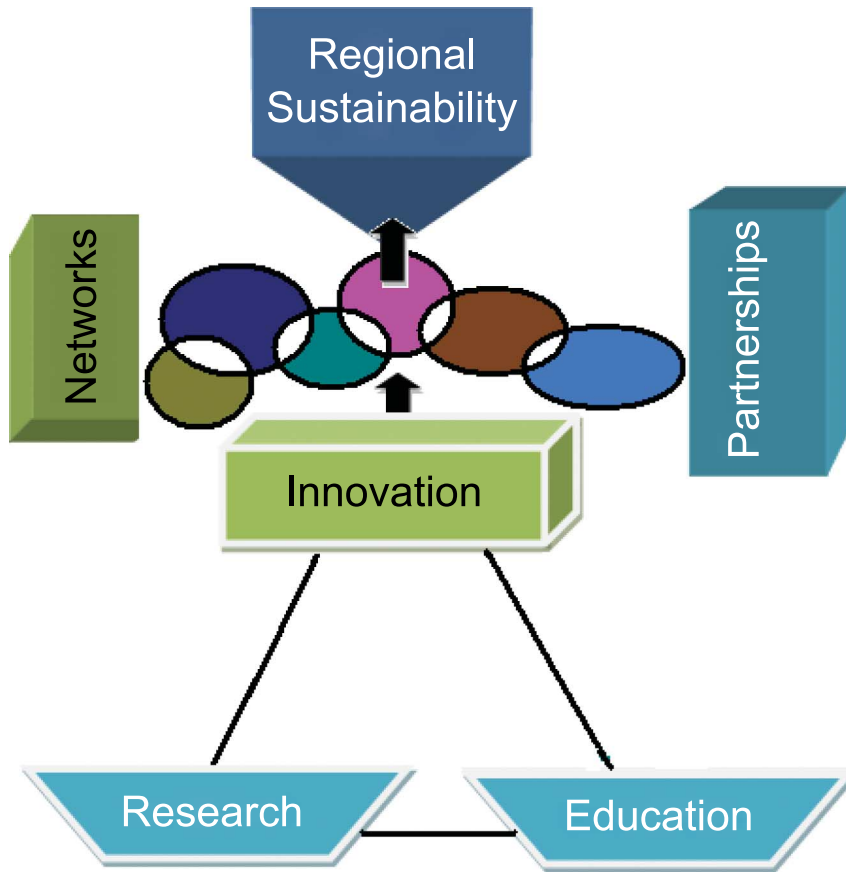


Figure 5. Knowledge triangle, networks and partnerships for environmental sustainability.

wastewater management, where socio-cultural, financial, institutional and technical issues are critical factors [14,51].

Figure 5 demonstrates the interconnections between the 'knowledge triangle' (education, research and innovation) and networks-partnerships Pathways for achieving sustainable development in water and environmental resources. Due to its dual function as research data generator and knowledge disseminator, the IEWS play a key role as a higher education institution. The IEWS has applied various complementary ways:

- Focusing on technological (web-based network structures and pilot-scale sites);
- Organizational (stakeholders, institutions and learning resources and their interaction);
- Educational and training issues (learning activities, virtual and face-to-face communication within the learning network);
- Research and development within joint project partnerships.

Formal and informal processes in the establishment of environmental networks and partnerships are as important as questions about methodologies by which they enhance and support shared learning or how these networks can be linked to the idea of sustainable environmental development. Cross-sectoral unions and collaborations should be established in

formal and informal educational contexts, where representatives of local NGOs, private companies, and consulting firms should be engaged.

As indicated earlier, there are only a few urban sewage works established in Palestine, because the design, operation and maintenance of urban wastewater treatment plants (WWTPs) require high capital costs and proper building capacity; hence regional WWTPs might be considered as a viable sustainable option. Any intended regional co-operation among Palestinian urban areas should be investigated and undertaken on a sound basis. Recently, Hophmayer-Tokich, and Kliot [52] investigated two cases on regional co-operation between neighbouring urban settlements to promote regional centralised WWTPs. Despite a few problems, both cases demonstrated many advantages including efficient use of limited financial and land resources, balancing socio-economic features and reducing pollution sources at regional levels. Finally, with the establishment of a public-private partnership with nearby rural communities and NGOs, the IEWS is drafting a proposal to create a training and research centre for onsite wastewater treatment and reuse at Birzeit University campus. Hosting onsite demonstration systems and reuse schemes will provide training and promote public awareness for community members and students from local universities and schools.

6. Conclusions

The relative wealth of physical research facilities and the strong core of well-trained researchers at the IEWS are a valuable resource for Palestine that can be used to foster applied scientific research and induce economic development. The availability of these resources has made it possible for Birzeit University to maintain and even increase its position relative to other Palestinian water science and engineering communities in the last five years. Partnerships and networking are important, where foreign aid agencies, NGOs, local businesses, and academia should be involved. All projects at the IEWS have integrated research with education and training to develop scientists, researchers, partners, and students who are well situated to secure a continued clean water supply and ensure a safe wastewater disposal in Palestine. Overall, capacity building for the management of water and environmental resources in Palestine can only be sustainable through constant effort to maintain the current highly qualified scientists and engineers with well established infrastructures and tolerable environmental working conditions. Although this paper has focused on specific water research activities, it aims to stimulate thought, further research and policy analysis. Many characteristics of the research projects evaluated are representative of the Palestinian research and scientific community. Thus, the information presented should be of interest not only to Birzeit University but to international agencies concerned to strengthen scientific research, both in Palestine, and in the wider developing world.

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References

- [1] Al-Sa'ed R., 2005, Obstacles and chances to cut pollution load discharges from the urban Palestine. *Water International*, **30**(4), 538–544.
- [2] World Bank, 1993, Developing the Occupied Territories: an investment in peace. World Bank, WA, USA. IBRD Staff Report.
- [3] UNEP, 2003, Desk Study on the Environment in the Occupied Palestinian Territories. Available online at: [http://www.unep.org/download_file.multilingual.asp?FileID=105] accessed 24 January 2010.
- [4] Bakir, H.A., 2001, Sustainable wastewater management for small communities in the Middle East and North Africa. *Journal of Environmental Management*, **61**, 319–328.
- [5] UNDP, 1998, Sustainable Management of Water Resources and the Aquatic Environment: UNDP's Role to date and strategy framework. Available online at: [<http://www.undp.org/seed/water/strategy>] accessed 1 December 2009.
- [6] Lidgren, A., Rodhe, H. and Huisingsh, D., 2006, A systemic approach to incorporate sustainability into university courses and curricula. *Journal of Cleaner Production*, **14**, 797–809.
- [7] Martinez, R., Gerritsen, P., Cuevas, R. and Rosales, A., 2006, Incorporating principles of sustainable development in research and education in western Mexico. *Journal of Cleaner Production*, **14**, 1003–1009.
- [8] Sagar, A.D., 2000, Capacity development for the environment: a view for the South, a view for the North. *Annual Rev. Energy Environ.*, **25**, 377–439.
- [9] Al-Sa'ed R., Abu-Madi, M. and Heun, J., 2009, Advancing environmental education and training for sustainable management of environmental resources in Palestine. *Applied Environmental Education and Communication*, **8**(1), 1–11.
- [10] Mahmoud, N., Amarneh, M., Al-Sa'ed R., Zeeman, G., Gijzen, H. and Lettinga, G., 2003, Sewage characterization as a tool for the application of anaerobic treatment in Palestine. *Environmental Pollution*, **126**(1), 115–122.
- [11] Fuqaha, A. And Al-Sa'ed R., 2006, Development of a two-stage biofilter system to enhance the effluent quality of a UASB pretreated domestic sewage. *Dirasat: Engineering Sciences*, **33**(2), 117–127.
- [12] Ali, M., Al-Sa'ed, R. and Mahmoud, N., 2007, Start-up phase assessment of a UASB–septic tank system treating domestic septage. *Arabian Journal of Science and Engineering*, **32**(1C), 65–75.
- [13] Al-Sa'ed, R. and Mubarak, S., 2006, Sustainability assessment of onsite sanitation facilities in Ramallah-Albireh district with emphasis on technical, socio-cultural and financial aspects. *Management of Environmental Quality: International Journal*, **17**(2), 140–156.
- [14] Muga, H. and Mihelcic, J., 2008, Sustainability of wastewater treatment technologies. *Journal of Environmental Management*, **88**, 437–447.
- [15] Al-Sa'ed, R., 2007, Pathogens assessment in reclaimed effluent used for industrial crops irrigation. *International Journal of Environmental Research and Public Health*, **4**(1), 68–75.
- [16] Al-Sa'ed, R., 2007, Sustainability of natural and mechanized aerated ponds for domestic and municipal wastewater treatment in Palestine. *Water International*, **32**(2), 310–324.
- [17] Samhan, S., Al-Sa'ed, R. and Mahmoud, N., 2007, Removal of pathogenic microorganisms in pilot-scale UASB-septic tanks and Albireh urban wastewater treatment plant in Palestine. *Water International*, **30**(5), 538–544.
- [18] MEDA, 2004, Efficient Management of Wastewater, its treatment and reuse in the Mediterranean Countries. Granted project, Euro-Mediterranean Regional Programme for Local Water Management. Water Studies Institute, Birzeit University, Palestine.
- [19] PWA, Palestinian Water Authority, 2006, Training needs assessment: Water supply and wastewater service providers. Final report 2005, PWA and GTZ, German Technical Cooperation, Palestine.
- [20] SWITCH, 2006, Learning alliances. Available online at: [<http://www.switchurbanwater.eu>] accessed 12 February 2010.
- [21] PROMEMBRANE, 2007, Promotion and Focussing of Current Research Activities of Membrane Technology in Water Treatment in the Mediterranean Region. Available online at: [<http://www.promembrane.info>] accessed 10 October 2009.
- [22] Gibson, G., 2001, Building Partnerships: Key elements of capacity building. IIED Final Report, CoDevelopment Canada, Vancouver, BC, Canada V5K 1Z8.
- [23] Plummer, R. and Gibbon, J.F., 2004, Some observations on the terminology in co-operative environmental management. *Journal of Environmental Management*, **70**, 63–72.
- [24] Capdevila, I.; Bruno, J. and Jofre, L., 2002, Curriculum greening and environmental research co-ordination at the Technical University of Catalonia, Barcelona. *Journal of Cleaner Production*, **10**, 25–31.
- [25] Leendertse, K., 2003, Networks as instruments for scientific capacity building. In: Proc. Int. Seminar on Strengthening Capacity in Developing Countries for Water Resources Research, International Foundation for Science (IFS), Stockholm, Sweden.
- [26] POWER, 2004, Partnership for Water, Education and Research. UNESCO-IHE Institute for Water Education, Delft, The Netherlands. Available online at: [www.unesco-ihe.org] accessed 16 November 2009.
- [27] TEMPUS, 2004, Institutional capacity building in the environment sector in Palestine. Granted project, Tempus Program, Water Studies Institute, Birzeit University, Palestine.

- [28] Al-Sa'ed, R. and Hithnawi, T., 2006, Domestic septage characteristics and co-treatment impacts on Albireh wastewater treatment plant efficiency. *Dirasat: Engineering Science*, **33**(2), 187–198.
- [29] Mimi, Z. and Amjad, A., 2009, Intrinsic vulnerability, hazard and risk mapping for karst aquifers: a case study. *Journal of Hydrology*, **364**(3–4), 298–310.
- [30] Gaillard, J. and Tullberg, A., 2001, Questionnaire survey of African scientists – IFS grantees and INCO beneficiaries. Report No 2, IFS MESIA Impact Studies, International Foundation for Science (IFS), Stockholm, Sweden.
- [31] Ghadban, S., 1998, Engineering education in Palestine: An analytical study. *European Journal of Engineering Education*, **23**(2), 213–232.
- [32] Yahya, A. and Salamin, Y., 1997, Towards sustainable north-south scientific collaboration. In: Proc. of the Alexander von Humboldt Stiftung International Symposium on Exchange of Scientists and Cooperation with Developing Countries. Bonn, Germany.
- [33] UNOCHA, 2005, Occupied Palestinian Territory: West Bank Closures-Ramallah. Available online at: [<http://www.reliefweb.int/rw/RWB.NSF/db900SID>] accessed 22 March 2010.
- [34] Shobeiri, S.M. and Prahallada, N.N., 2007, Understanding environmental education curriculum by secondary school students. *International Journal of Environmental Research*, **1**(4), 354–357.
- [35] Mikkelsen, P., Larsen, B., Bjerg, O. and Henze, M., 2000, Evaluation of teaching in environmental engineering. *Water Science and Technology*, **41**(2), 83–91.
- [36] Johnston, C.R., Caswell, D.J. and Armitage, G.M., 2007, Developing environmental awareness in engineers through Engineers Without Borders and sustainable design projects. *International Journal of Environmental Studies*, **64**(4), 501–506.
- [37] Al-Sa'ed, R., Sayadi, S., Ghata, A., Abdel-Shafy, H., Schories, G., Oropeza, M., Lorenzo, A. and Drioli, E., 2009b, Advancing membrane technologies for wastewater treatment and reclamation in selected Arab MENA countries. *Desalination and Water Treatment*, **4**, 287–293.
- [38] OARE, 2008, Online Access to Research in the Environment (OARE). Available online at: [www.oare-sciences.org] accessed 21 September 2009.
- [39] Avila, B., 2003, Integrating Research and Education: Biocomplexity Investigators Explore the Possibilities: Summary of a Workshop. National Academies Press, Washington, DC, USA.. Available online at: [<http://www.nap.edu/catalog/10627.html>] accessed 12 December 2009.
- [40] Alaerts, G., 1997, Capacity building as knowledge management: Purpose, definition and instruments. In: Proceedings 2nd UNDP Symposium on Water Sector Capacity Building, Delft, The Netherlands.
- [41] Khatri, K. and Vairavmoorthy, K., 2007, Challenges for urban water supply and sanitation in the developing countries. In: Proc. Int. Symposium on Water for a Changing World-Enhancing local knowledge and capacity, 13–15 June 2007, Delft, The Netherlands.
- [42] Sharp, L., 2002, Green campuses: the road from little victories to systematic transformation. *International Journal of Sustainability in Higher Education*, **3**(2), 128–145.
- [43] Zimmo, O., Al-Sa'ed, R. and Gijzen, H., 2000, Comparison between algae-based and duckweed-based wastewater treatment: differences in environmental conditions and nitrogen transformations. *Water Science and Technology*, **42**(10/11), 215–222.
- [44] Zimmo, O., Al-Sa'ed R., van der Steen, P. and Gijzen, H., 2002, Process performance assessment of algae-based and duckweed-based wastewater treatment systems. *Water Science and Technology*, **45**(1), 91–101.
- [45] Zimmo, O., van der Steen, P. and Gijzen, H., 2004, Nitrogen mass balance across pilot-scale algae and duckweed-based wastewater stabilization ponds. *Water Research*, **38**, 913–920.
- [46] Nazer, D., Al-Sa'ed, R. and Siebel, M., 2006, Reducing the environmental and economic impact of the unhairing-liming process in the leather tanning industry. *Journal of Cleaner Production*, **14**, 65–74.
- [47] Mahmoud, N., 2008, High strength sewage treatment in a UASB reactor and an integrated UASB-Digester system. *Bioresource Technology*, **99**(16), 7531–7538.
- [48] Abu-Madi, M., Braadbaart, O., Al-Sa'ed, R. and Alaerts, G., 2003, Willingness of farmers to pay for reclaimed wastewater in Jordan and Tunisia. *Water Supply*, **3**(4), 115–122.
- [49] Abu-Sharbak, N., Al-Sa'ed, R. and Abu-Madi, M., 2007, Analysis of operation costs at Al-Bireh wastewater treatment plant: A Palestinian case study. Proc. Int. Conf. Kalmar ECOTECH'07, Kalmar University, Sweden.
- [50] Sarkar, S., Saha, M., Takada, H., Bhattacharya, A., Mishra, P. and Bhattacharya, B., 2007, Water quality management in the lower stretch of the river Ganges, east coast of India: an approach through environmental education. *Journal of Cleaner Production*, **15**, 1559–1567.
- [51] Sujaritpong, S. and Nitivattananon, V., 2009, Factors influencing wastewater management performance: case study of housing estates in suburban Bangkok, Thailand. *Journal of Environmental Management*, **90**(1), 455–465.
- [52] Hophmayer-Tokich, S. and Kliot, N., 2008, Inter-municipal cooperation for wastewater treatment: Case studies from Israel. *Journal of Environmental Management*, **86**, 554–565.