



جامعة بيرزيت  
Birzeit University



Professional Environmental Educational  
For Sustainable Development  
**'Plugging the Hole,**  
16 - 17 November, 2011 - Birzeit University, Palestine

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## **Our Mission**

**Education, training, research and consultancy for the planning, provision and management of water and environmental aspects**

## FOREWORD

Palestinian universities, as centres of knowledge and education, have a huge responsibility. Palestinian Environmental Law and the Palestinian Environmental Policies underline the promotion of environmental awareness and education to be at all levels in the Palestinian society. Universities therefore have to make tremendous efforts to cooperate with all levels of the Palestinian society, to develop solutions, to transfer their knowledge, to help in education and to offer the required training to change attitudes and practices. The Institute of Environmental and Water Studies (IEWS) at Birzeit University organized an international conference entitled “Professional Environmental Education for Sustainable Development: Plugging the Hole” on 16-17 November, 2011 at Birzeit University. The conference forms part of an EU funded project through TEMPUS Programme organized by representatives from the project partners and local water and environmental organizations. The Tempus Project Partners are:

- o Birzeit University, Al-Quds University and An-Najah University, Palestine
- o Ministry of Higher Education, Palestine
- o National Technical University of Athens, Greece
- o WEDC, Loughborough University, Loughborough, UK
- o Royal Institute of Technology, Stockholm, Sweden

The objective of the Conference is to start to join up the educational gaps between disciplines and organizations, and between all disciplines and the wider goals of sustainability. The conference asks what different disciplines can contribute towards addressing sustainable environmental development, how they can and should connect with related disciplines and how evidence-based environmental policy and educational practices might be developed and implemented.

The event offers all levels of professionals working in the field of environmental science, engineering and related topics a place where they can share effective ideas and methods for the teaching and learning of water and environmental disciplines at all levels. This ranges from practical case studies of community awareness raising to pedagogic studies, knowledge transfer techniques, dissemination or methods of assessing the impact of capacity building. The conference has a twofold objective:

(1) Explore and get advice on reforms of environmental higher education and development of partnerships with local enterprises and (2) Provide a space for dialogue between stakeholders, to discuss and explore new and innovative methods of treatment, better understanding and assessment of resources and their supporting ecosystems, proper management for conservation and approaches to achieve the dual aim of economic development and ecological sustainability.

The ninth issue of Birzeit Water Drops (BWD) which is the official bulletin of IEWS contains 17 papers which were presented during the conference.

**Nidal Mahmoud**  
Director of the IEWS

**Ziad Mimi**  
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## TABLE OF CONTENTS

Foreword		3
Table of Contents		6
The Application of Warfare Ecology to Belligerent Occupations	Michael Mason	8
Immediate and Short-term Impact of an Outdoor Environmental Health Awareness Program among Children in Gaza city	Amal Sarsour, Abdelnaser Omran and Yehia Abed	22
Towards a Sustainable Environmental Education: A case Study-Birzeit University	Oraib El-Sayrafi	34
Medical Solid Waste at Primary Healthcare Centers in Two Palestinian Governorates and their Remedial Measures	Issam Al-Khatib	47
Environmental Awareness among School-Age Children in Gaza – Palestine	Yehia Abed and Amal Sarsour	59
Runoff Estimation by the Curve Number for Wadi Ta’amira in Bethlehem – Palestine	Reem Zeitoun	72
Ecoland: An integrative group work in the environmental science study	Henk J Lubberding, Elena Ostrovskaya, Edwin MA Hes	84
Dental Fluorosis and Associated Risk Factors in Gaza Strip Children	Lamis Abuhaloob and Yehia Abed	93
Combating Poverty and Climate Change in the Occupied Palestinian Territory through community Participation	Enas Bannourah and Nadine Sahouri	107
Overview of the Search for reform of Environmental Studies in the Higher Education System	Marwan Haddad	118
Developing a GIS-based Suitability Map for Rainwater Harvesting in the West Bank, Palestine	Sameer Shadedd	136
Environmental Education for Engineers: Selecting the Syllabus	Brian Reed	154
E-learning – Experience from the “Energy Academy” Distance Training Programme	Angelis-Dimakis, A., Mandaraka, M. and Assimacopoulos, D.	168

Flushing of Total organic carbon (TOC) in Jericho Sub-basin springs and the formation of THMs in Jericho drinking water	Amer Marci, Saed Khayat, Lamia Hadidoun, Tichm Andreas and Mohamad Sbaih	179
Evaluation of focus groups attitudes and perspectives Towards Palestinian environmental higher education programs	Marwan Haddad and Salah Yasin	194
Temporal Rainfall Distribution and its Impact on the Amount of Generated Recharge on Karst aquifer systems	Muath Abusaada and Martin Sauter	210
Effect of Vehicles on Environment	Mohammad Karacen	223
Assessment of a roughing filter as a pre-treatment system for slow sand filter at Aqbat Jaber refugee camp	Mohammad Yasin and Nidal Mahmoud Kebreab Ghebremichael & Branislav Petruveski	234



# **The Application of Warfare Ecology to Belligerent Occupations**

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## ABSTRACT

Insofar as warfare ecology aims to examine all war-related conditions, belligerent occupations are a necessary stage in its broad taxonomy. Under international law, belligerent occupations are covered by a distinctive subset of *jus in bello* (humanitarian law), which is imprecise regarding ecological changes. This paper examines the potential role of warfare ecology in studying belligerent occupations, highlighting the multiple, often indirect, means by which such occupations shape ecological processes. Particular attention is paid to the Israeli occupation of Palestinian territory, due to its protracted duration, although also discussed are environmental effects associated with the US and UK occupation of Iraq. The onus on the occupying power, under international humanitarian law, to protect the conditions of life for civilians can plausibly be applied to the environmental resources of the resident population. It is argued that warfare ecology can make a significant contribution both to assessing the effects of occupations and, through the generation of policy advice, to promoting the reduction of harmful consequences.

**Key Words:** Warfare ecology, belligerent occupations, Israeli-Palestinian conflict, Iraq

## Introduction

The emergent field of warfare ecology is concerned with the application of environmental research to the full range of war-related conditions. As noted by Machlis and Hanson (2008: 729), an accurate taxonomy of warfare is essential to the development of this field of study, which indicates a need explicitly to incorporate military occupation. All occupations are covered by international humanitarian law, though ‘permissive’ occupations have contested legal status depending on the presumed consent of the displaced sovereign authority and the civilian population within the territory controlled by external military forces. The subject matter of this paper is restricted to *belligerent* occupations, which under Article 42 of the 1907 Hague Regulations, are defined as territory placed under the control of a hostile army (International Committee of the Red Cross 2010): such occupations lack the consent of the civilian population and its recognized representatives. It should be noted that civilian authorities (domestic or external) may be responsible for governance in belligerent occupations, but only under the supervision of the occupying authority.

Under international law, belligerent occupations come under a distinctive subset of *jus in bello* (humanitarian law), complementing the legal norms governing the conduct of hostilities (Dinstein 2009: xi). These norms are drawn from customary international law, the Hague Regulations (1907), the Fourth Geneva Convention (1949) and Additional Protocol I (1977) to the Geneva Conventions (Protocol I). As humanitarian law has evolved, it has focused increasingly on minimizing the impact of the occupying power on civilian resources and infrastructure until such time as the occupation ceases and legitimate government is re-established. Indeed, the overriding principle of the international law of belligerent occupation is that the civilian population of an occupied territory must benefit from maximal safeguards feasible in the circumstances (Schmitt 2003; Roberts 2006). It should be noted that the designation of a ‘belligerent occupation’ is often disputed by the state in military control, such as the Israeli position on East Jerusalem and Gaza, and Morocco’s stance on the Western Sahara. In this paper, authoritative weight will be accorded

to declarations on belligerent occupation by relevant representative bodies of the international community, notably the UN Security Council, the International Court of Justice and the High Contracting Parties to the Fourth Geneva Convention.

After briefly outlining the relevant provisions on environment protection in international humanitarian law, this paper surveys the environmental effects of belligerent occupations, highlighting the multiple, often indirect, means by which such occupations shape ecological processes. Particular attention is paid to the Israeli occupation of Palestinian territory, due to its protracted duration (since November 1967 as dated by UN Security Council Resolution 242), although also discussed are the environmental effects associated with the occupation of Iraq (deemed by the UN Security Council Resolution 1483 to be under occupation from May 2003 until June 2004, when an Iraqi Interim Government replaced the Coalition Provisional Authority). It is argued that warfare ecology can make a significant contribution both to assessing the effects of occupations and, through the generation of policy advice, to reducing harmful consequences.

## **Belligerent occupation and the environment**

Existing humanitarian law prohibits extreme and disproportionate damage to the environment by belligerents during armed interventions. Along with customary international law, the key treaties of relevance are the Hague Regulations, the Fourth Geneva Convention, Protocol I and the Convention on the Prohibition of Military and Hostile Use of Environmental Modification Techniques (1977). However, it is only in recent years that environmental considerations have seriously been treated as a legitimate constraint on warfare, which can be attributed to the precedents created by UN Security Council Resolution 687 (1991) establishing Iraqi liability for environmental (and other) damage during the First Gulf War and also to Article 8(2)(b)(iv) of the Rome Statute of the International Criminal Court (2002), which states that the intentional infliction of “widespread, long-term and severe damage to the natural environment” is a war crime (see Bunker 2004).

While belligerent occupation falls within the scope of international humanitarian law, the application of its provisions on environmental protection are more uncertain; for belligerent occupation typically features low levels of violent conflict, where the occupying power encounters at most sporadic resistance from those opposed to its control. Furthermore, the relevant legal regime for environmental protection covers in practice the routine exercise of authority by the occupying power in its efforts to secure stable governance. The environmental protection duties of humanitarian law are, under belligerent occupation, largely indirect. In its overriding responsibility to meet the needs of the civilian population, the occupying power is obliged to exercise guardianship of natural resources (Hague IV: Article 55) and not to undertake extensive destruction and appropriation of property (Fourth Geneva Convention: Article 147). In addition, Article 54(2) of Protocol I prohibits the destruction, removal and disablement of civilian objects indispensable to the survival of the civilian population, including agricultural areas, drinking water installations and irrigation works. It should be noted that, according to UN General Assembly Resolution 305 (1972), an occupied population retains permanent sovereignty over its natural wealth and resources (Okowa 2009: 244-245). The onus on the occupying power, under international humanitarian law, not to make fundamental changes in the constitutional, social, economic and political order of an occupied

territory (Roberts 2006) can therefore plausibly be applied to the environmental resources of the resident population.

There remains debate amongst scholars as to the application of multilateral environmental agreements and customary international environmental norms to warfare. Given the growing body of international environmental law, its potential scope for influence on the practice of belligerent occupation is substantial. The more restrictive interpretation is that the exceptional status of a belligerent occupation means that only humanitarian norms apply as the specific law (*lex specialis*) tailored to the situation: peacetime environmental norms are effectively suspended insofar as they clash with this *jus in bello* (see Bunker 2004: 204). Less restrictive positions counter that peacetime environmental treaties remain applicable (e.g. Schmitt 1997: 41). In this paper, the latter perspective is adopted, which is consistent with the understanding in humanitarian law that belligerent occupations should make as much space as possible for the continuation of pre-occupation norms of governance. This covers arguments that international human rights law continues to apply, as well as other international treaties applied in peacetime. It is argued here that the population under occupation continues to be covered by the core customary rule of international environmental law – that states should not cause significant harm to the environment of other states or areas beyond national control. This means, for example, that these populations are entitled not to suffer environmental injuries caused by the occupier and/or *other states*.

### Assessing the environmental effects of occupations

Like other conflict-related conditions, the presence of a belligerent occupation often presents major practical obstacles to scientific efforts to determine impartially the environmental effects of hostilities. Even if an occupation is stable enough to qualify as ‘post-conflict’, there may be serious limitations in data availability and monitoring, while both the occupying power and political representatives of the occupied may have neither the willingness nor capacity to undertake environmental assessments. It is also the case that the Post-Conflict Needs Assessments (PCNAs) undertaken by the international community have tended to sideline environmental considerations, except insofar as they have obvious linkages to human health, livelihoods and security (UNEP 2009: 5). As formulated by the UN Development Group and the World Bank, PCNAs are undertaken with the consent of the occupying power (following an invasion) or domestic authorities (following a civil war), and are oriented to short-term recovery needs and longer-term reconstruction needs. In the past decade there has been a provision within PCNAs to consider environment as a cross-cutting theme. A recent UNEP review of PCNAs conducted from 2000 to 2006 – including reports on periods of belligerent occupation in Iraq and Georgia – identified a growing recognition of immediate environmental problems, though a neglect of longer-term environmental needs and effects (UNEP 2009).

Outside the PCNA process, UNEP has developed arguably the most credible set of post-conflict environmental assessments (PCEAs) within the international community. Since 1999, it has conducted ten PCEAs, including in Kosovo (2001), Afghanistan (2003), Lebanon (2007) and the Gaza Strip (2009). The PCEA methodology encompasses background research, systematic sampling, fieldwork and laboratory analysis: in the interests of transparency and neutrality, the

terms of reference and methodological protocols are shared with all relevant parties. When field assessments are not possible for political or security reasons, UNEP has also conducted *Desk Studies on the Environment* – notably in 2003 for the occupied Palestinian territory and Iraq.

While a comprehensive survey of relevant UNEP environmental assessments is outside the scope of this paper, their categorization of ecological effects will now be applied to belligerent occupations. This classifies consequences by: direct changes to natural resources and ecosystems – distinguishing here between (i) the effects of large-scale conflicts and (ii) the direct effects of occupation practices – and (iii) indirect effects on natural resources and ecosystems. While UNEP post-conflict assessments in practice have tended to focus on negative environmental consequences, there are occasions – as noted below – when military interventions have led to *positive* ecological consequences, whether or not these were intended. These include removing regimes that have employed environmental pollution as a military tactic (e.g. the firing of oil wells and trenches by Iraqi forces in 2003).

## **Direct conflict effects on natural resources and ecosystems**

The most obvious source of war-related environmental damage within occupied territories is the legacy of large-scale military action either preceding an occupation (e.g. the Coalition attack on Iraq between March-May 2003) or taking place during an occupation (e.g. the Israeli attack on the Gaza Strip, code-named *Operation Cast Lead*, between December 2008-January 2009). At the same time, contemporary armed conflict may exacerbate pre-existing environmental vulnerabilities, posing longer-term risks to the populations of occupied territories. UNEP environmental assessments of armed conflict in Iraq (UNEP 2003b; 2003c) and the Gaza Strip (UNEP 2009a) listed the following problems as significant:

### *Water and sanitation*

In Iraq during Saddam Hussein's regime, poor maintenance of the water infrastructure and unsustainable irrigation practices were, prior to the 2003 conflict, already causing severe contamination of surface water and salinization of agricultural land. This was both the result of misrule and the effects of the international sanctions regime, which blocked imports of equipment and chemicals necessary for water infrastructure maintenance (Physicians for Human Rights 2003: 3). The focus of US and UK attacks on major urban areas resulted in serious impacts on Iraqi water distribution and sanitation systems, in large part because of deliberate cuts to electricity supplies (UNEP 2003b: 71). While water supplies in major cities were restored by April 2003, water networks and pumping stations were subject to acts of sabotage during and after the Coalition occupation, impeding investments in sanitation and sewage systems. Without significant improvements in water infrastructure, the population continues to face a high risk of disease epidemics, as evident from the major cholera outbreak in 2008 (IRIN News 2008). In the Gaza Strip, severe water quality and sanitation problems accentuated by the Israeli blockade and economic sanctions (which were introduced after the election of the Hamas Government in January 2006) were further stressed during *Occupation Cast Lead* by Israeli military damage to water wells, as well as to the water distribution and sewage network. For example, a direct hit to

the embankment wall of the Az Zaitoun wastewater treatment plant led to a wastewater and sludge spillage affecting 55,000 square metres of agricultural land (UNEP 2009a: 33-36).

### *Waste*

The Iraqi capacity for waste collection and disposal was eroded by the UN sanctions regime preceding the start of the US and UK attack in March 2003. While hampered in its *Desk Study on the Environment* by the lack of information on Iraqi waste management practices, UNEP concluded that accumulations of domestic, demolition and clinical waste were already posing significant risks to human health; and that previous military conflicts – including the 1991 Gulf War – had resulted in large and widespread quantities of military debris and toxic material (UNEP 2003b: 34-37). Impacts of the 2003 conflict was judged to have exacerbated the critical waste management situation in Iraq, aggravating health and safety risks to urban populations: the risks included disease vectors sourced to human remains, clinical and food waste, and exposure to hazardous dust and debris (UNEP 2003b: 71). More confidence is attached by UNEP to its assessment of waste problems in the Gaza Strip on account of the extensive access of its technical team to impacted areas in May 2009. Israeli military actions during *Operation Cast Lead* impacted almost 2,700 buildings in the Strip, generating approximately 600,000 tonnes of debris (UNEP 2009a: 27). While the international community has funded the clean-up of this debris – including provision for materials recovery and re-use – concerns remain about the insufficient capacity of local landfill sites and the absence of a dedicated facility for processing hazardous wastes. A lingering post-conflict challenge is the presence in landfills of hazardous health care waste mixed with domestic wastes, which can be traced to the disruption of medical waste disposal systems during the Israeli bombardment (UNEP 2009a: 77). As in Iraq, the physical impacts of the conflict overloaded a solid waste infrastructure that was already weak and fragmented.

### *Pollution from oil fires and spillages*

The UN sanctions regime that weakened solid waste management in Iraq also prevented proper maintenance of its oil infrastructure, and UNEP surmised that significant degradation of soil and groundwater, and flaring-induced air pollution, were likely to have been present before the invasion (UNEP 2003b: 38). During the immediate hostilities, Iraqi forces set fire to a number of oil wells (in southern Iraq) and oil-filled trenches (around Baghdad) to impede US/UK surveillance and weapons systems. In contrast to the substantial ecological damage caused by the firing of Kuwaiti oil wells by the retreating Iraqi army in 1991, UNEP observed a more localized diffusion of pollutants in 2003: indeed, given their potential contamination of soil and groundwater bodies, unfired oil trenches were assessed to more environmentally damaging over the long-term (UNEP 2003b: 74-79). Fuel stations and tanks were systematically targeted by Israeli military forces in the 2008/2009 Gaza Strip hostilities, although the UNEP post-conflict environmental assessment uncovered no evidence of major oil pollution incidents (UNEP 2009a: 30-31): here, the small-scale, dispersed nature of Gazan industrial facilities is likely to have reduced the risk of high-consequence oil pollution from military strikes.

No military actions in the 2003 Iraqi conflict had ecological effects comparable in scale to the massive degradation of ecosystems unleashed by domestic policy choices in the preceding decade, notably the destruction of the Mesopotamian marshlands as a result of the construction of upstream dams and politically-motivated drainage schemes. UNEP's *Desk Study on the Environment in Iraq* illustrates vividly the shrinkage of the southern wetlands, with dramatic losses in biodiversity (2003b: 39-44). Elsewhere in Iraq, over-exploitation of dryland ecosystems had increased the risk of desertification prior to the Coalition invasion. In terms of ecosystem damage during the 2003 Iraqi war, UNEP estimated widespread degradation to desert environments from intensive military activities. The use of depleted uranium munitions by Coalition forces was also highlighted as giving rise to environmental and health risks, although with continuing uncertainties as to the long-term effects (UNEP 2003b: 80-82; UNEP 2003c: 20-21).

For the Gaza Strip, *Operation Cast Lead* had major environmental effects on its already vulnerable farmland. In its 2009 environmental assessment, UNEP reports on the findings of a UNDP post-conflict survey, which claimed that 17% of the total cultivated area of the Gaza Strip was seriously damaged, including 17.5% of the orchards and 9.2% of open fields. A long-term reduction in agricultural productivity is also forecast as a result of the extensive destruction of the vegetation cover, because of: (i) the mixing and degradation of the thin topsoil cover, (ii) the unavailability of heavy ploughing machinery to break up dense soil crusts caused by the tracks of Israeli military vehicles, (iii) increased sensitivity to soil erosion and desertification, and (iv) the intolerance of young fruit and olive saplings to the brackish water now routinely used for irrigation in the Gaza Strip (UNEP 2009a: 32). Furthermore, the rebuilding and restocking of destroyed greenhouses, livestock and poultry farms is severely constrained by Israeli and Egyptian restrictions on the movement of people and materials across their borders with the Gaza Strip.

### **Direct environmental effects of occupation practices**

Direct changes to natural resources and ecosystems may also be caused by occupation practices. Under Article 147 of the Fourth Geneva Convention, destruction and appropriation of civilian property is only justified by 'military necessity', which would cover, for example, the unavoidable degradation of water and agricultural resources as a result of the movement and deployment of military assets. Outside such direct consequences, the occupying power is bound by humanitarian law not to utilize natural resources for the purposes of its domestic population: should these resources be privately owned, there is a prohibition against confiscation (Hague Regulations, Article 46) and, if they are publicly owned, there is an obligation to administer them under the rules of usufruct; that is, a right of use that conserves the capital stock of the resources in question (Hague Regulations, Article 55). International environmental law reinforces the principle here that the occupying force should not create long-term environmental damage: Principle 21 of the 1972 Stockholm Declaration on the Human Environment enjoins states not to cause damage to the environment of other states or of areas beyond the limits of national jurisdiction.

Since 1967 the enduring occupation by Israel of the West Bank (including East Jerusalem) and the Gaza Strip provides much practical evidence on the environmental effects of the coercive control of a territory. Israel has always been resistant to the notion that the Fourth Geneva Convention is *de jure* applicable to the occupied Palestinian territory (oPt), though the Supreme Court of Israel has repeatedly ruled that the West Bank and the Gaza Strip are areas subject to the application of law of belligerent occupation (Dinstein 2009: 23). Authoritative representatives of the international community, including the UN and the High Contracting Parties to the Fourth Geneva Convention, have also consistently maintained the international humanitarian law applies to the oPt. This includes the Gaza Strip even after the unilateral Israeli disengagement in September 2005, because, it is claimed, effective control is still exercised by Israel. Similarly, while annexed by Israel in 1980, the international community continues to regard East Jerusalem as subject to occupation. The application of humanitarian law to the oPt raises critical issues about the environmental responsibilities and impacts of the occupying power and its citizens, including the 290,000 Israeli settlers who currently reside in the West Bank (in contravention of Article 49 of the Geneva Convention and Article 8(2)(b) of the Rome Statute of the International Criminal Court).

### *Water resources*

The oPt has low levels of per-capita water availability – three-quarters of the population are estimated to consume between 60-100 liters for domestic use per capita per day (lcpd) compared to 330 lcpd in Israel (Zeitoun 2008: 14). In the West Bank, average water availability for Palestinians is lowest at 50 lcpd compared to 369 lcpd for Israeli settlers. In the Gaza Strip it is just over 90 lcpd, with very poor drinking water quality (World Bank 2009: 13, 28). According to recent reports by the World Bank (2009) and Amnesty International (2009), Palestinian water insecurity is largely the result of the occupation, as Israel effectively controls shared Israeli-Palestinian water resources. While joint governance rules and water allocations were established under the 1995 Oslo Interim Agreement, these have failed to allow the development of a functioning water infrastructure for the Palestinians, entrenching instead a highly asymmetric access to water resources in the West Bank. In the Gaza Strip, the economic blockade has prevented necessary investments in water and sanitation, including local desalination capacity and the option of transferring water from the West Bank Mountain Aquifer: as a result the Coastal Aquifer is being severely degraded by over-extraction and pollution from sewage and irrigation (UNEP 2009b: 55-62).

The effects of the occupation on water resources are compounded by the Israeli ‘security fence’ or barrier complex constructed first along the border with Gaza in 1987 in response to the *First Intifada*, and then, since 2002, as a Separation Barrier from the West Bank (eventually to reach a planned 763km), running mostly within the Palestinian side of the Green Line and encompassing major Israeli settlements in occupied territory. For the Gaza Strip, this has meant the denial of entry to equipment and supplies necessary to repair water facilities following the recent conflict. In the West Bank, movement and access restrictions on the civilian population are having severe public health and environmental impacts. For the crucial Western Aquifer Basin, for example, which is the largest groundwater resource between the two territories, Israeli prohibition of new Palestinian wells, and restrictions to existing Palestinian wells caught on the Israeli side of the Separation Barrier, are significantly reducing supplies of agricultural water for the northern West

Bank (Trottier 2007: 121).

### *Agricultural resources*

As agriculture in the West Bank and the Gaza Strip accounts for two-thirds of Palestinian withdrawn water, water deficits induced by the Israeli occupation have significantly constrained the goals of the Palestinian Authority to develop this sector – one that accounts for 10% of Palestinian GDP and 15% of total employment. Coupled with declining water availability, access and movement restrictions have inhibited agricultural labor inputs and the export of agricultural goods (World Bank 2009: 25-26). In the West Bank, plans to increase the contribution of irrigated agriculture (currently only 6% of the cultivated area), which would be supportive of high value vegetable and fruit crops, have been held back by Israeli restrictions on well-drilling. Israeli government and settler activities are also a significant constraint on Palestinian agricultural activities; for example, the politically-motivated destruction of Palestinian olive trees by settlers, along with the clearance of agricultural land for the construction/expansion of settlements and their associated security infrastructure. Similarly, investment in the agricultural sector in the Gaza Strip has been frustrated by the Israeli closure regime imposed following the election into government of Hamas: farmers have substantially reduced the planting of export crops (e.g. cherry tomatoes, peppers, cucumbers) on account of the severe difficulties in moving them across the border.

It should be noted that the agricultural sector is also a crucial underpinning of the food security of the Palestinian population, and here occupation practices have increased the vulnerabilities of households and communities. In 2008 25% of the West Bank population and 56% of the Gaza population were deemed by the Food and Agriculture Organization to be food insecure, resulting in major food aid interventions by international humanitarian agencies (FAO 2008). While recent droughts have affected food production (particularly for the rain-fed cultivated fields and rangelands of the West Bank), these climatic stresses have been accentuated by the security and settlement practices of the occupying power. To be sure, the attribution of agricultural sector impacts to particular occupation practices is often contested between the Israeli Government and the Palestinian Authority, and the institutional weaknesses of the latter are also a contributing factor to food insecurity. However, there is consensus amongst international organizations active in the oPt – e.g. UNDP, FAO, World Food Programme – that the occupation is significantly impeding the development of the Palestinian agricultural sector. This includes indirect environmental effects from the coping strategies employed by local communities (see ‘Indirect Effects of Occupation Practices’ below).

### *Waste pollution*

In its *Desk Study on the Environment in the Occupied Palestinian Territories*, UNEP (2003a) noted with alarm the various environmental and health threats from waste pollution in the West Bank and Gaza Strip caused by: (i) a lack of treatment facilities for wastewater resulting in pollution of the Mountain (West Bank) and Coastal (Gaza Strip) Aquifers, (ii) the open burning of municipal solid waste and the mixing in landfill sites of hazardous and non-hazardous waste, and (iii) the lack of storage and disposal options for hazardous wastes. Inadequate management by Palestinian

authorities was blamed for some of these environmental risks, but a number were directly linked to occupation practices. For wastewater pollution, it is notable that, since 1967, Israel has only established one sewage pre-treatment plant (at Tulkarem) for the Palestinian population in the West Bank, and has also blocked or delayed the upgrading of the three sewage treatment plants in Gaza. Even more obviously a consequence of occupation is the release of large quantities of poorly treated domestic and industrial sewage by most of the Israeli settlements and outposts in the West Bank: in addition, approximately 200,000 Israelis living beyond the Green Line in East Jerusalem produce substantial quantities of untreated or partially treated sewage that flows eastwards into the West Bank, causing environmental damage to soil and water resources (Amnesty International 2009: 69-70).

In 2003 UNEP judged Israeli environmental authorities to have limited control over an estimated 131,000 tons of solid waste produced by the Israeli settlements in the West Bank (UNEP 2003a: 59-68). Until Israeli National Master Plan 16 (1986) on solid waste treatment, hundreds of illegal waste dumps were scattered across Israel and the oPt. The subsequent decommissioning of dump sites only applied to Israel, and though military orders issued by the Israeli Civil Administration in the West Bank applied Israeli waste disposal standards to settlements, the Palestinian Authority has alleged that the unregulated disposal of untreated solid waste (including hazardous wastes) continues and that decommissioned sites have not been made safe (Tagar and Qumsieh 2006: 12-13; Amnesty International 2009: 70). As with wastewater management, access and movement restrictions associated with the occupation have hampered solid waste management. In the West Bank, curfews and roadblocks, which increased in the wake of the *Second Intifada*, have disrupted the transfer of waste to municipal disposal sites, triggering the creation of unregulated, temporary disposal sites and the open burning of waste. For the Gaza Strip, the temporary storage and burning of waste intensified during and after *Operation Cast Lead*, while the shutting down of incinerators (due to electricity shortages) resulted in the indiscriminate dumping of hazardous wastes in landfill sites (UNEP 2003a: 58-70; UNEP 2009a: 44-54).

### *Conservation of biodiversity*

The variety of physical environments within the oPt gives rise to rich land and marine biodiversity. While there is no systematic database of biodiversity in the Gaza Strip and the West Bank, the oPt shares threats to biodiversity with other territories in the Mediterranean biome – these include rising human population density, urbanization, agricultural land use and invasive species. However, the unique structures and practices of the occupation have negatively affected biodiversity. In the West Bank, the main negative effects have been caused by extensive settlement building, the construction of the Separation Barrier, and the associated growth of a parallel road infrastructure for the use of settlers and the military. Not only have these practices resulted in the loss and fragmentation of wildlife habitats, they have also eroded the rich agricultural biodiversity built up over centuries by Palestinian farmers, from crop varieties to domesticated bees (UNEP 2003a: 95-103). In the Gaza Strip, desertification processes in the southern agricultural lands have been accelerated by the imposition by the Israelis of a closed security area along the border, preventing farmers from gaining access to their lands. The Strip has one protected natural area. In 2002 the Palestinian Authority established the Wadi Gaza Nature Reserve on a salt marsh ecosystem that

historically served as a major resting point for migratory birds: this site has been severely degraded by sewage-related contamination, which at least in part is attributable to delays in installing a wastewater treatment plant as a result of the Israeli blockade on materials and investment into Gaza (UNEP 2009a: 41-42, 50).

It should be noted that military interventions do not necessarily generate negative ecological consequences for biodiversity. There are historical examples of landscapes and ecosystems benefitting ecologically from exclusionary zones enforced by the military, such as the Korean and Cypriot demilitarized zones (e.g. Pearson et al. 2010). Similarly, recent efforts to restore the Mesopotamian marshes in Iraq indicate that military interventions and occupations may enable ecological restoration of previously degraded ecosystems (Stevens 2007). Nevertheless, in the Palestinian and Iraqi cases, the direct ecological effects of occupations have been judged by international organizations to be overwhelmingly negative on balance.

### **Indirect environmental effects of occupation practices**

As with conflict more generally, occupation practices can indirectly affect natural resources and ecosystems by influencing (constraining or enhancing) the adaptive coping strategies employed by local populations and displaced people (UNEP 2009b: 6). These indirect environmental effects, mediated by the behavior of the occupied population, are multiple, and can be assessed according to different timeframes and scales, but generally they relate to the means by which affected communities respond to the material and social constraints imposed on them by an occupation. Of course, even assuming the occupying power complies with international humanitarian law, the coercive nature of belligerent occupation often entails significant restrictions on the livelihood options for affected civilians. Aside from the environmental consequences caused by military actions preceding or interrupting an occupation, the civilian population must also cope with, and adapt to, the stresses of occupation practices, such as movement restrictions, personal insecurity and disincentives to wealth creation.

In Iraq under the Coalition Provisional Authority (April 2003 to June 2004), the severe lack of security and stability aggravated humanitarian demands from a population already weakened by the conflict and the preceding UN sanctions regime. The collapse of the oil and agricultural sectors (the two largest sectors of employment), along with insurgent attacks in major urban areas, saw a dramatic reduction in livelihood opportunities (Sen 2003). As the scale of the humanitarian crisis in Iraq was not foreseen by the occupying powers, it overwhelmed their post-invasion governance capacity. The Iraqi population became heavily dependent on international aid, while natural resource use was plagued by corruption and illegal trade, notably in oil. It should be noted that the Coalition Provisional Authority did attempt to facilitate environmental *benefits* in some of the recovery and coping strategies it directed at the occupied population. For example, in October 2003, the US Government began a three-year agricultural reconstruction and development program: \$343 million was invested in activities that included soil conservation, improved water management and support for agricultural livelihoods (USAID 2009). Nevertheless, the great bulk of the \$33 billion in grants and loans pledged by international donors in October 2004 did not address environmental issues (UN Development Group/World Bank 2006: 6).

In a protracted belligerent occupation, as with the Israeli presence in Palestinian territory, there may be long-term damage to the capabilities and assets of the affected population (including refugees and internally displaced groups) resulting in negative environmental effects. Such damage is more likely to the extent that the protective rules of humanitarian law are not effectively implemented or enforced. There is strong *prima facie* evidence that this is the case in both the West Bank and Gaza. In the former area, Israel control of natural resources and movement restrictions on the Palestinian population have increased environmental pressures; for example, rangeland degradation in the south Hebron hills caused by over-grazing, because Palestinians are denied access to traditional pastures and other livelihood opportunities. In the Gaza Strip, the Israel blockade has induced short-term coping mechanisms with negative environmental and social effects; for example, the use of vegetable oils for fuel causing local air pollution, soil contamination as a result of the use of untreated wastewater for agriculture, and increased water scarcity from unregulated well-digging (UNDP 2010). While Palestinian governance failings are apparent in both the West Bank and Gaza, the occupying power has major responsibility, both legally and practically.

Climate hazards and other external environmental stresses can also affect the indirect environmental effects of occupation. In Iraq, post-conflict recovery of irrigated agriculture and the Mesopotamian marshlands has been threatened by three years of drought, as well as upstream damming of the Euphrates and Tigris rivers by Syria and Turkey. Benvenisti has argued that the law of occupation includes grounds for the occupying power to safeguard freshwater resources by negotiating with neighbouring states (2003: 870-872), though the Coalition Provisional Authority made no such representations to Syria and Turkey. For Palestinians, climate change modelling predicts, over this century, a decrease in precipitation of up to 35% (with significant seasonal variation), a significant warming of between 2.6°C and 4.8°C, and a tendency towards more extreme weather events. According to UNDP, the Israeli occupation has significantly weakened the capacity of Palestinians to cope with, and adapt to, climate hazards, notably from restrictions imposed on the development of efficient water infrastructure, as well as the loss and degradation of agricultural land as a result of security and settlement practices (UNDP 2010).

## Conclusion

Belligerent occupations are part of the conflict continuum covered by warfare ecology. They are also covered by a distinctive subset of international humanitarian law (*jus in bello*) – the legal norms governing the conduct of war. Existing humanitarian law includes provisions that prohibit unnecessary environmental damage, yet their application during periods of occupation is uncertain, relating largely to the control of civilian resources and infrastructure by the occupying power. The legal norms governing occupation are also hampered by the absence of an international enforcement agency: at best, these norms are selectively enforced by relevant states and international organizations. This paper examined the potential role of warfare ecology in accounting for the environmental effects of belligerent occupations, highlighting the multiple, often indirect, means by which such occupations affect ecological processes. Examples were drawn from the occupation of Palestinian territory by Israel and the occupation of Iraq by the Coalition Provisional Authority.

It was argued that warfare ecology can make a major contribution to assessing the effects of occupations and, through the generation of policy advice, to promote means for reducing negative ecological consequences. Nevertheless, there remains unresolved the question as to the nature and scope of environmental protection duties borne by an occupying power under international humanitarian law. On the one hand, these seem largely indirect: in its overriding responsibility to meet the needs of the civilian population, the occupying power is obliged at best to exercise the guardianship of natural resources under its control. On the other hand, this role of ‘temporary trusteeship’ indicates that the occupied population actually retains permanent sovereignty over these resources and associated ecosystem services. If the latter is the case, then warfare ecology has a vital role to play in showing how the environmental responsibility of an occupying power is much more than the prevention or mitigation of particular impacts arising from its military activities. Indeed, it implies that the occupying power must strive to ensure that the occupied population is also protected from other sources of significant environmental harm.

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# **Immediate and Short-term Impact of an Outdoor Environmental Health Awareness**

## **Program among Children in Gaza city**

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## ABSTRACT

Children are the most important target group in the implementation of environmental awareness and health programs. The study aims to evaluate the effectiveness of short term environmental health awareness program effects on children's knowledge, attitudes, and behaviors toward their environment in Gaza city primary schools in an after-school setting. The researchers utilized quantitative and qualitative measures by incorporating the observations of children's engagement in program activities as well as conducting a focus group discussion with the children and self-reported questionnaire to collect data. Pre- and post-tests were designed to determine the changes in the levels of environmental health knowledge, attitudes, and behaviors. Results indicate positive shifts in knowledge and changes in environmental attitudes and behavioral intentions. The level of knowledge about environmental health before attending the awareness program (pre test) was (71.3%), and it became (79.2%) after attending the program (post test). Their positive attitude toward the environment was (76.6%), while it became (85.7%) post test. The level of children behavior towards environmental health issues was (76.6%) pre test and became (90%) post test. There are differences in the level of environmental health knowledge, attitude, and behavior based on gender favoring males. Recommendations were made for future studies.

**Keywords:** Outdoor environment, health awareness, Environmental program effect, Palestinian children, Gaza city, Palestine.

## Introduction

The Palestinian environment is suffering from serious contamination and in the severe deterioration of the natural resources. These serious problems occurred as a result of more than 40 years of Israeli occupation, continuous invasions to Palestinian territories, and from long term isolation as a result of the regional political circumstances, limited land resources due to land confiscation, alarming population growth and the exploitation of the natural resources within the districts of the West Bank and Gaza Strip.

Also, the underdeveloped environmental protection system, the absence of funding, weak capacity and weak infrastructure of the factors, caused serious threats, fast depletion and contamination of environmental resources, degradation of the level of wastewater treatment and a severe shortage and degradation of water quantity and quality. In addition to the severe problems in the ability to dispose of solid waste in the dumps, which led to the accumulation of it in the streets and neighborhoods, and making them vulnerable to play with, by children, animals, which forced the citizens to burn it. That led to air pollution, which, in its turn, leads to health risk among citizens. All of these problems and other environmental problems have become increasingly in the recent period, that the Gaza Strip has narrow surface area, about 365 km<sup>2</sup>, and rapid population growth (which is about 3.2% based on estimates of the Palestinian Center for Census Statistics,

2010). This has led to an increase in census, up to the approximately 1.5 million people, in 2010, and the high population density of up to about, 4206 people/km<sup>2</sup>, and population growth is still continuing (PCBS, 2010). Moreover, the suffering from siege and borders closures since more than 4 years ago, in addition to the last war on Gaza in December 2008, which increased the threats and environmental crisis in Gaza Strip.

As a result of these data, the dissemination of environmental awareness is a prerequisite and a pressing need in order to achieve the concepts of sustainable development and to promote the principles of environmental action within the Palestinian community. Whereas, it is important to highlight that, the environmental damage already inflicted cannot be reversed unless a collective thinking and efforts are made by coordination among different institutions concerned with the environmental health protection. It is only possible through environmental awareness and fostering of environmental ethics. On the other hand, in view of the needs of the present and future generations; education at schools, colleges and at the various society levels is imperative. Moreover, public awareness and community participation can help to achieve change in attitude preventing further damage to the environment (Abu Safieh, 2006).

As the children are the most important target group in affecting their arena, the implementation of environmental awareness programs and health among them is indispensable, whether formal or informal awareness programs, not only about the environmental vision of tomorrow or the next day, but would show a desire to bring about an immediate change of the positions expressed by their peers and parents about the environment and its various items.

Accordingly, efforts & interventions have been made to raise the level of environmental awareness, among the Palestinian children, in addition to, change positively their attitudes & behaviors toward the environment. These efforts have been run by both the governmental organizations in implementing formal education inside schools, and non-governmental organizations in implementing non-formal education outside schools boundaries. Abu Safieh (2006) in her study which aims to document the achievements in the field of environmental awareness for youth and children in Palestine, emphasized, the main activities implemented over the last ten years, whether it is formal or non formal environmental activities. The survey revealed that, according to different national & international organizations, most of Palestinian environmental organizations prefer working with children. Some informants stressed on the increasing difficulties of reaching children, especially in the school space, due to many reasons. For example, that the Education Directorates have increased their stipulations & conditions making access to schools more difficult. There might be no real measurement of impact for any of the implemented projects. Key informants indicated and presented evaluation reports, annual reports, and managerial and financial reports, but no measurement of impact (Abu Safieh, 2006).

While some research and evaluation work has focused on classroom EE program outcomes (Camargo *et al.* 2009), this study focuses on outdoor programs and asking: “To what extent do these programs attain their goals? Such as increasing the knowledge, change in positively in the

attitude and behaviors toward the environment among the school children.

This study aims to assess the effectiveness of environmental awareness program that attempt to link specific environmental knowledge, and attitude towards different environmental issues such as water conservation, solid waste recycling, cleaning the surrounding environment from garbage, refuse, and dust and rubles debris with the behavior of school children. To address this question, programs attempt to assess outcomes informally or through program evaluations.

## **Simulation and experiment**

The researchers utilized quantitative and qualitative measures by incorporating the observations of children's engagement in program activities as well as conducting a focus group discussion with the children after participating in the awareness program. Also, a self-reported questionnaire was applied to collect data for the assessment of the effectiveness of a short-term environmental health awareness program implemented for the 4<sup>th</sup>, 5<sup>th</sup>, and 6<sup>th</sup> grades of a children's primary school in an after-school setting in Gaza City.

The questionnaire used questions with likert-type question response format, and multiple choice responses formats. While, there were 24 knowledge questions covered different environmental health items, there were 30 questions about attitude towards environmental health issues, and 22 questions to reflect the children behaviors toward different environmental health issues. There were also nine questions about children's satisfaction with the awareness program.

The questionnaire was developed using pre-post test format. Subjects were first asked to answer the questionnaire before starting the awareness program, which reflect their knowledge, attitude and behavior before participation in the program, and then they were asked to fill the post test questionnaire at the last day of the awareness program, which indicate their knowledge, attitude and behavior after their participation in the program.

The study children from the 4<sup>th</sup>, 5<sup>th</sup>, and 6<sup>th</sup> grades of a children's primary school in Gaza City where selected randomly from the children who attended Ajyal Association to participate in the activities implemented in the association in the same period of the study, Gender equity was considered, even there wasn't equity in the numbers between males and females. Meeting with the children mothers was conducted, and consent form was signed after receiving approval from the children family to participate in the study. At the first day of the program fifteen children were participated in the study, but there was problematic in the attendance of all children in the study that some of these children were dropped from the study, and the final no. of study children became 9 children, who filled the pre-post test and attend all the program activities.

The experiment was implemented during the Semester break in Winter 2011, and implied 8 days, distributed among the two weeks During the Semester Break. Following each activity day in the study, notes were taken on specific topics covered during the day. Possible questions were developed from these notes to determine if the units impacted children's knowledge, attitudes and behavior. The researchers developed the environmental health activities plans, and test their applicability to fourth, fifth, and sixth graders, and determine the response of the children to the lesson plans. During the study period, input from children was sought to help the researchers

create survey questions in a language that children could understand in the future. Eight lesson plans were used during the study period. The lesson plans were presented during two weeks at Ajyal local Association for children in Gaza City. Each lesson lasted between 100 to 120 minutes (including power point presentation, leading discussion, storytelling, and break for refreshments, doing hands on activities and involving children in purposefully entertainments, such as painting or playing with puppets).

After the study, efforts were made to determine which lessons had worked better than others. Several criteria were used to determine if the lessons were successful, including the amount of time the leader spent talking and leading discussions versus doing hands on activities, and the reaction of the children during the lesson. For example, were they talking to each other and saying things such as “I’m bored.” “Finally”, “when the break will be”, or “can we have break”, “can we paint”, “we want to play with puppets”, etc. The children were asked if they had a good time the day a particular lesson was presented and also asked what they would change about the presented lesson.

Analysis of the collected data was carried out using SPSS software (version 16). The data were subjected to descriptive statistics included means, frequencies, percentages, and standard deviations, to estimate the differences in results between pre test and post test. Student’s paired *T*-test was used to compare the data pre test and post test, with a *P*-value of <0.05 considered to be significant.

## **Discussion and result analysis**

### **1. Level of environmental health knowledge, attitude and behavior among children in Gaza City (pre test-post test)**

The first part of questionnaire contained 24 questions on environmental health knowledge. For each correct answer, 1 mark was awarded and no marks were awarded or deducted for wrong answer. As shown in table 1, out of the 24 points reflecting the level of environmental knowledge among children pre test, the mean of the score was 17.11 with standard deviation of 6 and percentage of 71.3%, while it became 79.2 Post test, and the result was statistically differences between pre and post test. These results indicate that the level of environmental health knowledge among children in Gaza city increased after attending the awareness program.

The second part of questionnaire contained 30 questions to reflect children attitude towards environmental health issues. For each answer which reflects positive attitude toward environmental health issues the researchers scaled the responses to each statement into 4 possible responses, Strongly Agree=4; Agree=3; Disagree=2; and Strongly Disagree=1. While for the answer reflecting negative attitude toward environmental health issues, the researchers scaled the responses to each statement into 4 possible responses, Strongly Agree =1; Agree =2; Disagree = 3; and Strongly Disagree =4. As shown in table (1), out of the 120 points of 30 questions reflecting the level of environmental health attitude among children before attending the awareness program (Pre Test), the mean of the scores was 91.89 with standard deviation of 14 and percentage of 76.6%. While the

level of environmental health attitude among children after attending the awareness program (Post Test), the mean of the scores was 102.89 with standard deviation of 13 and percentage of 85.7%. These results indicate that the level of positive environmental health attitude among children in Gaza city increased after attending the awareness program. The result doesn't reach statistically differences between the children attitude before and after attending the awareness program.

The Third part of questionnaire contained 22 questions to reflect children behaviors towards environmental health issues. For each answer which reflects positive attitude toward environmental health issues the researcher scaled the responses to each statement into 4 possible responses, Always =4; Sometimes =3; Almost never = 2; and Never =1. While for the answer reflecting negative attitude toward environmental health issues, the researcher scaled the responses to each statement into 4 possible responses, Always =1; Sometimes =2; Almost never = 3; and Never =4. As shown in table 1, out of 88 scores reflecting the level of positive behavior of study children towards environmental health issues before attending the awareness program was with mean of 67.44 and percentage of 76.6%, while the mean of study children behavior after attending the program was of 79.22, and percentage 90%. This means that the study children behavior towards environmental health issues improved after attending the awareness program.

The result doesn't reach statistically differences between the children attitude before and after attending the awareness program because the no. of children is not enough.

**Table 1: Level of Environmental Health Knowledge, Attitude, and Behavior Pre Test, and Post Test**

Item	Knowledge		Attitude		Behavior	
	Pre	Post	Pre	Post	Pre	Post
<b>Number of children</b>	9	9	9	9	9	9
<b>Mean</b>	17.11	19	91.89	102.89	67.44	79.22
<b>Standard deviation</b>	6	5	14	13	16	6
<b>Percentage %</b>	71.3	79.2	76.6	85.7	76.6	90
<b>t</b>	-1.877		- 3.194		-3.085	
<b>df</b>	8		8		8	
<b>sig</b>	0.003*		0.035		0.005	

## 2. Level of environmental health knowledge, attitude and behavior in related to gender

As shown in table 2, the percentage of environmental knowledge about environmental health issues among study children before attending the awareness program, among males was 79.2%, while it was among 65%, which mean that the level of environmental awareness among males' children in Gaza city was higher than of females Pre Test. While percentage of post test, was among males of 80.2%, and among females was 78.3%, which mean that the level of environmental awareness among males' children in Gaza city was higher than of females Post Test.

**Table 2: Level of Environmental Health Knowledge, Attitude and Behavior in Related to Gender**

Item	Knowledge		Attitude		Behavior	
	Pre	Post	Pre	Post	Pre	Post
<b>Male</b>	79.2	80.2	85.4	94.6	85.2	92.6
<b>Female</b>	65	78.3	69.5	78.7	69.8	88

As shown in that table above, the percentage of study children positive attitude towards environmental health issues before attending the awareness program, among males was 85.4%, while it was among females 69.5%, which mean that the level of environmental awareness among males' children in Gaza city was higher than of females Pre Test. In post test results, the table shows that the percentage of positive attitude among males was 94.6%, while it was among females about 78.7%, which mean that the level of environmental awareness among males' children in Gaza city was higher than of females Post Test.

Also, the above table shows that the level of study children positive behavior towards environmental health issues before attending the awareness program was 85.2%, while it was among females 69.8%, which mean that the level of environmental awareness among males' children in Gaza city was higher than of females Pre Test. Finally, the percentage of study children positive behavior towards environmental health issues after attending the awareness program among males was 92.6%, while it was among females 88%, which mean that the level of environmental awareness among males' children in Gaza city was higher than of females Post Test.

### 3. Level of children satisfaction about the awareness program

There were nine questions about children's satisfaction with the Awareness program, such as "I learned a lot since I joined the program"; "There were variety in the program activities"; "I enjoyed participating in the program"; "I wish repeat such program again"; "I will tell my friends about the program and encourage them to participate"; "Did you learn of such activities in the school"; "Did you attend all program activities"; "Did you re-use things in house"; "Did you start telling family and friends about the importance of maintaining health and the environment".

As shown in table 3, the level of children satisfaction about awareness program was about 81.2%.

**Table 3: Level of Children Satisfaction about the awareness Program**

Item	N	Mean	Standard deviation	%
Program Satisfaction	9	29.22	4	81.2

### 4. Relationship between children who are satisfied with the program and their knowledge level:

As shown in table 4, Person's correlation coefficient results indicated that, there was a positive

correlation between environmental health knowledge of children after attending the awareness program (Post –Test) and children satisfaction with the program , and it was .456 ( $n = 9, p = .218$ ). The correlation between level between environmental health knowledge of children after attending the awareness program (Post –Test) and children satisfaction with the program didn't reach statistically significance.

**Table 4: Relationship between children who are satisfied with the program and their knowledge level**

	<b>Knowledge Post Test - Program Satisfaction</b>
Pearson Correlation	0.456
Sig. (2-tailed)	0.218
N	9

( $P < 0.001$ )

All study children indicated satisfaction with the program. The level of children satisfaction about awareness program was about 81.2%.which indicates a high degree of satisfaction with the program. The correlation between level between environmental health knowledge of children after attending the awareness program (Post –Test) and children satisfaction with the program didn't reach statistically significance. This finding agrees with the study of Vadala (2004), which reveals that there was not a significant relationship between participant's satisfaction with the program and their environmental knowledge at the end of the program. Also, the finding supported by the Ballntyne, Fien and Packer (2001) who found that, just because a student liked the program does not make them more environmentally aware.

### 5. Correlation between knowledge, attitude and behavior Factors group Post Test

As shown in table 5, the children in the program study sample had appositve correlation but not statistically significant of 0.273 ( $n = 9, p = .476$ ) between knowledge and attitude, while there is statistically significant correlation of 0.811 ( $n = 9, p = 0.008$ ) between knowledge and behavior, and correlation of 0.228( $n = 9, p = 0.555$ ) between attitude and behavior with no statistically significant.

**Table 5: Correlation between knowledge, attitude and behavior Factors**

	<b>Knowledge - Attitude</b>	<b>Knowledge - Behavior</b>	<b>Behavior - Attitude</b>
Pearson Correlation	.273	.811**	.228
Sig. (2-tailed)	.476	.008	.555
N	9	9	9

\*\* . Correlation is significant at the 0.01 level (2-tailed).

This outcome is curious since the model used for this study suggests that attitude changes precede behavior changes. It could be that students already had positive attitudes about the environment, but lacked knowledge about how to put these attitudes into practice (Vadal, 2004). Therefore, when they were provided with lessons their knowledge increased and their behavior increased.

Attitude is also difficult to measure because it is made up of cognitive, affective and behavioral components (Vadal, 2004). Affective attitude or emotion is the most difficult to measure and the results may indicate this difficulty. The fact that the behavior mean increased significantly but the attitude mean did not might be due to the impact of social norms on an individual's behavioral intentions. The children might have had a weak or negative attitude about the environment, yet their behavior might be positive due the impact of society's opinions or expectations on their behavior (Vadal, 2004).

## 6. Observation results

The awareness program implied 8 days of activities (Introductory Lecture; Water issues; Solid waste; Waste water; Reduction and Reuse; Personal Hygiene; General Environmental Health behaviors; Practices & groups work). Total score of the children participation in the program activities is 52.

As shown in table 6, the general participation in all program activities days, were varieties, that the results shows, the rank 1 in children actively participation was in the day of solid waste reduction and reuse, that this activity implemented outside the organization, and the children were interesting on hands activities and learning new skills. While the last and weakness participation was in the first day which implies the introductory lectures, that the children were not have enough previous knowledge about most information of this day, so they were listening and receiving these new information more that participation.

**Table 6: Cross tabulation between the children total participation and each program activity**

<b>Program Activities</b>	<b>Score of children Participation in the program activities</b>	<b>Percentage</b>	<b>Rank</b>
Introductory Lecture	26	50	7
Water issues	27	52	6
Solid waste	35	67	2
Waste water	29	56	5
Reduction and Reuse	38	73	1
Personal Hygiene	34	65	3
General EH behaviors	27	52	6
Practices & GW	31	60	4

## Focus group results

Focus group was conducted with the nine study children after finishing the awareness program.

The meeting with the children was conducted to see if there were other places such as schools, outside of school, such as at home, that they were learning about the environmental health issues. Also, what is the favorite part or activity in the program, less activity you prefer in the program, if their attitude changed positively towards environmental health issues after attending the program. The results of focus group were analyzed manually.

These results indicated that, the children had never participated at school or any outdoor awareness program like the environmental health awareness program they attended during this study.

Most of them prefer solid waste and recycling activities day, in addition to the day they received the hygiene kits. All children stated that they started using the hygiene kits contents at home. All of them agreed that they interested with all the program activities and there was no activity they dislike it. All children said that before attending the program they were not care about removing the garbage from the ground, but now they through it in the trash bin. Also, all of them start to use tooth brush and brushing their teeth every day, and take care of their personal hygiene specially washing their hands before and after eating, and after using the toilet.

## Conclusion

This study aims to evaluate the environmental health awareness program effects on children's knowledge, attitudes, and behaviors toward their environment in Gaza city. The researchers utilized quantitative and qualitative measures by incorporating the observations of children's engagement in program activities as well as conducting a focus group discussion with the children. A Pre- and post-tests self-reported questionnaire was also applied to collect data for the assessment of the effectiveness of a short-term environmental health awareness program implemented for the 4<sup>th</sup>, 5<sup>th</sup>, and 6<sup>th</sup> grades of a children's primary school in an after-school setting in Gaza City. It aims to determine the changes in the levels of environmental health knowledge, attitudes, and behaviors of school children who participated in this program. Results indicate positive shifts in knowledge and change in environmental attitude and behavior. The level of knowledge about environmental health before attending the awareness program (pre test) was (71.3%), and it became (79.2%) after attending the program (post test). Their positive attitude toward the environment was (76.6%), while it became (85.7%) post test. The level of children behavior towards environmental health issues was (76.6%) pre test and became (90%) post test. There are differences in the level of environmental health knowledge, attitude, and behavior based on gender favoring males. Recommendations were made for future studies.

The study results demonstrated that the outdoor environmental health awareness program, implemented in the experimental group was more effective in enhancing children environmental health knowledge, attitude and behavior. Results have opened new opportunities for growth in outdoor environmental health awareness program, and other research should investigate other outdoor awareness programs. That this study can be considered as first step of having this type of immediate and short-term data to evaluate the effectiveness of such program, and to be the base for future studies which concentrate on the overall long-term success of its programs, in enhancing children to be pro environmental knowledge attitude and behavior. So, it can be considered as one

of the important solutions to plug the hole and strength the environmental education for sustainable development.

This study was small in scope, number of children, but its findings concerning immediate and short term effect of an outdoor environmental health awareness program on children knowledge, attitude and behavior.

Based on what was learned from using the experimental quasi study, several Suggestions for future studies should be implemented. The design must be strengthened to control for the confounding factors. A future study should be longer to obtain a larger sample. The study cannot be done in winter fall semesters because it's short and hampers and impede the full participation of children because of time constraints.

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# **Towards a Sustainable Environmental Education:**

**A case Study-Birzeit University**

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## ABSTRACT

Many educational institutions draft policies for environmentally sustainable and responsible practices and activities. Such policies incorporate sustainability principles into university structures and activities and they promote an environmentally responsible culture across the university community. Reforms on educational systems, departments, centres, and campus life are continuously carried out. One effective guideline is committing to continuous improvement of the campus performance and acting as a model for new generations and young leaders. Examples of BZU awareness on sustainability are visible, yet its commitment to sustainability should be explicitly stated. Simple statements expressing such commitment should be visible to the university community. BZU should function as a sustainable community and adopt responsible practices in areas such as consumption of energy, food, water, products and transportation. It has to cooperate with the local community to increase the awareness, knowledge, technologies and tools to help create an environmentally sustainable future. Several phases have already been implemented at BZU to encourage students and faculty participation such as establishing a safety committee and an environmental group. The university incorporated the concepts of sustainability into several courses. Examples can be found in Engineering, Science, Geography and Humanities. The adoption of sustainability concept by BZU was clearly exhibited by establishing the Institute of Environmental and Water Studies. Teaching by example is a model that can be adopted to promote environmental education. This is manifested by greening the campus, harvesting rain water, paper recycling and by adopting online communication and e-learning methods. There are challenges ahead: developing national policies, enhancing greater community participation and tackling particular acute problems such as waste tires, stone sludge, recycling of cans and plastics bags, voids created by abandoned quarries and solid waste accumulation.

**Key Words:** Birzeit, Sustainability, Environment, Education, Case Study.

## Introduction

Universities function as centres for teaching and research. They provide the professional training for high-level jobs and play a key role in increasing the body of theoretical knowledge as well as its application to practical problems. The performance of the university determines the progress of mankind and has quite an impact on the economic, scientific, social and human development of nations. It is not accidental that the economically strong nations have a good higher education sector. To be globally competitive, higher education and knowledge are the key factors.

Unfortunately, some universities restrict their activities mainly to a close circle of professors and students from the upper class of society and carry out their activities in relative isolation. Such universities lose contact with the society and are unaware of the changing needs of the society. The true university mission can be achieved only if the university and society are organically linked together. The university has to place the needs of society at the centre of its activities. It can and should be a leader in creating a societal change. As such, the university can spearhead the move towards a change:

*“The goal of education is to make people wiser, more knowledgeable, better informed, ethical, responsible, critical and capable of continuing to learn...Education, in short, is humanity’s best hope and most effective means in the quest to achieve sustainable development” (UNESCO, 1997).*

A number of international education initiatives view education as a fundamental human right and stress the need to provide educational opportunities to everyone. One concept that touches upon all aspects of the society is that of sustainable development. The term “sustainable development” was first adopted by the World Conservation Strategy (IUCN, UNEP, WWF 1980) and later stressed by the Brundtland Report (WCED, 1987). The Brundtland Report defined sustainable development as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs”.

Higher education was quick to recognize the reality that humanity is adversely affecting the environment in unprecedented manner. Colleges and universities could not dissociate themselves from the looming problems. Their fundamental responsibility to teach, train and disseminate knowledge in various fields had to be re-oriented to include environmental sustainability. Responding to this urgent challenge, Jean Mayer, the president of Tufts University called for a conference attended by 22 universities in 1990 in Talloires, France. The conference issued the Talloires Declaration for sustainability which is the first official statement made by university presidents expressing commitment to environmental sustainability in higher education.

The Talloires Declaration (ULSF, 1990) is a ten-point action plan for embedding sustainability and environmental literacy in teaching, research, operations and outreach at colleges and universities. Three years later, the International Association of Universities (IAU) adopted Higher Education and Sustainable Development as one of its priority themes. IAU stressed the key role higher education could and should play in the overall process of achieving sustainable development:

“Leaders of higher education institutions and their academic colleagues are in a key position to contribute to an equitable and ecologically sound future by making sustainable development a central academic and organizational focus. This requires the generation and dissemination of knowledge through interdisciplinary research and teaching, policy-making, capacity-building, and technology transfer. It is critical that higher education institutions understand and accept their responsibility within the broader context of social and economic development, and the building of democratic, equitable and ecologically-minded societies.”(IAU 1993).

The loss of federal funds had an unexpected effect on environmental sustainability programs. Trying to absorb the impact of budget reduction, institutions of higher education added sustainability programs while cutting other “less lucrative” programs. These institutions recognized the rise in the demands of students and employers in sustainability-related educational programs. More students are expressing interest in sustainability-related programs and more employers are keen to hire recent graduates that have basic understanding of sustainability issues (Hanover 2011). Re-orienting academic programs received a further boost when the UNESCO implemented a Decade of Education for Sustainable Development in 2005. UNESCO called for integration of Education for Sustainable Development into curricula at all levels and all sectors of education worldwide (UNESCO 2005).

There is an abundance of literature covering attitudes and initiatives regarding Sustainability implementation in university curricula and the most common barriers that impedes implementation. Creighton (1998) examined the track record of universities regarding improving the environment. She outlined the major key ingredients in a successful environmental policy. Creighton argued that the green university of the future should be a responsible institution that uses natural resources wisely, reduces waste and pollution and takes measures to minimize the environmental impact of the waste it generates. Scot and Gough (2003) explored the policy of sustainable development, learning theory and practice as well as evaluation and future challenges. They argued that no sustainable development can be achieved when learning is absent. Learning is a long journey, yet, it is a powerful impetus of innovation and a key factor in sustainable development. The community can understand sustainable development through good schooling, higher education, professional training and development and proper communication. A recent report (Hanover 2011) reviews literature related to sustainability fostering in higher education institutions. It examines the prospects, obstacles, and projections for sustainability education within the current market and addresses student and employer priorities. Case studies, sustainability policies and campus greening are widely reported. The websites of Cambridge, Oxford, Cornell, UTS, Macquarie, Otaga and Singapore clearly articulate their policies on environmental sustainability and their attempts at implementing such policies. Birzeit University is yet to follow suit.

## **Sustainable environmental education at Birzeit University**

### **University profile**

Birzeit University was founded in 1924 as a small school. In 1972 plans were underway to develop a four-year program leading to bachelor's degrees in arts and sciences and to build a new campus on the outskirts of the town of Birzeit which is 24 Km north of Jerusalem. The University campus includes more than 20 buildings on 200 Acres serving 9250 students (7820 undergraduates in nine faculties and 2300 graduate students in the faculty of graduate studies). The percentage of female students gradually increased during the past few years: being 52.6% in 2005-2006 to 60.4% in 2010-2011.

Birzeit University employs 470 faculty members and 560 other staff members. It is a member Association of Arab Universities and a member of the International Association of Universities. In its stated mission, BZU endeavors to excel in higher education, scientific research, and service to the community. Since its establishment, the University has remained committed to providing equal learning opportunities to qualified individuals and to prepare students to become good citizens active in their society and committed to its advancement and well-being.

### **Statement of policy**

Examples of BZU awareness on sustainability are visible, yet its commitment to sustainability is not explicitly stated. There are implicit references in university documents referring to environmental sustainability; yet, the declared university mission lacks a direct reference to this issue.

### **Embedding environmental sustainability in academic programs**

Birzeit University established the Institute of Environmental and Water Studies (IEWS) to address the problems in water and environmental sectors in Palestine. IEWS replaced Water Studies Institute which was established in 2001. The newly established institute aims to provide knowledge, advisory services, graduate education (Master level), research and continuous education through short-term training in water and environment and related issues.

The Institute of Environmental and Water Studies offers two Master programs: Master in Water and Environmental Engineering and Master in Water and Environmental Sciences. The first program targets students with engineering background. It focuses on water supply and treatment as well as sewerage and wastewater treatment technologies. The second program targets non-engineering student mainly, of natural sciences and agriculture. This program concentrates on interdisciplinary water issues related to water quality, soil-water plant relations, instrumental techniques and pollution prevention.

The Institute has been heavily engaged in a number of activities related to environment sustainability. It organized a workshop on 29 May 2010 to develop “a strategic plan for the reform of environmental studies at the higher education system in Palestine”. This workshop is the third of a series of workshops within a project funded by the Tempus program. Other workshops organized by the institute cover the usage of pesticides in agriculture and public health. Through its extension unit, IEWS held training courses on integrated management of wastewater in the Mediterranean and training of trainers program in the environmental health field. The Institute regularly invites prominent guest speakers to deliver lectures on water and environment issues. It developed a strong cooperation with local universities such as An-Najah University in Nablus and Al-Quds University in Jerusalem as well as a long partnership with Delft in Netherland. The Institute of Environmental and Water Studies participated in the Fifth World Water Forum, Istanbul 15-22 March 2009.

Several departments incorporated courses on environment and sustainability within their discipline. Examples include Geography, Public Health, Civil Engineering, Mechanical Engineering, Architecture, Chemistry and Biology. The University offers around 45 courses that are directly related to sustainability and environment. Some departments (Mathematics, Physics, Humanities, etc.) are reluctant to embed environmental issues within their programs. According to faculty members in these departments, teaching and sustainability are seen as two completely unrelated ideas. While teaching should focus on the content of a subject and aim to ‘cover’ a syllabus, sustainability is something that has no bearing on their subjects. Some lecturers presented relevant examples of sustainability within the course syllabus to help students appreciate content of their discipline. A couple of departments (IWES and Civil Engineering) have adopted an integrated approach where sustainability is viewed as an essential component of the academic programs. Once BZU clearly states its commitment to sustainability, these departments would re-orient their programs accordingly.

## Research activities

It is important to consider the other educational activity of universities, namely, research. Academic inquiry and research can be a driving force for achieving a sustainable future. This

hardly needs stressing, as university research and scholarly activity can play a significant role in finding solutions to some critical social and environmental problems like poverty alleviation and pollution. Research can cross barriers and reinforce education for sustainable development whereas changes in the curriculum has its limitations since, in some departments, the curriculum is almost impermeable (Holmberg & Samuelsson 2006).

The mission of BZU clearly specifies the importance of scientific research. Research activities related to environmental sustainability at BZU are increasing. More faculty members and graduate students are engaged in this area. Such research activities were reported as articles in refereed journal, working papers, MA theses, reports, lectures and contribution to books. During the academic year 2008-2009, 23 graduate students were engaged in research related to environment and more than 20 articles were published in journals (Birzeit 2009).

In order to disseminate information and knowledge among water and wastewater professionals, the Institute of Environmental and Water Studies (IEWS) took the initiative to publish Birzeit Water Drops (BWD). Birzeit Water Drops is quarterly bulletin that includes excerpts from longer articles or documents, the Institutes' publications, main findings of the MSc thesis and important activities of the Institute (IEWS 2011).

The Center for Development Studies (CDS) publishes an annual report on Palestine Human Development. The center also publishes reports on other community-oriented projects. Of special interest are those reports related to empowering marginalized groups and integrating them in the development process. Examples include reports on human development and environment in Palestine, gender and human development in Palestine, human rights and sustainable development in Palestine, funding Palestinian development, education in Palestine: a Strategic Review and Palestinian Refugees: Where To? (CDS, 2011).

### **Faculty and student involvement**

In line with its declared mission, BZU sought to encourage its students to engage in local community service projects. Since 1972, every undergraduate student has been required to complete 120 hours of community service in order to fulfil graduation requirements, making community work an integral part of student's life at BZU. The activities of the program include: working with farmers during the harvest season, especially during the important olive-picking season, working at hospitals, schools, and nurseries; and working with women and local organizations. These activities are undertaken in many localities in the West Bank and the Gaza Strip. The program has been running for about four decades, and according to the university, it has had an extensive and positive impact on the community as well as the students. Faculty members are encouraged to participate in the program.

Realizing their vital role in preservation of the environment and contributing to environmental awareness in the society, BZU students established an environmental club. This club organized the activities of the Environment Day on 22 February 2011. The activities of the environment day included an exhibition on "re-use of plastic industries", and a series of scientific lectures. Guest lecturers covered several important topics: plastic recycling in Palestine, car tires and the environment, the safety of plastics, importance of sustainable development and the current status

of graduate studies in environmental topics.

### **Water, electricity and heating**

In view of the shortage in water supply in Palestine, BZU was one of the leading institutions to initiate pioneering projects in that sector. The University has been harvesting rain water from the surface and sub-surface drainage system and storing it to be used when needed (Figures 1 and 2). BZU erected a water treatment station (Figure 3) in 1980 to recycle all waste and sewage water from campus. The recycled water had been used to irrigate the trees on campus. It also served as a research site for the Institute of Environmental and Water Studies (IEWS).



**Figure 1: Football Field**

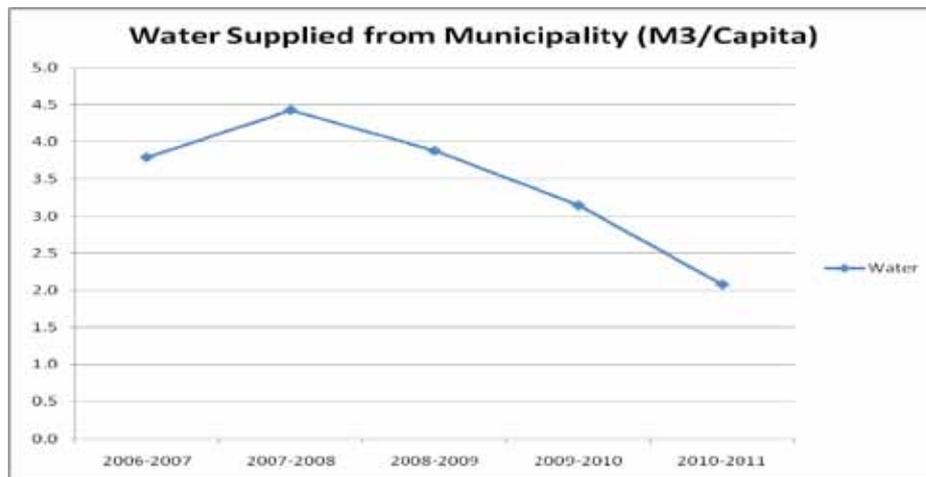


**Figure 2: Storage of Rain Water**



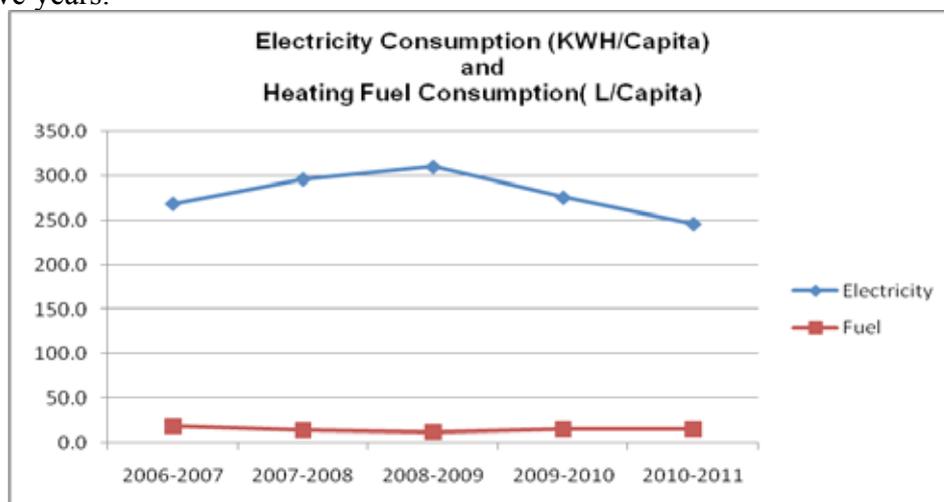
**Figure 3: Waste Water Treatment Station**

Measures to use water supply economically and wisely are constantly examined and reviewed. Such measures and the expanding use of stored rain water led to a net decrease in the amount of water supplied by Birzeit Municipality (Table 1, Figure 4).



**Figure 4: Water Supplied from Municipality**

The increasing consumption of electricity and heating fuel on BZU campus is alarming. (Table 1, Figure 5). The university adopted some key measures to cut that consumption. Ceiling fans are used instead of air conditioning, energy-saving light bulbs are installed, LCD screens are replacing old energy-consuming screens and desk top computers are being replaced by laptops. University employees are encouraged to depend on natural sun light instead of light bulbs whenever possible. Figure 5 below gives an indication of the change in electricity and heating fuel consumption over a period of five years.



**Figure 5: Electricity and Heating Fuel Consumption**

**Table 1: statistics on water, electricity and fuel consumption**

Year	2006-2007	2007-2008	2008-2009	2009-2010	2010-2011
Water(m <sup>3</sup> /capita)	3.8	4.4	3.9	3.1	2.1
Fuel (L/capita)	18.9	14.4	12.3	15.4	15.4
Electricity(kWh/capita)	268.8	296.5	310.6	275.7	246.0
Students	7,664	7,900	8,714	8,897	9,252
Employees	691	759	819	1,095	1,126
Students +Employees	8,355	8,659	9,533	9,992	10,378

## Campus greening

The Engineering offices at BZU established a gardening unit to plant new trees and preserve the thicket of cypress and pine trees on the hill top close to the new administration building. The gardening unit planted grass in some areas, nursed naturally growing bushes and cleared enough space to have fire lanes (Figure 6) within the Pine thicket. Fire lanes were constructed to protect the bushes from wildfire and may provide access for fire fighters and their vehicles if a fire should occur. On January 15<sup>th</sup> of each year, students and University employees work hand in hand to plant trees on campus grounds. The activities on that day “Tree Day” had an enormous effect on campus greening and increasing environmental awareness among students and university employees.



**Figure 6: Fire Lane**

## Community outreach

Birzeit University carries out its engagement with the community through the involvement of students in the community work program which is coordinated by the office of student affairs. This includes various activities organized by the student council and student organizations that were outlined earlier.

Birzeit University has an impressive record of sustained community involvement, from literacy programs and the promotion of primary and rural health care to media training, legal reform and civic education. The early stage of community engagement was initiated when the department of literacy and adult education was founded in 1976. The aim was to increase the level of literacy amongst rural women living in the West Bank and Gaza Strip and provide basic primary health care and health-related advice. Within several years, this department helped and supervised tens of literacy and adult education centers across the West Bank and Gaza. It provided textbooks for “adult students” and trainers. The department was later merged with the development studies center in an ambitious move to enhance sustainable development in Palestine. One of the most interesting projects was the production of a television series (Ya..Noon) that deals with life concepts from a development perspective and at the same time offers training in language skills. The television program could reach adults who otherwise could not join literacy centers. It also circumvented the

obstacle of limited resources necessary for wide-spread literacy centers.

The University believed it had a central role to play in identifying community's social, cultural, economical and political challenges. In response to the specific needs of the community, BZU thus widened the scope of its community related activities and established a number of research institutes and centers and community oriented programs. These units set out to develop several programs aiming at sustainable development in Palestine. They provided training, workshops, professional skills, offered consultancies conducted applied research in their specific fields. The Center for Continuing Education (CCE), which was founded in 1991, represents a good example of the community-service extension units of the University. Since its establishment, the CCE provided technical assistance, training in counseling and social work, gender and environmental issues. A good number of non-governmental organizations (NGOs) and over 6000 Palestinians have benefited from CCE various training/educational activities.

Two community-oriented units have specific interest in environmental sustainability; Institute of Environmental and Water Studies (IEWS) and Birzeit University Testing Laboratories Center. The scope of work carried out by IEWS was discussed earlier. The kind of service offered by Birzeit University Testing Laboratories Center is of special interest. This center is accredited by international and local agencies to conduct tests in areas such as pharmaceutical sciences, environmental toxicology, pesticides, food safety, water quality, environmental sciences, microbiology, applied chemistry and pharmacy.

### **National and international cooperation**

Birzeit University Testing Laboratories Center is engaged in cooperation with international and local institutions in research projects, in areas such as food safety, pharmaceutical quality control, water quality and protection of Palestinian environment, in programs such as "Safe Use of Pesticides" and olive oil quality, in campaigns on environmental awareness, and in a project on solid waste management.

The Institute of Environmental and Water Studies (IEWS) at BZU was particularly active in establishing international links and was involved in joint projects on the national and international levels. Ten -year partnership with UNESCO-and IHE-Delft focused on exchange of research results and dissemination of knowledge in water and environmental engineering. 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. The Netherlands government provided financial support for a number of joint projects such as PoWER, WASCAPAL, WASTIVAL, and SWITCH (Al-Sa'ed *et al.*, 2009).

IEWS is currently leading a project on "a strategic plan for the reform of environmental studies at the higher education system in Palestine", funded by the Tempus program. This project is to be implemented in coordination with IEWS strategic partners: AL-Quds University, An-Najah National University, Ministry of Education and Higher Education, National Technical University in Greece, the Royal Institute of Technology in Sweden, and the University of Loughborough in the United Kingdom.

## Discussion and analysis

Several key issues can be examined to assess the extent to which a university is committed to sustainability. Universities across USA, UK and Australia drew action plans followed by an evaluation process and had to re-think their missions and re-orient research activities and campus operations. The Association of University Leaders for a Sustainable Future (ULSF) designed an interesting sustainability assessment questionnaire to evaluate university sustainability (ULSF, 2009). This will be one of the tools employed to assess Birzeit University sustainability status.

BZU is yet to declare its commitment to environmental sustainability. University mission can be modified to include a statement showing such commitment. BZU should have a clear policy on sustainability stressing its function as a sustainable community that adopts responsible attitude towards consumption of water, energy and food. Environmental activists among faculty and students would like the University to sign the Talloires Declaration for Sustainability. The administration showed an initial positive response, but need to be encouraged to do so soon.

The environmental activists and the environmental club need to join forces and form an action group to draw the necessary plans to integrate sustainability into all aspects of university activities. At present, BZU does not have clear plans to embed sustainability in its operational procedures or decision making processes. Accurate and timely data on consumption of water, energy and heating fuel should be collected on a regular basis. These data should be freely available to BZU community. It took quite an effort to obtain these data since the reporting was not designed to serve environmental sustainability.

BZU attempts at embedding sustainability in the curriculum and research are humble. Departments that are hesitant at incorporating courses or topics on environment and sustainability within their disciplines should be encouraged to re-think. Sustainability is not woven into traditional disciplinary education in science, math, literature, history and business. It is quite easy and desirable to integrate sustainability in economics, business, science and law. An interesting and courageous step would be to include a course related to environmental sustainability as a requirement for all undergraduates. One must note, however, that research is gathering momentum. Several departments of the university are engaged in research related to solar energy, water supply, pollution, phytoremediation and electricity-saving devices. Some of the research topics are aligned with the measures taken by the Engineering office to cut energy consumption. Implementation of such measures is slow and the scope can be widened and improved. There are bright spots in the operations field: water recycling, collection of rain water, curtailing air conditioning, using lap tops instead of desk computers, adopting E-learning and electronic filing and cutting waste. These operations can serve as models to be observed and copied by the local community.

Faculty and students are just beginning to get involved and their involvement is expected to rise. There exists a successful activity of community work that is still very much alive. Environmental activists can help widen the scope of the well-established community work program to include sustainability. Integrating sustainability in this program would have a positive and desirable impact on the local community and encourage students and faculty to contribute to an environmentally healthy society.

The strong cooperation with local and international institutions is worth commending. Partnership with UNESCO-and IHE -Delft helped the university to focus on research and implement a capacity building program in environmental sustainability. Cooperation with local and European universities was enhanced by the financial support of Tempus. Now, a number of universities are cooperating in a project addressing the reform of environmental studies at the higher education system in Palestine.

## Conclusion

For the notion of sustainability to become deeply rooted at Birzeit University, the university needs to develop clear strategic focus, vision, and plan. It should increase cultural diversity and inclusivity in its programs. Birzeit University should build reputation and trust as a source of research-based educational institution and provide the highest quality professional development experiences for sustainability policies (NAAEE, 2010). The university should strengthen organizational capacity to operate a thriving enterprise as a model for financial and environmental sustainability.

It must grow its financial resources and build infrastructure and capacity to sustain success. Birzeit University can re-orient its course offerings, and send a clear message to its students and employees and the community regarding its commitment towards environmental sustainability. Birzeit University should have an institutional framework to draw an action plan that would turn it into a living laboratory. One possible course of action is to incorporate a sustainability objective into the University's strategic plan. This could be announced in a specially designed website for the University's environmental sustainability activities that has links to research, teaching and community. Birzeit pioneered Palestinian higher education and was instrumental in establishing the Higher Council of Education in Palestine. It strived to enhance coordination, planning and development of higher education in Palestine. Birzeit University has the capability and expertise to establish itself as a sustainability leader among Palestinian Universities. To be at the forefront of sustainability, it should adopt a clearly stated mission on sustainability. One step in that direction would be to sign the signed the Talloires Declaration of the University Leaders for a Sustainable Future. This can be followed by identifying distinct sustainability tasks implied within the context of a modified University mission.

Such tasks may include incorporating sustainability principles in teaching, research and other university activities. A task force would, then, plan clear directions and a framework for change. That ought to help allocation of resources and prioritize human and material resources. Once the directions and targets are adopted, cost effective measures can be implemented with regular monitoring and reporting.

Engaging the student council and the employees union is a necessary step to raise awareness of environmental sustainability. To practice what is preached, campus operations ought to be carried out in ways that are based upon sustainability criteria. It is also important to monitor the trends and quantities of water, electricity, fuel. Endorsing environmental sustainability entails reducing waste, recycling of paper, cardboard and plastics. Sustainability should be an integral part of courses, research, facilities and decision making. In short, demonstration of environmental sustainability in all university activities would serve as good example for the local community. Cooperation with local and international institution is a key factor in enhancing the reform process of higher

education. To be true to its commitment of preparing students to become good citizens who are active in their society, Birzeit University has to educate its students in multiple fields. Its students should be versed not only in technology but its social and environmental impact.

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# **Medical Solid Waste at Primary Healthcare Centers in Two Palestinian Governorates and their Remedial Measures**

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## ABSTRACT

There are many risks associated with healthcare waste and its management. The aim of this study is to investigate waste management practices in primary healthcare centers of Nablus and Salfit districts in Palestine. A random sample of 190 (61.3%) out of 310 medical staff and paramedical personnel was interviewed and the current situation of healthcare waste management was determined through field investigation. The mean daily quantity of total solid waste generation per healthcare center was found to be 3.7 kg. Sharp objects were always generated in 82.4% of the centers, while radio-active waste was always generated in 15.4% of them. Regarding sharp waste, 66.3% of the respondents mentioned that it was disposed off in public containers. These results indicate that the management of waste materials in primary healthcare centers in the study area faced many problems. Staff awareness and training, separation of healthcare solid waste, establishment of healthcare solid waste treatment method are the major measures that are suggested for improvement of the waste management practices.

**Keywords:** Medical waste, medical waste management, regulations, primary healthcare centers, West Bank, Palestine.

## Introduction

There are some characteristics that make medical solid wastes (MSWs) hazardous which are infectiousness, toxicity, radioactivity, chemical reactivity, and sharpness of the edges (Tsakona *et al.* 2007). Proper and safe management of medical waste is necessary, to avoid problems of environment and public health, particularly regarding the transmission of infectious diseases, such as typhoid, acquired immunodeficiency syndrome (AIDS), cholera, and viral hepatitis B (Mato & Kassenga 1997, Nemathaga *et al.* 2008). Therefore, producers of MSW should include proper planning for waste management and risk reduction, taking into account the total cost for such an action (Mohee 2005, Abdulla *et al.* 2008, Shinee *et al.* 2008, Mohamed *et al.* 2009, Sawalem *et al.* 2009).

Segregation is the most important step in MSW management, the presence of hazardous medical waste with non-hazardous medical waste presents a threat to those managing wastes further along in the disposal chain (Ozbek & Sanin 2004, Mahnik & Horinek 2008, Graikos *et al.*, 2010). MSWs consist primarily of infectious, pathological, pharmaceutical, and sharps that have been contaminated with infectious agents, blood, organs, chemical, tissues, and general domestic wastes (Abd El-Salam 2010, Alagoz & Kocasoy 2008). MSWs may cause environmental nuisance due to stinking odour, flies, rodents, cockroaches, and vermin as well as contamination of ground water by untreated medical waste in randomly dumping sites and landfills (Nemathaga *et al.* 2008).

There are different good technologies used for MSW treatment and disposal with minimal risks to human health and the environment as well (Tudor *et al.* 2005, Silva *et al.* 2005, Nemathaga *et al.* 2008). Generally, there are many treatment methods and disposal practices for MSWs including landfilling, autoclaving, incineration, and recycling are used in combination. Each practice has its own advantages and disadvantages (Nemathaga *et al.* 2008). However, in developing countries,

MSWs have not received adequate concern. In many countries, hazardous and medical wastes are not segregated and still managed together with domestic wastes, thus creating a great health risk to workers inside healthcare facilities and municipal workers, the public, and the environment outside healthcare facilities (Silva *et al.* 2005, Alagoz & Kocasoy 2008, Alam *et al.* 2008, Bdour *et al.* 2007, Enkhtsetseg *et al.* 2008 ). In other developing countries, waste disposal options are limited, and incineration and open burning have been used as a solution.

The management of MSWs in the Palestinian Territories have extremely deteriorated since the outbreak of the second Palestinian uprising (Intifada) in 2000. This is partially due to the closure and segregation of the Palestinian localities as well as the closure of the main roads leading to the existing dumping sites by Israeli roadblocks and checkpoints (Al-khatib *et al.* 2009).

The primary healthcare centers (PHCs) are numerous and distributed throughout almost all localities in the Palestinian territory. The main services provided by the PHCs in the Palestinian territory include the reproductive health, medical care of children, school health services, programs for health education and environmental health services. The PHCs offer treatment services for cases of minor illnesses and general medicine, in addition to the follow-up of chronic patients through clinics (Al-Khatib & Othman 2006).

Most of the PHCs do not use a particular management system, but their MSWs pass through the municipal solid waste collection and are disposed of in randomly dumping sites or sanitary landfills. For the purposes of the recent study, the hazardous waste was considered any waste material that came in contact with blood and other potentially infectious body fluids. Therefore, the hazardous waste category includes both the truly hazardous and the potentially hazardous waste materials. The objective was thought to undertake the study to: (i) assess the human factor in handling and treatment of clinical waste( i.e., to study the existing approach and its compliance with the WHO standard procedures of the medical waste management rules) and (ii) quantitatively determine the amount of non-hazardous and hazardous waste in PHCs in two Palestinian governorates and (iii) to recommend a course of action for the proper waste management system for the large number of PHCs spread all over the Palestinian territory.

Nablus Governorate is one of the largest governorates in the West Bank of Palestine, while Salfit governorate is one of the smallest ones. Both governorates are located in the Northern part of West Bank of Palestine.

## **Materials and methods**

### **Medical waste management practices**

The study population consisted of all medical staff and paramedical personnel working in the PHCs in Nablus and Salfit Governorates in the northern West Bank. A random sample of 190 (61.3%) out of 310 medical staff and paramedical personnel were interviewed. The main tool used in data collection was a structured questionnaire that was designed specifically for the purpose of this study. The questionnaire aimed to collect information about medical staff and paramedical personnel's socio-economic characteristics, attitudes towards MSWs, MSWs management knowledge and behaviors such as MSWs segregation, presence of regulations and guidelines,

availability of necessary accessories, temporary storage, treatment, off-site transportation, final disposal, and occupational health and safety of all personnel working in the PHCs. After the questionnaire was pre-tested, it was administered to the respondents in the local language, which is Arabic. Pre-testing of the survey was conducted with an expert evaluator from Birzeit University. Responses were coded for statistical analysis. The interviews were conducted during May and June 2010. Analysis of data was performed by the use of Statistical Package for Social Sciences (SPSS) computer program version 16.0. Descriptive statistics such as means and ranges were computed. Appropriate test of significance (chi-square) was performed to determine the statistically significant relationships between the different variables.

Ethical considerations were taken into account while conducting this research that included taking the permission of the persons who were surveyed; there was an important consideration for the objectivity vs. subjectivity in this research. The field work team maintained their own views for themselves without having any effect on the answers of the surveyed persons. The findings were kept anonymous and the surveyed persons have known that.

## **Collection and separation of medical waste**

A collection program of five consecutive days was implemented for 20 PHCs in Nablus and Salfit governorates. The objective of this was to identify the main waste components (hazardous and non-hazardous) and assess their respective quantities. Waste collection and segregation took place for five consecutive days (most of PHCs in the study area as well as in other Palestinian governorates work only 5 days per week) during May and June 2010.

Collection or bag containers were placed at convenient positions in each primary healthcare center from the previous day. Facility personnel were supervised to ensure that the waste was collected in the correct container or bag. Containers and bags were collected and weighed by the end of the working day. It should be mentioned that during a collection day, the total amount of waste produced was collected, separated and weighed. Weights were recorded in computerized spreadsheets (Microsoft Excel). Medical waste production rates from PHCs are expressed as  $\text{kg d}^{-1}$  (per center) and  $\text{g patient}^{-1} \text{d}^{-1}$ . Due to its small generated values, the separated solid waste components were classified in the following two waste categories: (1) Hazardous MSWs and (2) non-hazardous MSWs.

## **Results and discussion**

### **MSW management**

#### **Types of MSW generated at PHCs**

At PHCs, different medical activities that generate different types of MSWs are practiced. Table 1 shows the percentage distribution of the frequency of MSWs generation according to their types. High percentage (75.7%) of the respondents reported that infectious waste is generated always or sometimes at the PHCs in Nablus and Salfit governorates. Sharp wastes are produced more frequently than other types of wastes as 94.7% of the respondents reported that sharp wastes are generated always or sometimes at PHCs. That is because PHCs vaccinate children against communicable

diseases and as a result of the large number of vaccinations carried out daily, a large quantity of needles and syringes are used at PHCs. Other types of MSWs such as pathological, pharmaceutical, radio-active and heavy metal waste are generated with lower percentages.

**Table 1: Percentage distribution of the frequency of MSWs generation according to their types at PHCs in Nablus and Salfit governorates**

Types of MSWs	Frequency of generation (%)		
	Always	Sometimes	Not generated
Infectious waste	36.8	38.9	24.2
Pathological waste	8.5	16.4	75.1
Sharp waste	82.4	12.3	5.3
Pharmaceutical waste	25.9	42.3	31.7
Radio-Active waste	15.4	18.1	66.5
Heavy metal waste	14.8	28.0	57.1

## Separation, packaging and labelling

Table 2 summarizes the presence of accessories necessary for MSWs separation at PHCs and separation practices and attitudes. Most of the respondents (89.5%) mentioned that sharp boxes are always available at the PHCs, while only 73.6% of them mentioned that sharp objects are always separated and put into the sharp boxes. 60.8% of the respondents mentioned that they always separate non-sharp MSWs including, mainly, infectious, pathological, pharmaceutical and chemical wastes to their different components, and 16.9% of them mentioned that they do not separate MSWs. That means the separation practices were performed in an incomplete way in some of the PHCs, so that a portion of the hazardous MSWs was mixed with general waste materials.

Only 38.4% of the respondents mentioned that yellow plastic bags are always available for MSW separation. From field observations, PHCs normally use ordinary black plastic bags which are against the instructions of WHO for separation, and they were used for the packaging of hazardous waste and they were not labeled. The international sign of infectious waste was available only on most of the sharp boxes, but not been marked on the containers of hazardous MSWs containers. In PHCs where separation of MSWs existed, all non-sharp hazardous wastes are collected in one container.

**Table 2: Percentage distribution of respondents regarding MSWs separation**

Question	Answers (%)		
	Always	Sometimes	No
Are sharp boxes available?	89.5	8.9	1.6
Are yellow plastic bags available?	38.4	6.8	54.7
Is there any control on MSW separation?	50.3	32.8	16.4
Do you separate non-sharp MSW to its different components?	60.8	22.2	16.9
Are you ready to separate MSW if necessary accessories are provided?	92.5	-	7.5
Is sharp waste placed in special containers?	73.6	6.6	19.8

## On-site collection, transport, and provisional storage

A temporary storage place should be available within the PHC in order to avoid an accumulation of solid waste at the points of generation. Only 38.3% of the respondents reported that there was a special storage place at the PHC where they work, while 61.7% reported that there was no special storage place. Only 51.1% of the respondents that mentioned the presence of the storage place reported that the dedicated storage location was set up in a place which was not near the access routes of patients. From the field observations, it was noticed that isolated compartments were not provided for the storage location of general and hazardous solid waste due to the lack of space available in most of the PHCs and due to the lack of experience and legislation regarding MSW management. It is important that if waste has to be stored before treatment, it should be placed in adequate, accessible only to authorized personnel, properly labeled packaging, and deposited in an area intended for that purpose only. Such space should be out of the reach of staff and patients and properly marked, and the storage time for hazardous waste is limited (Marinkovic *et al.* 2008).

The study found that 40.1% of the respondents reported that the transfer MSWs outside the healthcare center was done always on a daily basis, 29.9% of them mentioned that it was disposed sometimes on daily basis, and 30% of them mentioned that it was not disposed on daily basis.

Most of the respondents (94.4%) mentioned that hazardous non-sharp MSWs were disposed off in public containers specified for domestic waste, while 5.6% mentioned that hazardous non-sharp MSW were burnt. Regarding sharp wastes, 66.3% of the respondents mentioned that it were disposed off in public containers, while 22.7% of them mentioned that sharp wastes were sent to the health directorate of the governorate, and 11.0% of them mentioned that sharp wastes were burnt. It is well known those public containers are accessible to unauthorized personnel and scavengers.

Regarding the treatment of hazardous MSWs, 40.4% of the respondents mentioned that MSWs were always treated, 16.4% mentioned that MSWs were sometimes treated, while 43.1% mentioned that they were not treated. This situation is inappropriate and threatens public health and the environment, which is worse than some developing countries. For example in a study conducted in Iran, it is found that in all of the primary healthcare centers, sharp objects were separated almost completely, but separation of other types of hazardous healthcare solid waste was only done in 25% of the centers. The separated hazardous solid waste materials were treated by open burning, incineration and temporary incineration and methods in 42.5, 8.3 and 32.5% of the healthcare centers, respectively. In 16.7% of the centers the hazardous solid wastes were disposed of without any treatment.

When they were asked about the commitment of cleaning personnel with the safety measures including the personal protection equipment such as gloves, overalls, boots and masks, only 25% of the interviewees reported that cleaning personnel always commit to safety measures, while 23.3% mentioned that the cleaning personnel sometimes commit to safety measures, while 51.7% mentioned that the cleaning personnel do not commit to safety measures as shown in Table 3. It is worth mentioning that the highest percentage of cleaning workers who commit to professional

safety measures was in the PHCs located in the refugee camps, while the lowest percentage was in the PHCs located in the villages as shown in Table 3.

Due to the weakness of the commitment of the cleaning personnel to safety measure, almost all the medical and paramedical staff (98.9%) emphasized the necessity for training and awareness of cleaners on how to deal with medical wastes safely.

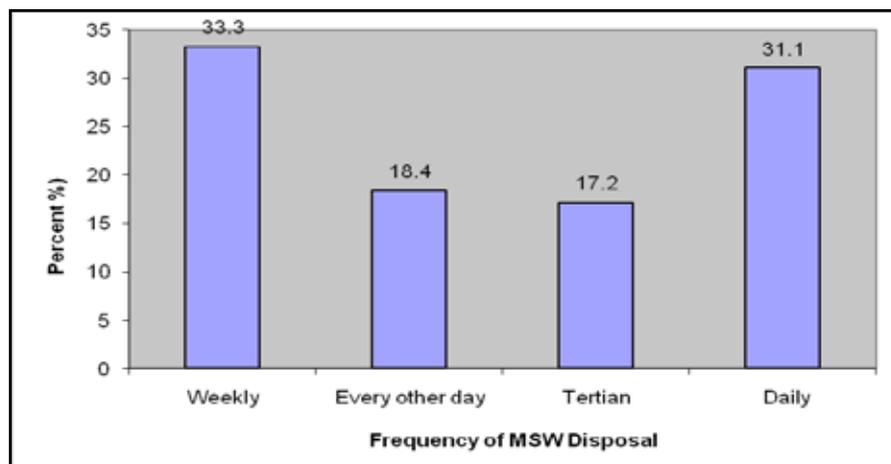
**Table 3: Percentage distribution of respondents regarding commitment of cleaning workers to professional safety measures**

Location	Do cleaning workers commit to professional safety measures?			
	Always	Sometimes	No	Total
City	20.9%	31.9%	47.3%	100.0%
Village	29.3%	6.9%	63.8%	100.0%
Refugee camp	29.0%	29.0%	41.9%	100.0%
Total	25.0%	23.3%	51.7%	100.0%

(Chi-square = 13.801, df = 4, p-value = 0.008)

### Off-site transportation

Regarding the off-site transportation frequency of medical waste, 33.3% and 31.1% of interviewees reported that it was once weekly and on daily basis respectively as shown in Figure 3. This means that the time of MSW storage in the municipal storage containers was more than that allowed due to the climate conditions in most of the centers during most of the year.



**Figure 1: Frequency of solid waste collection in the PHCs of Nablus and Salfit Governorates**

Most of the MSW are disposed off in public containers specified for domestic solid waste. Off-site transportation of general domestic waste is the responsibility of municipalities and village councils, but hazardous MSW should be transferred by producers which is not the situation in most of primary healthcare centers in the study area as it is not segregated.

## Training

Training programs about MSW management for nurses, doctors, technicians, and cleaning personnel were limited. This was clear when most of the medical staff and paramedical personnel (92.5%) emphasized that training on medical waste management issues is very important for all of them, while only 7.5% of them mentioned that it is not important. In addition, almost all medical staff and paramedical personnel (98.9%) emphasized the importance of training the cleaning personnel on MSW management issues; while only 1.1% of them mentioned that it is not necessary.

It is worth mentioning that any policy of MSW management cannot be effective unless it is applied carefully and on continuous bases. Thus, the training of healthcare personnel on the implementation of this policy is critical to the success of waste management program. The overall objective of the training is to develop awareness in the field of health issues, safety and environment on health care waste, and how their impact on the workers during their daily work. The training programs should highlight the functions and responsibilities of healthcare personnel in the administration program as a whole.

Health and safety in the workplace and environmental awareness is the responsibility of and the interest of all stakeholders. Training must include all the PHC staff: doctors, nurses and assistant nurses, medical lab technicians and cleaners. They should be convinced of the need for a comprehensive policy for the MSW management and the importance of training for that, and their value to the health and safety. This will ensure their cooperation in the implementation of such a policy (WHO 2006). There is lack of training among workers in healthcare facilities in many developing countries. For example, in a study conducted in the hospitals of El-Beheira Governorate, Egypt, it was found that training programs about MSW for medical staff and paramedical personnel were limited; about 37.5% of the hospitals had not provided training to doctors and other personnel about MSW and their potential hazards. About half of hospitals provided limited training for support staff, e.g., cleaning workers. The majority of hospitals (87.5%) preferred attending annual training (Abd El-Salam 2010). Similar results were also obtained from a survey of several healthcare facilities in 12 countries in Asia which revealed that the health-care personnel at these facilities are in need for training in the handling, transport, treatment, or disposal of medical wastes (Ananth *et al.* 2010).

## Quantity of waste generation

The optimal solution for MSW management resulting from the primary health care centers depends on the amount of wastes generated, and the opportunities available for the transfer of MSWs to the treatment plant nearby. The first step is therefore to determine the quantities of waste generated from the PHCs (WHO 2005). There are many factors affecting the MSWs generation in a primary healthcare center which are mainly: number of patients per day, the medical services supplied, and the number of healthcare personnel. The generation rate of MSW in PHCs is also influenced by many factors such as the economic, social, and cultural properties of the community such as consumption patterns and lifestyle. In this study, the rate of MSW production was calculated per number of patients (Prüss *et al.* 1999, Oweis *et al.* 2005), and per primary healthcare center.

Table 4 presents the quantity of hazardous, nonhazardous and total MSW generation in the primary healthcare centers in Nablus and Salfit governorates. As shown in Table 4, the mean and standard deviation of hazardous MSW generation per primary healthcare center were 1.5 and 0.7 kg day<sup>-1</sup> respectively. With regard to the fact that the coefficient of variation was very high (46.7%), the median parameter of 1.0 kg day<sup>-1</sup> was a better indicator to define the quantity of hazardous MSW production. Regarding the nonhazardous MSW, the mean and standard deviation were 2.2 and 0.8 kg day<sup>-1</sup> respectively, and the coefficient of variation was 36.4%. For the total MSWs, the mean and standard deviation were 3.7 and 2.1 kg day<sup>-1</sup> respectively.

The results of our study are consistent with the results of a study conducted in PHCs in Iran (Mesdaghinia *et al.* 2009), in which it was found that the mean and standard deviation of total MSW waste generation per primary healthcare center were 3.8 and 2.5 kg day<sup>-1</sup>, respectively.

**Table 4: Quantity of MSW generation in the PHC in Nablus and Salfit governorates**

Parameter	Hazardous MSW generation		Nonhazardous MSW generation		Total MSW generation	
	(kg day <sup>-1</sup> )	(g outpatient <sup>-1</sup> day <sup>-1</sup> )	(kg day <sup>-1</sup> )	(g outpatient <sup>-1</sup> day <sup>-1</sup> )	(kg day <sup>-1</sup> )	(g outpatient <sup>-1</sup> day <sup>-1</sup> )
Mean	1.5	34	2.2	55	3.7	89
Standard deviation	0.7	33	0.8	22	2.1	42
Fifth percentile	0.6	15	0.9	26	1.7	44
Ninety-fifth percentile	2.5	47	1.1	69	5.7	171
Coefficient of variation (%)	46.7	97.1	36.4	40.0	56.8	47.2
Median	1.0	26	2.1	54	3.1	81
Maximum	8.6	168	3.9	125	11.3	221
Minimum	0.5	13	0.6	21	1.2	35
Range	8.1	155	3.3	104	10.1	186

According to Table 4, the mean and standard deviation of total MSW production per patient were calculated as 89 and 42 g patient<sup>-1</sup> day<sup>-1</sup>, respectively. These values were higher than those generated in the primary healthcare centers in Iran, which were 63 and 27 respectively (Mesdaghinia *et al.* 2009). As the coefficient of variation of 47.2% was relatively high, the median of 81 g outpatient<sup>-1</sup> day<sup>-1</sup> could be a better indicator to state the per capita solid waste generation. This might be explained by the differences in the factors listed above (number of patients per day, the medical services supplied, and the number of healthcare personnel).

## Conclusions and recommendations

Waste from PHCs as well as other healthcare centers poses a risk for the cleaning personnel who handle these wastes, environmental health, and patients. MSW is hazardous and infectious, and requires specific treatment and management prior to its final disposal. PHCs in Nablus and Salfit governorates do not have sufficient safety prevention and comprehensive MSW management programs. As a result, many things can be put at risk and lost, including the surrounding environment and human life. Therefore, PHCs should prevent these incidents by using a comprehensive and extensive MSW management program. For example, the survey revealed that separation of different types of waste was not done according to the WHO guidelines and rules. High percentage of hazardous MSW was disposed of along with domestic waste and no supervision was performed in this matter. Some PHCs used resistant plastic bags and plastic containers for infectious waste while others used ordinary black plastic bags. High percentage of PHCs used resistant disposable plastic containers for sharp waste. After defining some faults of MSW management programs, it was found that these are often caused by a lack of knowledge level and safety practices of cleaning personnel about PHCs waste. Some of the PHCs participant staff in Nablus and Salfit Governorates do not concern themselves with the rules for the safe handling, storage, transport and disposal of PHCs waste. Therefore, the setting up of a waste separation system into three categories is a measure of high priority. In this system, MSW should be separated into three categories: (1) general waste (2) sharp objects, and (3) other hazardous waste materials (excluding radioactive and anatomical waste).

For this reason, an interested party such as the Environment Quality Authority in coordination with other related authorities and parties should establish laws or regulations followed by action plans using this research as a guideline for resolving the problems with comprehensive MSW management programs in Palestine. An interested party who can take action should use the WHO or the National Institute for Occupational Safety and Health (NIOSH) safety standard programs as guidelines to improve Palestinian PHCs waste management programs.

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# **Environmental Awareness among School-Age Children in Gaza – Palestine**

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## ABSTRACT

There is an important link between environmental science education and environmental awareness and attitude. The purpose of this study is to determine the level of environmental awareness and attitude among male and female students of class 9 in Gaza city and to investigate the relation between environmental awareness and attitude. The researchers constructed a questionnaire composed to measure both the environmental awareness and attitude. The questionnaire was completed by 400 students from eight governmental high basic schools selected in a stratified random way. SPSS (Statistical Package for Social Science) software version 13 was used to process and analyze the data. The results indicated that the students have a moderate level of environmental awareness (70.2%) and their positive attitude toward the environment was low (64.33%). Males have a significantly higher environmental awareness than females, while females have shown more positive attitude toward environment than males. The results show that there is a positive significant relationship between environmental awareness and attitude among the study population. Therefore, the findings of this study are useful to accentuate the importance of enriching our students' background in environmental knowledge and awareness, with equal opportunity for both males and females students.

**Keywords:** Environmental Awareness, Attitude, School-Age Children, Gaza – Palestine.

## Introduction

Environment has become one of the hot topics for discussion these days among most sectors of society, ranging from the level of primary classes, to the highest academic institutions. In recent decades, many studies have reported the general deterioration of environmental conditions (Nunez, 2000). Escalating environmental degradation includes deforestation, desertification, loss of biodiversity, ozone depletion, global climate change, pollution and over consumption of natural resources which directly impact our ability to develop economically while at the same time sustaining the health of people as well as plants and animals (Kibert 2000; Vadala,2004). Along with exponential population growth, these problems are especially significant in developing countries (Vadala, 2004). Our Palestinian environment is facing serious threats, such as: alarming population growth, limited land resources, long term isolation as a result of the regional political circumstances and the underdeveloped environmental protection system which caused serious deterioration, fast depletion and contamination of our environmental resources that, in its turn, lead to health risk among citizens (UNEP, 2003).

In order to ensure that our common future will be ecologically, socially and economically sustainable, the commitment to raise public environmental awareness was renewed in 1992 at the Earth Summit in Rio de Janeiro and is manifested in chapter 36 of Agenda 21 (Sheila, 2004). Since this conference, the theme of environmental education has shifted from ecological studies to an integration of social, economic and environmental studies and the importance of lifestyle became some of the main tasks concerning environmental education (Sheila, 2004).

According to Abu Safieh (2006), environmental awareness and education are important means for

preserving and protecting the environment, based on adjusting attitude and supporting positive behaviors toward the environment. She claims that the environment is a major source of living for Palestinians. Furthermore, it is important to highlight that the environmental damage already inflicted cannot be reversed unless there is a collective thinking and efforts are made by coordination between different institutions concerned by the environmental health protection. It is only possible through environmental education and adoption of environmental ethics. On the other hand, in view of the needs of the present and future generations; education at schools, colleges and at the various society levels is imperative. Moreover, public awareness and community participation can help achieve a change in attitude preventing further damage to the environment.

Based on this background, efforts were made in order to create awareness program among school children, mobilize them towards environmental issues and create an understanding about degradation and pollution of our environment and its associated impact on the health. The Ministry of Education conducted the first Palestinian environmental health curriculum for males only in the high basic school in Gaza Strip and West bank, starting with class 7 in the year of 2001– 2002, then in the next year applied part two of this curriculum on class 8, followed by third part on class 9, and finally part four of environmental health curriculum applied to students of class 10 in the academic year of 2004 – 2005.

## **Simulation and experiment**

A quantitative analytical descriptive method was used in this study to describe the present states of the level of environmental awareness among school age children in Gaza. According to Gaza municipality, Gaza city is distributed into four areas, popular area, agricultural area, residential area and new suburb area. The researchers selected randomly eight governmental high basic schools from these four areas, two governmental high basic schools were selected from each area , one for males and the other for females. From each area, one hundred students were selected, fifty students from school for male and fifty students from school for female. One class grade nine was selected randomly with 50 students from each school to avoid any disturbance for many classes in the same school during data collection.

A questionnaire in Arabic was designed to accomplish the objective of this research to investigate the students' environmental awareness and attitudes in respect to their relationship with gender, area of residence, grade of student scores achievement at school variables. This design of questionnaire was based on previously reviewed researches about education and how to measure the level of environmental awareness and attitude. The researchers concentrated on the variety of questions included in the questionnaire about different environmental issues which implies in the environmental health curriculum. Also, the researchers obtained different questionnaires form which was conducted in local and national countries, then adopted suitable questions and included it in the study questionnaire. The questionnaire consists of 54 questions divided in two sections. Group of environmental experts checked it to insure its validity.

SPSS (Statistical Package for Social Science) software version 13 was used to process the data. Mean, standard deviation, independent T-Test, and percentage was used. One – way ANOVA analysis test was used to explore if the level of environmental awareness and attitudes among the students in different areas of living.

## Discussion and result analysis

### 1. Level of environmental awareness

What is the level of environmental awareness among students of class nine in the governmental high basic school age children in Gaza, Palestine? To answer this question, descriptive statistics including measures mean, standard deviation and percentage were developed to show the current level of environmental awareness of these students.

**Table 1: the level of environmental awareness among high basic school children, according to their gender**

Item	sex of child	N	Mean	Std. Deviation	%
Environmental Awareness Score	Male	200	17.36	3.799	72.34
	Female	200	16.34	3.691	68.1
	Total	400	16.85	3.775	70.2
t- value = 2.72, P= 0.007					

The first part of questionnaire contained 24 questions on environmental awareness. For each correct answer, 1 mark was awarded and no marks were awarded or deducted for wrong answer. As shown in table 1, out of the 24 points reflecting the level of environmental awareness among school children, the mean of the score was 16.85 with standard deviation of 3.77 and percentage of 70.2%. These results indicate that the level of environmental awareness among the governmental high basic schools children of class nine in Gaza city was generally moderate. This finding agree with local study of Dadah (2002), which was conducted in Ramallah and El Bireh Governorate in West bank, and the results revealed that environmental awareness of the students appear to fall into the moderate range based on the survey results. Similar results were found with several studies in different countries which reported generally moderate level of students' environmental awareness, (Geok Chin *et al.*, 1998; Hsu and Roth, 1996). However, the finding was in contrast to the local study of Abu Jahjoh (1999), where results revealed that the level of grade nine students' knowledge about environmental value was about 66.9% only which can be considered as low level.

Also, in local study of Affifi (2000) which was conducted on the 400 sixth grade students in Rafah governorate and showed lowering of environmental enlightenment level of the students (65.3%) than accepted standard of the established study which is 80%. In addition, the study results disagree with the study on the Arab Community in Israel which reported that the level of environmental awareness about different environmental issues among students of academic institution for preparing Arab teachers and students of grade nine of the elementary school was very low (Naser and Naser, 2000). Another findings was in contrast to this study finding across different countries, Oman Sultanate (Salmi and Mekhlafy, 2003); Hong Kong (Sheila, 2004); Iran (Ehrampoush and Moghadam, 2005). This variation can be explained due to differences in cultures and environmental educational material which applied in their schools curriculum.

## 2. Level of environmental awareness and gender

As shown in table 1, the mean of environmental awareness among males was 17.36, with percentage of 72.34%, while it was among females 16.34, with percentage of 68.1%, which mean that the level of environmental awareness among males of the governmental high basic school children of class nine in Gaza city was higher than of females. Independent - Sample t-test was used and there was statistical significant differences in the level of environmental awareness among student of class nine in the governmental high basic school age children in Gaza city attributed to their gender towards male ( $P=0.007$ ). This result may be explained by that the environmental health curriculum was conducted on males students only of the governmental high basic school in three classes of this stage (7, 8, 9 class), while it wasn't conducted on female students of the same stage up to the date of the study implementation. So, whether there was another source of environmental issues such as, television, radio, informal programs, and males have more opportunity to develop their knowledge by learning more about the different environmental issues through formal education, which lead them to demonstrate a greater knowledge and awareness of the facts about environment more than females.

Similar results which emphasized the enhanced awareness of males compared to females were obtained in the local study of Mohsen (2003) which revealed a significant difference between males and females acquirement of environmental concepts. Another study of Kibert (2000) suggested that, male students did have a significantly higher mean knowledge score than female. Also, this finding is consistent with Moghadam and Ehrampoush, (2005), Gambro and Switzky (1999). However, this finding is different from local studies of Abu Jahjoh (1999) and Affifi (2000) which found that the students proved that gender has some significant statistical differences on the level of environmental enlightenment towards females who have got higher scores than males. Also, the finding of this study is different from Salmi and Mekhlafy (2003) and Sheila (2004) which indicated a significant difference in level of environmental knowledge by gender, with female students were more likely to have higher environmental knowledge than male students. Szagun and Pavlov (1995) in their study examined awareness among German and Russian adolescents. Results revealed that females of both nationalities had higher level of environmental awareness than did males. From the other side, there was many studies reported that there was no statistical differences in the level of environmental awareness by gender, such as the finding of Naser and Naser (2000), Dadah (2002), Kazy (1988), Nunez (2000) and Zimmerman (1996).

## 3. Level of environmental awareness and type of area

According to Gaza municipality, Gaza city is distributed into four areas, popular area, agricultural area, residential area and recent area. Eight governmental high basic schools were selected from these four areas, from each area two governmental high basic schools of class nine students were selected, one for males and the other for females. The selection considered equal number of males and females accordingly. Mean, standard deviation, percentage, and one – way ANOVA analysis test was used to explore if the level of environmental awareness among the students of class nine in the governmental high basic school children in Gaza differ due to the type of area.

As shown in table 2, the results reflect difference in the mean of the level of environmental awareness among school children according to the area, the mean of the level of environmental awareness among school children in the resident area was 19 and it was the highest among other areas of the study population, while the lowest mean was of agricultural area which reach 15.30, the second rank in the level of environmental awareness among these areas was of popular area which it's mean reached 17.2, and the third rank was of recent area which it's mean of the level of environmental awareness was 15.98.

**Table 2: the level of environmental awareness among high basic school children according to their residential area**

type of area	N	Mean	Std. Deviation	Rank
resident area	100	19.00	2.035	1
popular area	100	17.12	4.053	2
recent area	100	15.98	3.808	3
Agricultural area	100	15.30	3.799	4
<b>Total</b>	400	16.85	3.775	
F= 21.153			P< 0.001	

The results indicated that there was a statistical significant difference in the level of environmental awareness among school children due to the type of area ( $P < 0.001$ ). This finding can be explained by Van Liere and Dunlap (1980) who reported in their study that five major factors affect environmental awareness among different societies, which include age, gender, place of residence, political beliefs, and social level. Research comparing children from areas of varying socioeconomic status showed that participants' income was positively related to global environmental knowledge, as environmental awareness decreased in poorer neighborhoods, possibly because children had fewer opportunities to safely access natural resources (Arcury and Christianson's, 1993; McDaniel & Alley, 2005; Barraza & Cuaron, 2004; Bullard, 2006). With little chance for positive reinforcement of ecological concepts and ideas, children from low-income neighborhoods may be less inclined to change their perspective on environmental issues (Fisman, 2005).

Similar results were obtained in Salmi and Mekhlafy (2003) study on 3517 students from different 5 educational areas in Oman Sultanate, its results revealed that there was a statistical significance difference in the level of environmental awareness according to the type of educational area. However, the finding was in contrast to a local study of Affifi (2001) which reported that there was no statistical significance difference related to the place of residency (camp, town) throughout Rafah governorate in the environmental enlightenment level. Also, study of Dadah (2002) which was conducted in the Ramallah and El Bireh governorate, and the researcher in her study find out that there was no tistical significant difference in the environmental awareness among students based on their residential location. Another contrast finding was in Mexico Country, (Zimmerman, 1996).

## Level of environmental attitude

In this part, the researchers tried to assess the level of attitude toward environment of the grade nine students in the governmental high basic school children in Gaza city. To achieve this objective, descriptive statistics including measures mean, standard deviation and percentage were developed to show the current level of environmental attitude of these students. The second part of questionnaire contained 30 questions to reflect environmental attitude among the students of the study population. For each the answer which reflect positive attitude toward environment, 2 marks was awarded and 1 mark were awarded for the answer reflecting negative attitude toward environment. As shown in table 3, out of the 30 points reflecting the level of environmental attitude among school children, the mean of the scores was 19.30 with standard deviation of 5.89 and percentage of 64.33%. This result indicates that the level of positive environmental attitude among the governmental high basic schools children of class nine in Gaza city was low.

This finding is consistent with the local study of Nashwan (1997), which conducted a survey of 1590 male and female students of 3 levels in the elementary school (7,8,9 classes) in Gaza strip, to estimate the level of their positive attitude toward environment. The results revealed that above 50% of the study population have got positive attitude toward environment. Similar finding were also found in study of Singapore students' attitude toward environment which reported that the level of environmental attitude among the study population was about 66% (Geok chin *et al.*, 1998).

In contrast, this finding disagrees with Naser and Naser (2000) finding which reported that, in spite of low level of environmental awareness among the study population, the results emphasized high level of students' attitude toward their environment. Also, there was various studies reported high positive environmental attitude of students across different countries (Kazy, 1988 in Syria, Hsu and Roth,1996 in Taiwan; and Sheila,2004 in Hong Kong).

## Gender Effect on the level of environmental attitude

As shown in the table 3, the mean of environmental attitude among female of class nine in the governmental high basic school children is higher than the mean of environmental attitude among male of the study population.

**Table 3: level of environmental attitudes, among high basic school children, according to their gender**

Item	Gender	N	Mean	Std. Deviation	%
Environmental Attitudes	Male	200	18.34	6.730	61.13
	Female	200	20.27	4.740	67.57
	Total	400	19.30	5.89	64.33
T-Test value = -3.31			P<0.001		

There was a statistical significant difference in the level of environmental attitude among student of class nine in the governmental high basic school age children in Gaza city attributed to their gender towards male. So, this result agrees with the study hypothesis proposed that there is statistically significant differences at ( $P < 0.001$ ) in the level of environmental attitude among high basic school children due to their gender. This can be attributed to the fact that females across cultures are socialized to be more expressive to have stronger “ethic of care”, and to be more interdependent, compassionate, nurturing, cooperative, and helpful in care giving roles (Beutel and Marini, 1995; Chodorow, 1974; Eagly, 1987; Giiligan, 1983). On the other hand, males are socialized to be more independent and competitive (Chodorow, 1974; Gillagan, 1982; Keller, 1985).

Several studies revealed a significant relationship between gender and environmental attitude (Chonell *et al.*, 1999; and Clarke, 1996; Hample *et al.*, 1996), While this finding is consistent with many studies across countries, it is inconsistent with local study of Mohsen (2003) in Gaza strip and study of Ebrahim and Dusoky, 1985 in Egypt which reported that males was more attitude toward their environment than females. On the other hand many studies revealed no significant differences in the level of environmental attitude related to gender; both males and females nearly have got similar level of environmental attitude such as, local study of Nashwan, (1997) in Gaza Strip, Kazy, (1988) in Syria, and Sheila, (2004) in Hong Kong.

### Level of environmental attitude and type of area

As mentioned previously in this study, according to Gaza municipality, Gaza city is distributed into four areas, popular area, agricultural area, residential area and new suburb area

**Table 4: the level of environmental attitude among the students of class nine in the governmental high basic school children in Gaza differ due to the type of area**

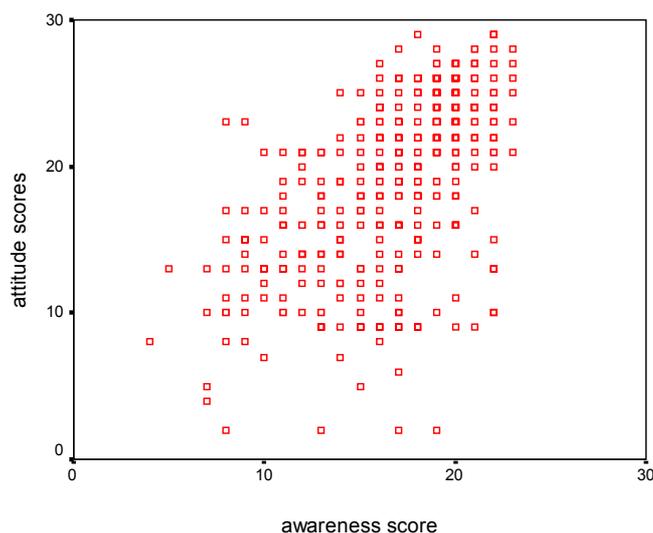
type of area	N	Mean	Std. Deviation	Rank
resident area	100	23.18	3.415	1
popular area	100	19.29	5.779	2
recent area	100	17.47	6.417	3
agricultural area	100	17.28	5.569	4
<b>Total</b>	400	19.30	5.893	
F= 25.566		P<0.001		

As shown in the table 4 above, the results reflect differences in the mean of the level of environmental attitude among school children according to residential area, and out of 30 points reflecting the level of environment attitude among the study population, the level of environmental attitude toward environment among study population was low in general, and according to the type of area, the level of students attitude toward environment was in the resident area higher than the other areas with percentage of 23.18% of the study population and rank 1, the second rank in the positive attitude toward environment was among students of popular area, then the third rank was of the recent area, and finally the fourth rank was of the agricultural area in Gaza city. There was statistical significant differences at the level of environmental attitude among children due to the type of their area at  $p < 0.001$ .

## Correlation between environmental awareness and environmental attitude among the study population

The purpose of this part of study is to determine whether there is a correlation between the environmental awareness and environmental attitude and among students of class nine in the governmental high basic school in Gaza city.

As shown in Figure 1 Person's correlation coefficient between environmental awareness and attitude indicated that, there was a positive correlation between environmental awareness and environmental attitude among the study population ( $r = .578$ ). The correlation between level of environmental awareness and attitude reached a strong statistically significance level ( $P < 0.001$ ).



Pearson Correlation = 0.578 , Pvalue < 0.001

**Figure 1: Relationship between environmental awareness and attitude**

This means that students with higher environmental awareness were significantly more likely to have higher environmental attitude. This finding can be explained by Roth and Perez (1989), who emphasized that, it can postulated that a good background in environmental knowledge could eventually lead to the development of positive attitudes toward the environment. Similar finding was also appeared in Iozzi (1984) study in which the strength and nature of attitudes relating to concepts were found to be related to previous knowledge of issues, with peer's attitudes and amounts of exposure to information. Evidence from Schahn and Holzer (1990) further supported that knowledge played a significant role in responsible behavior, explaining why students with higher environmental awareness were significantly more likely to have higher environmental attitude) The study finding is consistent with a study of (Arcury, 1990; Roth and Perez, 1989; Sheila, 2004) in which their results revealed positive correlation between environmental knowledge and environmental attitude students' knowledge and their attitudes toward environment.

However, this finding is in contrast to other researchers who have shown that, in some cases knowledge is low and level of concern is high (Brody, 1987; Blum, 1987). This is supported by other experiments mentioned in the literature review where awareness and attitude had a weak to moderate relationship (local study of Nashwan, 1997 in Gaza strip, Zimmerman, 1996 in Mexico, Gambro and Switzky, 1996 and Kibert, 2000 in US). This variation in the correlation between environmental awareness and attitude ranging from weak to high positive relationship, may be influenced by cultural differences, and this supported by many studies which indicated that people of different cultures have differences in the perception of interrelationship between humans and the natural (Nunez, 2000; Szagun and Pavlov,1995).

## Conclusion

As, the main aim of this study is to measure the level of environmental awareness and attitude among school children in Gaza city – Palestine, in attempt to conclude the main recommendations and implications depending on the study results about the present status of environmental awareness among our students in the study population. According to this, the researchers tried to present their recommendation in a justified way and consistent with the study results. In this study, the students of grade 9 were generally found to have moderate level of environmental awareness, with male students having significant higher knowledge and awareness level than females. As in the study, the elementary class 9 students were found to reflect low level of environmental attitude; this was inconsistent with various studies across cultures. Therefore, it's important to enrich our students' background in environmental knowledge and awareness, especially for the female students who did not have opportunity to learn about environment through environmental curriculum in their schools which was conducted on males only until the date of conducting this study. Also, there is serious need to improve the attitudes of males toward their environment through encouraging them to participate in different environmental events such as International Environmental day, and participating in environmental awareness campaigns, and how their participation in educating their peers about the importance of preserving the environment.

In view of the above mentioned, it is suggested that a plan for environmental education is needed in Gaza in order to strengthen the base and concepts of our students' environmental knowledge, awareness and attitude. Moreover, the researchers recommend that the environmental teachers should pay more attention toward developing higher and deeper environmental concepts to increase the students attitude toward their environment, and to insure that this be applied in a qualified way. Students should understand that environmental problems are embedded in existing political, economic and social system; they need freedom of speech to discuss environmental issues frequently and empower to make change to the present situation. For doing all of these, environmental education should not be restricted by formal education only, non formal environmental education programs should be increased and produced out of school timetable, such as environmental clubs, environmental summer camps and so on, as they will be the master of our future after few years, therefore we need to pay more attention toward improving their concern and commitments to protect our environment from further deterioration.

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# **Runoff Estimation by the Curve Number for Wadi Ta'amira in Bethlehem – Palestine**

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## ABSTRACT

The Soil Conservation Service method (SCS) is an appropriate approach for estimating hydrological parameters of the water balance. The study concentrates on the estimated surface runoff by this method for Wadi Ta'amira in Bethlehem -Palestine. The SCS method, also known as the hydrological soil cover complex method, is mainly used for small-ungauged watershed which depends on local properties of soil type, vegetation cover types, landuse categories and antecedent moisture condition. Determining the Curve number (CN) depends on the daily rainfall records over the watershed for nearly three decades from 1970 - 2000. From the accumulative five days of daily rainfall records, calculation is done to form the Curve Number with its initial abstraction and potential retention for the Dormancy and Vegetation period. A Digital Elevation Model (DEM) is compiled to delineate the border of the catchment. An areal photo of high resolution for Bethlehem governorate is used to draw a landuse map showing the main activities in the study area which are used to determine the Curve Number (CN). The areal rainfall is prepared from the isohyetal map. The result of calculated surface runoff shows high percentage which is valuable for future planning. Surface runoff has 70.36 mm/yr which is considered to be 16.76% of areal rainfall. This study provides useful new information for hydrological parameters which are significant for the Eastern Basin with its local wells that support water for the southern part of the West Bank mainly Jerusalem, Bethlehem and Hebron districts.

**Key Words:** SCS: Soil Conservation Service method, CN: Curve Number, DEM: Digital Elevation Model

## Introduction

Water budget is an important view for hydrological studies since it gives the main incoming and outgoing of any water body or a groundwater reservoir over a period of time. The major inputs of the water budget are for precipitation, surface inflow and ground water inflow whereas the major outputs are for surface water outflow, ground water outflow and transpiration loss. The surface inflow and ground water inflow belongs to general infiltration while surface outflow is for surface runoff and ground water outflow for springs or seepages (Dury, 1970). The accumulation of the balance is due to evaporation and change in storage. The two major parameters of the water budget belong to infiltration and runoff since its measurements are possible whereas the other parameters may or may not be computed.

There are also empirical formulas for calculations; among them is the Soil Conservation Service (SCS) method, which is rather used over other estimation methods since it is related directly to local parameters of a basin like the landuse activities and cover, soil type, effective rainfall, the ground imperviousness and antecedent moisture condition. The Curve Number Method is the only available method for the researcher for estimating the surface runoff in the study area since it depends directly on local parameters.

The Soil Conservation Service (SCS) method is widely used to estimate runoff from small to medium-sized watersheds. The SCS method is used because it is simple and practical; its parameters values are related to physical characteristics of the watershed. (Ponce, 1989). The study area is considered a small watershed since its size is below 1000 km<sup>2</sup>. The hydrologic soil-cover complex,

which is a combination of a hydrologic soil group with a type of cover, describes a combination of landuse and treatment, hydrologic surface condition and antecedent moisture condition.

Bethlehem contributes to arid and semi-arid climate with an increase in aridity towards the Eastern Slopes in the Jerusalem desert. However, the range of rainfall decreases from west to east due to drop in elevation. For instance, the average annual rainfall for Bethlehem during 1900 to 2006 from Cremisan Monastery of coordinates 166400E to 126000N and 820 m elevation is 574.7 mm/yr.

Bethlehem lies on the Eastern Basin of the Mountain Aquifer which has a hydrological importance since it is one of the main aquifers that supply water for the southern part of the West Bank. Wadi Ta'amira is one of the main wadis in Bethlehem governorate since it drains its surface runoff towards the Dead Sea. Estimation of surface runoff for the area can help the sustainability of water quality and quantity for future generations.

## **Study area**

Wadi Ta'amira drainage basin is one of the main wadis in Bethlehem governorate; it is within 117 -130 N and 168 -179 E referenced on the Palestinian Grid. The catchment is drained by Wadi Ta'amira, third order attribute of Wadi Darajah that flows south east towards the Dead Sea.

The study area has mainly two types of soil: Brown Lithosols and Loessial Arid Brown Soils and Brown Rendzinas and pale Rendzinas. About 30-50% of these soils are outcropped with rocks. (ARIJ, 1997), (ARIJ, 1995).

## **Methodology**

Methodology constitutes of determining the watershed boundary and landuse activities of the study area. Areal rainfall over the catchment is important to compute surface runoff by SCS method. The methodology is as follows:

### **Watershed boundary**

With the help of GIS program TNT-mips (Microimages inc.2001) a Digital Elevation Model (DEM) is prepared to delineate the border of the catchment. The topography of the study area shows Wadi Ta'amira is draining towards south east; the main wadis in the study area are also recognized .

### **Soil Conservation Service (SCS) method**

The SCS runoff curve number represents three hydrologic factors; soil group, the cover complex and antecedent moisture conditions. The soil type of the study area is very important in the choice of the Curve Number analysis since this method has one of its major inputs for analysis is the soil type of the catchment. In addition, the soil type will give a brief description on the availability of an area for the estimated rate of infiltration and runoff. All soil types are classified into four

hydrological soil groups of certain runoff producing properties. These groups are A, B, C and D (McCuen,1998), (Ponce, 1989), (NEH, 2002).

Grasslands are evaluated by the hydrologic condition of native pasture in which the intensity of grazing and the percent of areal coverage by native pasture is visually estimated. Thus the type and density of the vegetation cover on a watershed have a major impact on the infiltration capacity of the soil. The cover type quality is defined as poor, fair and good. In comparison to (McCuen, 1998) and (Mays, 2001) the cover type quality of the study area is considered as poor since it is less than 50% of the surface is covered with plants.

Antecedent Moisture Condition (AMC) shows the availability of watershed wetness and soil moisture storage prior to a storm. The Soil Conservation Service (SCS) developed three antecedent soil moisture conditions which are labeled as AMCI for dry, AMCII for normal and AMCIII for wet conditions. They depend on the total rainfall in the 5 days period preceding a storm relatively with the soil condition (McCuen, 1998) , (Mays, 2001).

**Table 1: Classification of Antecedent Moisture Classes (AMC) for the SCS method of rainfall abstraction (McCuen, 1998; Mays, 2001)**

Total 5-days antecedent rainfall (mm and inch)				
AMC group	Dormant season		Vegetation season	
	mm	inch	mm	inch
I	< 15	<0.5	< 30	<1.4
II	15 - 30	0.5-1.1	30 – 50	1.4-2.1
III	> 30	>1.1	> 50	>2.1

The Curve Number for normal antecedent moisture condition (AMCII) is calculated in equation (1) as follows: (McCuen, 1998), (Mays, 2001)

$$CN = \frac{1000}{10+S} \dots\dots\dots\text{Eq. (1)}$$

The initial abstraction, consists mainly of infiltration, interception and surface storage occurring before runoff begins. It is in terms of a runoff Curve Number as an integer in the range of 1 to 100 in the following form: (McCuen, 1998), (Mays, 2001)

$$S = \frac{1000}{CN} - 10 \dots\dots\dots\text{Eq. (2)}$$

In which CN is the runoff Curve Number dimensionless and S, 1000, 10 are given in inches. Hence, the catchment’s capability for rainfall abstraction is inversely proportional to the runoff Curve Number. For example, a Curve Number equals 100 no abstraction is possible with runoff being equal to total rainfall. To the contrary a CN equals 1 practically all rainfall will be abstracted with runoff equal to zero (McCuen,1998). It is determined according to the hydrologic soil group, landuse activities and hydrologic conditions.

Computation of equivalent CN as CNI for AMCI of dry condition and CNIII for AMCIII of wet condition are according to (McCuen, 1998) and (Mays, 2001) as follows:

$$CN (I) = \frac{4.2 * CN (II)}{10 - 0.058 * CN (II)} \dots\dots\dots Eq. (3)$$

$$CN (III) = \frac{23 * CN (II)}{10 + 0.13 * CN (II)} \dots\dots\dots Eq. (4)$$

The runoff estimation by the SCS method is computed after the following equation from (McCuen, 1998) and (Mays, 2001) as follows :

$$Q = \frac{(P - 0.2 * S)^2}{P + 0.8 * S} \dots\dots\dots Eq. (5)$$

Where:

- Q = Actual runoff
- P = Rainfall (P ≥ Q)
- S = Potential maximum retention after runoff begins

with a restriction of P ≥ 0.2S. This is the rainfall – runoff relation used in the SCS method for estimating direct runoff from storm rainfall (Mockus, 1972).

### Landuse activities

With the help of GIS program TNT-mips (Microimages inc.2001) and an aerial photo of high resolution, a landuse map is prepared showing the main activities of the catchment. The weighted Curve Number of normal condition is calculated as in equation (6) as follows:

$$CN (II) = \sum \left( \frac{CN * LU \%}{100} \right) \dots\dots\dots Eq. (6)$$

Where:

- LU% = Landuse activity percent
- CN = Curve Number of each activity
- CN(II) = Curve Number of normal condition

The curve number of each landuse activity percent is compared according to landuse condition form (McCuen, 1998) and (Mays, 2001).

### Areal rainfall by Isohyetal method

The isohyetal map of the area covering the period 1970-2000, is prepared using Surfer 7 and TNT mips software packages. The Isohyetal method is considered to be more accurate method rather than others because it takes care of the orographic features and storm characteristics while drawing the contours of equal rainfall depths of a basin. The drawn isohyets follow the principles of elevation contours in which they form closed contours that do not cross each other. The area within each pair of adjacent isohyets is used to weight the average rainfall associated with them. (Patra, 2003), (McCuen, 1998). Mathematically, the mean areal rainfall for a watershed is computed as follows:

$$\overline{Pm} = \sum_{i=1}^n \frac{A_i}{A} * \overline{P}_i \dots\dots\dots \text{Eq. (7)}$$

Where:

- $\overline{Pm}$  = The mean areal rainfall in mm
- $A_i$  = Area of the watershed between two adjacent isohyets i and i+1 in m<sup>2</sup>
- $\overline{P}_i$  = Average precipitation for isohyets i and i +1 in mm
- n = Number of isohyets intervals
- A = Total area of the basin in m<sup>2</sup>
- $A_i/A$  = This ratio is the weight applied to the particular precipitation range.

The accuracy of this method over others is dependent on the density of the rain gauge network. It needs enough rain gauges to draw the isohyets.

## Results and discussion

The study shows the present results from the proposed methodology as follows:

### Watershed boundary

A Digital Elevation Model (DEM) is prepared to delineate the border of the catchement. The topography of the study area shows Wadi Ta’amira is draining towards south east and the main wadis are also recognized. The slope of the area is 0.039 towards south east where its highest point is 805 masl and the lowest discharge point is 310 masl. The size of the watershed is 46.39 km<sup>2</sup> with a length of 12.54 km towards south east.

Wadi Ta’amira basin is of fern shape catchement characteristic. In the fern shape catchement the tributaries are long and narrow thus the runoff of the tributaries will leave the basin (Ragunath, 1983).

### Soil group classification

In order to distinguish the SCS soil group, identification is done either over soil characteristics and county soil surveys or identifying minimum infiltration rate of the soil group. The study area has mainly two types of soil: Brown Lithosols and Loessial Arid Brown Soils and Brown Rendzinas and pale Rendzinas. By comparison the soil type of the study area with the four hydrologic soil groups A, B, C and D: the soil type is classified as C soil. It is mainly clay loams, shallow sandy loam, soils of low organic content and usually high in clay which is similar to the soil type of the catchement. Group C soil has a minimum infiltration rate of 0.05 - 0.15 inch/hr.

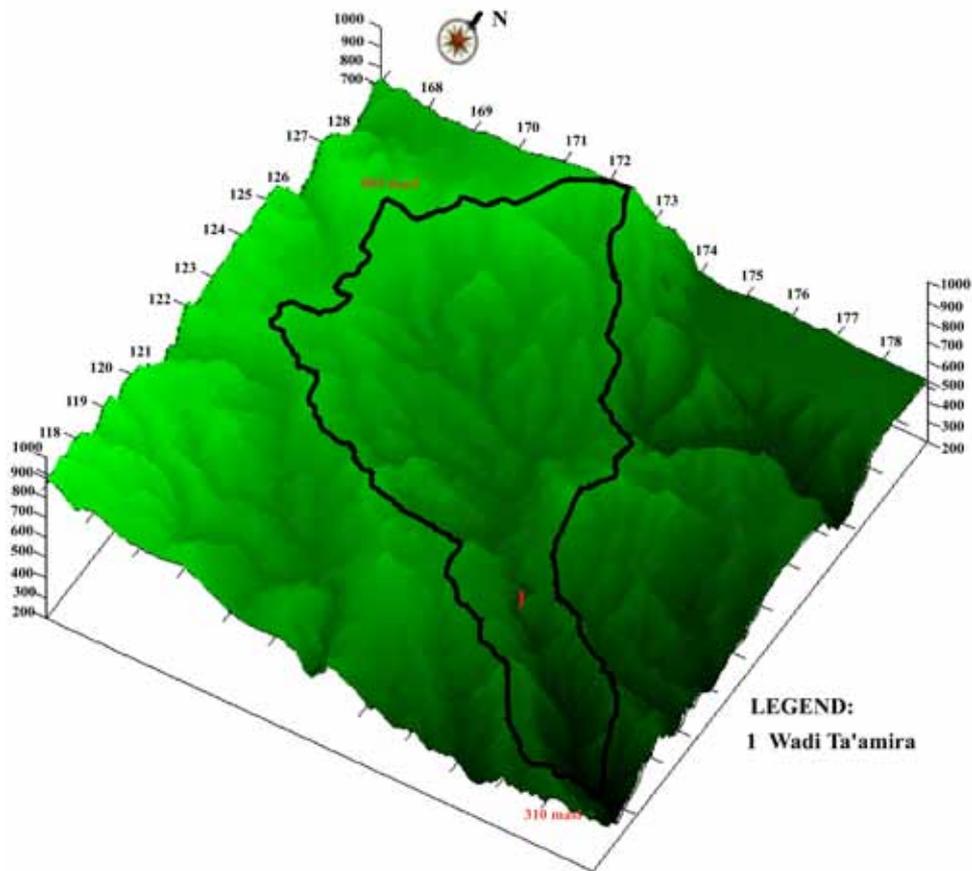


Figure 1: A digital Elevation Model for Wadi Ta'amira showing the border of the catchement area.

## Landuse activities

Landuse map is prepared showing the main activities along the study area. Figure (2) shows (33.7%) of the total area is mainly for open spaces which helps in increasing the infiltration and recharge while impervious Palestinian built up areas is (27.7%) which will cause high runoff. The choice of the CN values for each activity is estimated upon the present available data. According to (Mays, 2001) and (McCuen, 1998) the CN values are compared for the different landuse activities along the study area and then multiplied with percent landuse area as in equation (6). The weighted CN is computed after equation (6) and it is 85.7 which will be used later in the calculation of CNI, CNIII and surface runoff.

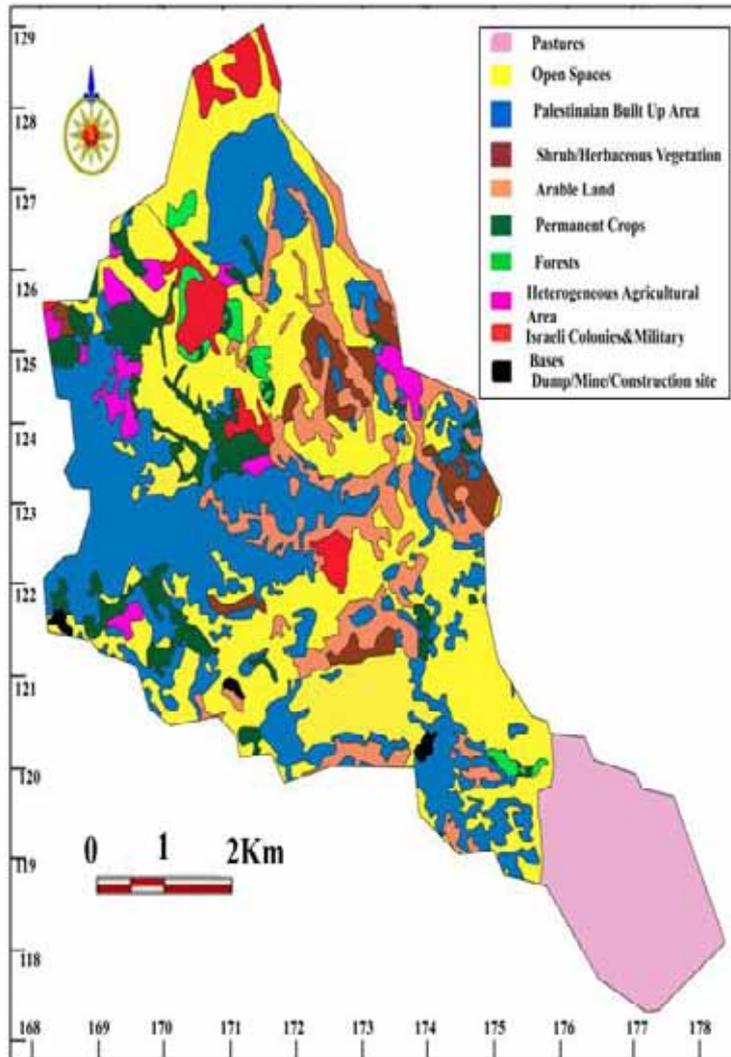


Figure 2: Landuse map of Wadi Ta'amira drainage basin (2006)

### Vegetation and dormancy

Vegetation and Dormancy period are important in the choice of AMC in order to form the CN. The practice on the agricultural lands either contoured or straight row reflects the different hydrologic runoff taking into consideration the hydrologic conditions poor, fair or good. The quality and density of the vegetation cover in the study area have a major impact on the infiltration capacity of a soil. By a field review of the watershed, the cover type and quality in the study area is poor since it is heavily grazed and less than 50% is covered with plant cover.

The present vegetation cover in the study area are mainly olive, almonds, vine trees, rain fed crops such as wheat and barely with arable land. After personal communication with engineers and directors of Agriculture Center in Hebron and Bethlehem in 2006, the Vegetation period for

permanent crops which are olive trees and almond trees starts from February and ends in late June. On the other hand, for winter crops, the vegetation starts from December till May. Thus as a result, the Vegetation period for the plant cover in general in the winter season starts from February and ends in June while the Dormancy period is between September and January.

### Mean areal rainfall

After computation in equation (7), the average depth of the rainfall over Wadi Ta'amira drainage basin within the period of 1970-2000 is 419.83 mm. The annual volume of the rainfall over the area will be 19.48 Mill.m<sup>3</sup>. Figure (3) shows the isohyetal map for study area. The Isohyetal method takes into consideration the orographic effect, elevation differences of stations. In addition, most of the rain gauges are distributed within small spatial distribution within the catchement and some of the rain gauges are found nearby the study area.

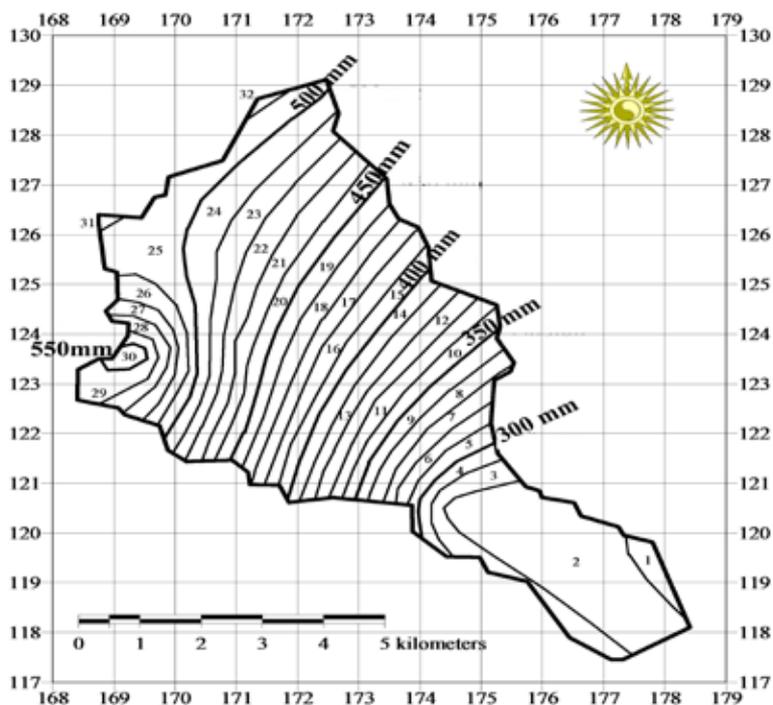


Figure 3: Rainfall contour map of Wadi Ta'amira drainage basin for the period 1970 - 2000

### Soil Conservation Service (SCS) method

The SCS runoff curve number (CN) represents three hydrologic factors: soil group, the cover complex and antecedent moisture conditions. In Wadi Ta'Amira drainage basin the effect of previous input factors for SCS method and the estimated surface runoff are shown as follows:

## Antecedent moisture conditions (AMC)

Antecedent soil moisture has significant effect on the rate and volume of runoff. The choice of AMC class after (McCuen, 1998) and (Mays, 2001) in Table (1) is based on the accumulative rainfall amount for five successive days in mm and inches. The study area is considered to be of soil type C. This soil type has slow infiltration rate when thoroughly wetted. It has minimum infiltration rate of 0.05 - 0.15 inch/hr. It is of clay loams, soil low in organic content, shallow sandy loams and usually high in clay. The study area is considered as AMCII with soil condition of average antecedent moisture condition which has an average runoff potential. After calculation of CNII from landuse map activities which shows to be 85.7, CN I and CNIII are computed after equations (3) and (4) respectively. Potential retention (S) is also calculated in equation (2). The results are as in table (2) for the Dormant and Vegetation season as follows:

**Table 2: The results of Curve Number conditions in Dormancy and Vegetation season**

	CN(I)	CN(II)	CN(III)
CN	71.6	85.7	93.2
Potential retention (S)	4.0	1.67	0.73

## Surface runoff

Runoff calculation is done for the study area over the period 1970-2000 by the SCS method in equation (5), the runoff in the Dormant season is 46.47 mm/yr (2.2 Mill.m<sup>3</sup>) which represents 11.07 % of the areal rainfall. Whereas in the Vegetation season the runoff in the study area is 23.89 mm/yr (1.1 Mill.m<sup>3</sup>) and represents 5.69 % of the areal rainfall. From the result of surface runoff calculation by the SCS method, in both the Dormant and the Vegetative season is 70.36 mm/yr which is 3.3 Mill.m<sup>3</sup> and represents 16.76% of the areal rainfall. The runoff change in both seasons is dependant on the uptake of water by plants more in the Vegetative period which will decrease the rate of runoff.

## Interception, depression storage and soil moisture

Interception is the process when precipitation is retained by vegetative cover or surfaces either absorbed by it or lost through evaporation. The studies showed that interception is much greater during the growing season than other times of the year due to the vegetative cover.

The total vegetative cover in the study area is 23.09 % of the total area from Figure (2) whereas the Palestinian built up areas are 27.66 %; thus the landuse activities has an impact on the quantity of interception. In addition, most of the storms in the West Bank are moderate storms which may have sometimes intense rainfall days above 100 mm/day. In general, interception loss will be assumed negligible in the water balance of the study area since there are no direct measurement of interception is done.

Depression storage is the water stored in small spaces above land surface in which rainfall is abstracted in natural or artificial depressions. It is affected by the topography, soil characteristics and land form. The topography of the study area is hilly since it is part of the Eastern slopes of

the West Bank. The soil type of C group of clayey soil with low permeability has an effect on the quantity of depression storage. Wadi Ta'amira, like most wadis of the West Bank, is terraced wadi. However, there are no available data for depression storage and interception or on soil moisture along the West Bank. So, the depression storage is assumed to be negligible, in the water balance due to unavailable data although it has valuable effect.

## Conclusion

The study area, as part of the West Bank, depends on precipitation for replenishing the aquifer. The isohyetal map over the study area shows that the area receives 419.83 mm/yr which is sufficient to recharge the local aquifer. Bethlehem contributes to arid and semi-arid climate with an increase in aridity towards the Eastern Slopes in the Jerusalem desert. Rainfall data over the last ten decades shows that the area was faced with dry and wet years. This variation will affect on the water table of the aquifer which will need future efficient management.

Estimation of surface runoff by SCS method is a versatile, an accurate and widely used procedure for runoff. It is an adequate procedure to be implemented in other parts of the West Bank in order to give sufficient data for future water planning. The computed surface runoff (16.76%) by the SCS method for the period 1970-2000 shows high percentage. It will provide useful new information to determine the quantity of available water for agricultural uses and future economical plans. The landuse map shows high vegetative cover (23.09%); thus it is preferable to encourage the agriculture sector in order to decrease the terraced lands. The Palestinian built up areas present high percentage (27.7%) of the total area which will affect on surface runoff. The local municipalities should also limit the uncontrolled urbanization which will increase water loss through runoff. According to the present result of the SCS method, the study area is considered to be of C soil hydrologic group. The weighted CN for normal condition is 85.7 whereas for CNI and CNIII are 71.6 and 93.2 respectively. Other input and output parameters of the water balance will be discussed in future studies.

## Recommendations

I recommend the local government to take advantage of these results and to harvest the surface runoff in the form of dams or concrete dams which will be useful for irrigation purposes. I also advise the local municipalities to build up artificial pools for surface runoff in the form of harvesting wells, or artificial wetlands which will maintain the diversity of the area for future generations.

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## **Ecoland: An integrative group work in the environmental science study**

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## ABSTRACT

After 11 modules of 3 weeks, all participants of the 3 specialisations in the MSc programme in Environmental Science go into their last module, the common group work Ecoland, before they will start their individual MSc thesis project. The group work consists of a role-play in which the techniques and knowledge obtained during the earlier phases of the programme are integrated. The case study is named Ecoland dealing with the environmental situation in the fictitious Republic of Ecoland, where the environment is under threat. To simulate reality and to increase the involvement of the participants the group work is performed as a role-play, in which the participants represent competing consultant firms and the EPA (Environmental Protection Agency); the teachers are members of the Ecoland government. Important items in the group work are technological aspects, nutrient recycling, sustainable development and planning & management.

After successful completion of the Ecoland group work participants will be able to:

- solve complex environmental problems by integrating the content of the preceding modules;
- make decisions on the basis of a limited amount of information and time;
- work in a team of individuals with different scientific and cultural backgrounds to solve complex environmental problems.

**Keywords:** Cooperative learning, Environmental planning & management, EPA & consultancies, Role-play

## Introduction

Every year in October, the MSc programme in Environmental Science at UNESCO-IHE starts with 4 specialisations. After 11 modules of 3 weeks, all the participants of 3 specialisations (technology, planning and management, water management) go into their last module, the common group work called Ecoland. Afterwards, the last part of their 18 months they will spend to their individual MSc thesis project. The group work consists of a role-play in which the techniques and knowledge obtained during the earlier phases of the programme are integrated.

The case study is dealing with the environmental situation in the fictitious Republic of *Ecoland* (figure 1). The environment is under threat by increasing population growth and economic activities, which is of great concern to the government of this country. Besides the technological aspects, important items, which have to be taken into account, are nutrient recycling, sustainable development and planning and management. Because of lack of expertise, the government has invited several international consultant firms to study the problems and to formulate recommendations on how to improve the environmental situation. The government has appointed the Environmental Protection Agency (EPA) to coordinate the activities of the consultants. The students represent competing consultant firms and the EPA; the teachers act as members of the Ecoland government. During the group work meetings have to be prepared and attended by the participants, presentations have to be given and reports have to be submitted.

The group work is organized in such a way that it helps the participants to develop following skills:

## Objectives of the group work

The main objectives of the group work are:

1. To apply and integrate the knowledge acquired in the preceding months of the programme by working on a complex environmental problem;
2. To apply and practice skills in a systematic problem analysis, in order to study all relevant aspects of the environmental problem, to formulate conclusions and to come up with recommendations on minimising or solving the problem;
3. To practice skills in decision making in the context of uncertainty and limited information available;
4. To understand the importance of a multidisciplinary approach and teamwork in solving environmental problems.

In addition, more general objectives are:

5. To co-operate in a small heterogeneous group;
6. To practice speaking in public and report writing;
7. To get acquainted to work under time stress;
8. To discriminate between things of major and minor importance, when working on a complex problem.

## **Set-up**

To simulate reality and to increase the involvement of the participants the group work is performed as a role-play.

As a project group in a consultant firm, the participants will have to define a project leader who manages the group and a project secretary who keeps all records and acts as a report editor. The consultancy firms and the EPA receive different assignments from the Ecoland government throughout the group work period. The involved staff have a double function; besides a teacher they also play a role as ministers in the government of Ecoland (Minister of Water, Minister of Environment, Minister of Energy). At the end of the group work the Ecoland government invites a panel of experts to assess final presentations of the EPA and consultants. The panel of experts consists of staff members not directly involved in the group work. In table 1 a detailed overview of the assignments is shown.



**Figure 1: Map of Ecoland**

Every week contact hour sessions were organised for each group and used for exchanging information about problems and progress (table 1). Each session was prepared (by means of an agenda), chaired and reported upon by the participants. The company secretaries typed minutes and sent them to the government two working days after the meeting. There were also two specific sessions (in the middle in the conference format and in the end of the group work) when students presented the results of their assignments. Assignments were provided as a hand out. Two reports have to be written: a preliminary country wide interim report and a final action plan for a specific problem. The final report to the government (not more than 50 pages) contained all the items of the study and a collection of all minutes.

**Table 1: Time Schedule and Assignments**

Day 01		Introduction of the group work
Day 02	Assignment 1	Curricula vitae + company profile + task distribution Curricula vitae + EPA organisation + task distribution
Day 04	Assignment 2	Problem analysis (consultants) vision statement EPA)
Day 05		Contact hours between government, EPA and consultants
Day 06		Field visit to area with comparable problems
Day 07		Minutes of meeting with government
Day 08	Assignment 3	Preliminary action plan (consultants) Detailed vision and policy implications (EPA)
Day 09	Assignment 4	Ecoland conference
Day 10		Contact hours between government, EPA and consultants
Day 12		Minutes of meeting with government
Day 14	Assignment 5	Draft detailed action plan (consultants) Draft policy document, monitoring and evaluation plan and assessment criteria (EPA)
Day 15		Contact hours between government, EPA and consultants
Day 17		Minutes of meeting with government
Day 17	Assignment 6	Final report to government
Day 19	Assignment 7	Final presentations

## History

The idea of a common, integrated group work for all Environmental Science participants was developed about 20 years ago. Since then the country Ecoland changed a lot and many different staff members were involved. Every year a new set of environmental problems has been developed (table 2) and in time assignments were adjusted; the number of participants varied between 25 and 45 within the period 2005-2010. All groups (EPA and the consultancies) consisted of maximally 5 members; the number of staff involved was 2 to 3. The members of the consultancies had to come up with a name for the company. A selection of creative names is shown in table 3.

**Table 2: Examples of environmental problems in Ecoland**

<b>year</b>	<b>Topic</b>
2011	Lake Behero
2010	Water quality and water quantity
2009	Saving the great rivers of Ecoland
2008	Water shortage
2007	Integrated wastewater treatment
2006	Water supply for aquaculture
2005	Sustainable use of Henkerik forest
2004	Saving the Eco Sea

**Table 3: Some creative names used by the consultancies**

ECO-care
EcoConcern
Ecofriends
EcoHarmony
Environconsult
Envirosolution
Junos Green
Triple bottom line
WEConsult

Recently, some new activities were introduced. In the second week the participants have to organise a conference in Ecoland. EPA has the lead and the consultants are presenting scientific results on the running topic; ministers of Ecoland are attending the conference. A journal is issued - the Ecoland Herald - where the activities of the government, EPA and the consultants are critically followed. An example of the Ecoland Herald is shown in figure 2.



# ECOLAND HERALD

Thursday 12 August 2010 – Chief editor: A. Hinton – PO Box 1111, Hancity – 1500 Eco\$

**FAIRY TALE WEDDING IN ATTIX**  
*Zofar. Dr Henika Halbron, Minister of Economic Affairs said yes to famous Atticed captain of Industry Richard Clouting. During a private ceremony in the capital of Attix the 'deal' was closed. Speculations are that Mr Clouting is actively looking for investment opportunities in the construction sector of Ecoland. Is the wedding more than just a romantic affair? Read more in the Ecoland Herald plamsour section (p18 and further)*

**LUBBERING GIVES UP**  
*Sidonia Lubbering (28), the daughter of Minister Lubbering of Public Works, ends her active athletics career. The first and only gold medalist ever in world championships athletics (2009, 10 km) is forced to put away her spikes due to a knee injury. During an emotional press conference Sidonia thanked her father Herik and mother Annicko for their continuous support. President de Rayter van Stevenack awarded Sidonia with the Order of the Pink Flamingo and thanked her for being an inspiration for Ecoland's youth. Sidonia produced a silent smile after the question if her next career would be in politics.*

**Feijen Reservoir at lowest level ever! (from EPA)**  
*Ecoland's EPA announced yesterday that the water level in the Feijen reservoir had reached the lowest level ever measured since the construction of the Feijen dam in 1978. In an emergency meeting with the government, it was decided to ration the water. Impacts can be expected for energy production, drinking water supply and irrigation.*

**Going out tonight?**  
*Hancity Rovy bar – Spin  
 Capoeira performance by Academia de Luta Regional Baiara from Brazil  
 Ribosity Starlight Cinema – Spin  
 Why women hate men – drama  
 Back to the future 13 – comedy  
 Hancity Concert Hall – Spin  
 The Rotterdam Philharmonic Orchestra  
 Works from Bach, Haydn and Mozart*

**Government looking for environmental improvement**  
*Hancity. The Ecoland government has hired eight international consultants to finding solutions for the existing environmental problems. The consultants are invited to come up with priority lists of the problems. The first conclusions will be presented during the first Green Ecoland conference on coming Friday. The two political parties of the Ecoland government, ELP and LFP, are disagreeing about how to tackle the environmental problems since they are in charge. In addition, they also disagree about the response to the claim of Basic with respect to the water quality of River Running, which is the main supply to their precious Sunrise National Park. Ultimately, international environmental consultants were appointed to come up with solutions. The Minister of the Environment, Dr Ostroskaya, says "this was the only way out for quick decisions. The eight consultants only make an analysis and we still have to decide about the implementation phase. We take it very seriously and we have appointed Dr Koff Eslun, the famous Ecoland environmentalist, as the chairman of EPA to guide the process." Two of the consultants already opened an office in Ecoland, WEConsult and WAES. The other consultants are from the Netherlands, South Africa and Barsoba.*

**Results Eco Lottery**  
*The winning numbers of yesterday's lottery are:  
 4 – 7 – 18 – 22 – 31 – 37  
 There are 2 players with 6 correct numbers, each winning 120 mio Eco\$. Twelve players have 5 correct numbers and win each 2 mio Eco\$.*

**Weather forecast (EcoMeteo)**  
*Today will be a hot day with temperatures of 32 °C in Hancity, 28 °C along the Ecossea coast up till 35 °C in the North of the country. For the coming days similar temperatures are predicted.*

**Financial news**  
*The Eco\$ is on the rise again compared to foreign currencies. Gold prices continue to rise.*

USD (\$) Δ	671.61
EURO (€) Δ	1.062.15
Petroleum (Eco\$) ▼	140,000
Gold (Oco\$ / g) Δ	18.316
Ecolandones (%) ▼	-1.39

**Figure 2: The Ecoland Herald**

## Assessment of students

The assessment of students (marking) is based on the final report, the oral presentations and the individual contributions.

Throughout the group work, the performance of the participants was continuously assessed. Assessment was based on quality of the interim assignments, participation in discussions, physical presence, presentations and the final report. There were both an assessment of individual performance and an assessment of the performance of the group. Individuals were supposed to write each at least one chapter of the final report and all the members of teams were asked to participate in the final presentations. Table 4 presents breakdowns of marks given to the students. In addition to the marks given by the staff, the participants are supposed to also mark each other - anonymously - to a maximum of 10% and according to the system shown in table 5.

These peer ratings are informative about what is going on in the teams. Teams that are working well together turn in reasonably consistent peer ratings, while teams with conflicts among their members turn in peer ratings that can vary considerably. In addition, it can help to avoid subjectivity in marking the teams.

**Table 4: Marking breakdown**

	Group	Individual
Marking by participants (table 5)		10%
Assignment 1	10%	
Assignment 2	10%	
Assignment 3	10%	
Assignment 4	10%	
Assignment 5	20%	
Assignment 6	10%	
Assignment 7	20%	

**Table 5: Marking by participants**

Consider a group of 5 members - A, B, C, D and E - and the average mark is 7.5. All can then distribute  $4 \times 7.5 = 30$  over their 4 colleagues to indicate to how they think to which extent group colleagues contributed to the final result. Example is shown below.

Points received by	Points given by					Average, to be filled out in table 4
	A	B	C	D	E	
A		7	7.5	7	8	<b>7.4</b>
B	8.5		7.5	8.5	8	<b>8.1</b>
C	6	6		6.5	6	<b>6.1</b>
D	8	9	7.5		8	<b>8.1</b>
E	7.5	8	7.5	8		<b>7.8</b>
Total	30	30	30	30	30	37.5

## Discussion

The participants are divided in groups according to their education background (to keep in any group specialists from different disciplines), geographical background and gender (to have internationally and gender balanced groups), as well as their performance level (to balance weak and strong students in groups), which is in line with Felder and Brent (2001): “*The primary condition for forming a group is heterogeneity in ability levels. All the top students in the class should not be clustered together, leaving the weak students to fend for themselves. In heterogeneous groups with some good students and some weaker students, everybody wins*”.

The group work is usually well appreciated by the participants as giving them an opportunity to convert their theoretical knowledge into practical expertise, which is the major goal of this learning process.

From the literature it is known that a group work should have the following five elements in place to be qualified as cooperative learning (Johnson et al 1998; Felder & Brent 2001):

- *Positive interdependence.* The team members have to count on one another to do what they are supposed to do, otherwise everyone loses.
- *Individual accountability.* Everyone is held responsible for understanding both their part of the work and everyone else’s parts.
- *Face-to-face interaction* (at least part of the time). This rules out the familiar “You do problem one, you do problem two, I’ll do problem three, and we come together, staple the problems together, and hand them in”. That happens a lot, but it isn’t cooperative learning.
- *Development of interpersonal skills* (needed to work effectively in teams). Students are not born knowing how to do conflict resolution, communication, leadership, time management, and so forth; some attention must be paid to helping them learn how to do those things.
- *Regular self-assessment of group functioning.* Periodically, teams have to stand back from what they’re doing and ask themselves, “What are we doing well as a team? What could we be doing better? What are we going to differently next time?”

During the Ecoland group work students were more inclined to interact with instructors than - for example - during lectures. There were also more interactions not only with the teachers but also within the teams that lead to development of their communication and teamwork skills. Team members perceived that they needed each other in order to complete the group’s task (“sink or swim together”, as Johnson et al (1998) mentioned). In the Ecoland group work, the instructors structured the students’ positive interdependence by establishing mutual goals (maximize own and each other’s productivity), joint rewards and shared resources (members have different expertise). However, the students were responsible themselves for what results they would achieve, and this was also a highly motivating element for them. I see all these required elements having presented in our group work, which, therefore, can be qualified as “cooperative learning”.

## Conclusions

- A common group work is a good integration step (in Environmental Science) to make students aware of complex situations;
- The cooperative type of learning in a common group work is a powerful instrument for students to practice their knowledge and skills, to work in teams, and to understand that complex environmental problems program can be solved in a multidisciplinary teams much more effectively
- To mimic real life situations, the composition of the groups should be as diverse as possible.

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## **Dental Fluorosis and Associated Risk Factors in Gaza Strip Children**

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## ABSTRACT

Dental Fluorosis is a serious oral health problem in Gaza Strip. Objectives: To estimate Dental Fluorosis prevalence and severity in Gaza Strip, to explore its associated risk factors, and to examine the association between Dental Fluorosis and fluoride concentration in Municipal Wells of Drinking Water (MWDW). Methods: A cross sectional study recruited stratified cluster random sample of 350 children aged 12-18ys and their mothers. Data was collected by interviewed questionnaires. Dental Fluorosis prevalence and severity were determined using Thyllstrup-Fejerskov Index (TFI). Chi-square test examined the association between the study variables (P-value <0.05). Results: Prevalence of Dental Fluorosis was 78%. Prevalence of sever Dental Fluorosis is significantly higher among children receiving fluoride concentration in MWDW >1 ppm (P-value <0.005). Living near main road (P-value <0.013) and using open fire as heating system (P-value <0.001) significantly increased the risk. Factors as being child of Professional and Managerial fathers (P-value <0.002), covering brushes with pea size fluoridated toothpaste (P-value <0.001), and not swallowing fluoridated toothpaste (P-value <0.043) significantly reduced the Dental Fluorosis risk. Conclusion: Health and environmental preventive interventions for high fluoride exposure in Gaza Strip should consider all Dental Fluorosis's risk factors.

**Key Words:** Dental Fluorosis, Palestinian Children, Gaza Strip, Water Fluoride

## Introduction

Groundwater is the major source of the drinking water supply in the Gaza Strip and there is a gradual decrease of water availability and quality over years because of inadvertent overuse. Studies have shown that from 1987 to 1994, the water in 81% of Gaza wells could be considered suitable for drinking (Abuzahrah, 1995; MOH, 2003; Shomar *et al.*, 2004; PCBS, 2007). By the year 1994 less than 78% of tested water wells had a fluoride concentration meeting the WHO guidelines for recommended fluoride concentration (0.7 and 1.2 ppm fluoride ) in water supply (Kuhail & Zoarb, 1994, WHO, 1994). While in 1984, a guideline value of 1.5 ppm fluoride was recommended by the WHO as a level at which Dental Fluorosis would be minimal (WHO, 1984).

Ten years later, Shomar *et al.* (2004) was able to show that the fluoride concentration in groundwater wells as well as in the soil samples in the Gaza Strip was lowest in the northern areas of the Gaza Strip, while, in south Gaza the water fluoride concentration measured up to 4.4 ppm. The water pollution has increased gradually as a result of losing a large amount of surface water and groundwater because of water overuse, an increase in pollution from agricultural and industrial wastes, and seawater intrusion (Abd Alwarith, 1998; Shomar *et al.*, 2004).

Fluoride is important to prevent dental caries among children. However, undesirable fluoride intake increases the risk of having Dental Fluorosis (Fejerskov *et al.*, 1988). Several studies have posited that artificially or naturally fluoridated drinking water is the primary source of fluoride intake among children and adults in different communities (Harrison, 2005).

In the Gaza Strip, previous studies have illustrated a significant positive association between high fluoride concentration in drinking water (received home tap water) and the prevalence and

severity of Dental Fluorosis in children (Sansur, 1991; Shomar et al., 2004). Shomer measured the prevalence of Dental Fluorosis in permanent teeth among 353 schoolchildren (5-16 year-old) living in the five governorates of the Gaza Strip using Dean's fluorosis index (Dean, 1942) and found the prevalence was around 60%. This prevalence increased from northern to southern governorates where the lowest rate was reported in north Gaza (9%) and the highest in Khan-Younis (94%). The study demonstrated a positive correlation ( $r= 0.72$ ) between Dental Fluorosis prevalence and the fluoride concentration in ground water wells for the five governorates (Shomar *et al.*, 2004).

In 2005, the prevalence of Dental Fluorosis among 16 years-old children (10<sup>th</sup> grade) in governmental schools was the highest in Mid-Zone (34.0%), then in Khan-Younis (33.5%), Gaza City (14.4%), and Rafah (10.9%), and it was the lowest in Gaza North (5.6%) (MOH, 2006). The Palestinian Ministry of Health has identified Dental Fluorosis as a serious health problem in the Gaza Strip among school children and attributed it to a high fluoride concentration in drinking water (MOH, 2005).

Based on that the objectives of this study were to estimate the prevalence and severity of Dental Fluorosis, to explore the possible associated risk factors of Dental Fluorosis among Palestinian children aged 12-18 years in Gaza governorates, and to examine the association between Dental Fluorosis and fluoride concentration in Municipal Wells of Drinking Water (MWDW) which supply children's homes.

## **Simulation and/or experiment**

This is a cross-sectional study including 12-18 years old children in the 5 Gaza governorates (North Gaza, Gaza City, Midzone, Khan-Younis, and Rafah). The researcher selected a proportional stratified cluster random sample from the five governorates. The sample size, according to Epi Info 6 statistical programs, was 350 children. Each selected cluster was surveyed for water supplies for the known wells and by chemical examination for fluoride concentration. Children aged 12-18 years old who were born and have spent their first seven years of life in the same house at the time of the study and who were drinking from the municipal supply drinking water were interviewed with their mothers.

The researcher used a questionnaire to collect data of socio-economic and demographic status, associated risk factors of Dental Fluorosis including use of toothpaste, applications of fluoride tablets and supplements, environmental sources of pollution by fluoride, availability of water purification system, source of drinking water and average fluoride concentration in municipal wells that are supplying drinking water and Thyllstrup-Fejerskov Index (TFI) of Dental Fluorosis (Thyllstrup and Fejerskov, 1978). The researcher asked the child to brush his/her teeth, and then recorded the TFI score of the buccal surfaces of all teeth, including the permanent molars with normal sun light.

The fluoride concentrations in drinking water wells had been collected from Environmental Health Laboratory "Public health lab: food and water" at Ministry of Health. The average fluoride concentration for three years for each drinking water well were calculated and considered as

fluoride concentrations in drinking water of this well serving the selected cluster. In case that data is not available, the researcher selected a year before or after to replace the missing year.

The study questionnaire was revised and validated by 12 experts in psychological, environmental, public health, dentistry, and dental public health specialization. Then the questionnaire was piloted among 10 children with their mothers from different areas in all Gaza governorates. The pilot sample was excluded from the study. The researcher used Statistical Package of Social Sciences SPSS for data coding, entry and analysis. Cross tabulations between Dental Fluorosis and each of potential risk factors were developed. The relationship between variables was examined using Chi-square test or Fisher test. Results were considered statistically significant when P-value <0.05.

The researcher secured the Helsinki Ethical Committee agreement, Palestinian Ministry of Health agreement to conduct the study and informed consent from the children and their families, including complete explanation about the research purposes, confidentiality and the optional participation in the study.

## **Discussion and result analysis**

### **Socio-demographic and economic characteristics of study population**

Table 1 shows that children age was categorized into three groups, the larger age group in the study sample is 12-13 years old and the females composed 56.9% of the study population. Fathers of children were 48.6% unemployed and 40.3% of fathers were educated between 7 to 12 years. Most mothers (91.7%) were householders and 61.4% of them finished between 1 to 9 years of education. Depending on the relative poverty line (equals 1800 NIS) in Gaza Strip (PCBS, 2004) the families who under poverty line were 67.7% of all study sample. This was nearly similar to the estimation of poverty rate by Palestinian Central Bureau of Statistics for the year of 2004, when the poverty rate according to a household's monthly income was estimated to be 65% in Gaza Strip (PCBS, 2005).

### **Prevalence of Dental Fluorosis among Palestinian children**

The researcher categorized TFI scores of Dental Fluorosis into 3 categories, the first one represents children who are free of Dental Fluorosis and their TFI score is 0, means, normal. The second group composes of children whose TFI score of their teeth is between 1-4 and it represents the children who suffer from questionable to moderate Dental Fluorosis. The third group consists of those children whose TFI score of 5 or more and this is considered sever Dental Fluorosis. It is worth demonstrating that the highest TFI score was 8, so that the researcher determined the third category between TFI score 5-8.

Depending on the Thyllstrup-Fejerskov Index (TFI) of Dental Fluorosis, children free of Dental Fluorosis were 22% while the prevalence of Dental Fluorosis among Palestinian children in Gaza Strip is 78%. Among those who had Dental Fluorosis, there were 63.4% in the group of 1-4 TFI score of Dental Fluorosis. The highest prevalent group for those with 3 TFI score (20.3%) while the lowest one for those with 1 TFI score (13.1%). There were also 14.6% in the group of 5-8 TFI

score of Dental Fluorosis, The highest prevalent group for those with 5 TFI score (7.4%) while the lowest once for those with 8 TFI score (0.3%), as illustrated in table 2.

**Table 1: Prevalence and severity of Dental Fluorosis among Palestinian children (12-18 ys) in Gaza Strip**

ITF Scores of Dental Fluorosis	Number of children	%
Normal	77	22.0
1-4	222	63.4
5-8	51	14.6
Total	350	100.0

Shomer *et al.* (2004) found that the prevalence of Dental Fluorosis (60%) among schoolchildren (5-16 year-old) living in the five governorates of the Gaza Strip was lower than that (78%) estimated in the present study.

The results of current study are higher than Dental Fluorosis prevalence (56.3%) in school children aged 6-9 in Campeche, Mexico (Beltrán-Valladares *et al.*, 2005), the prevalence of Dental Fluorosis (50%) in Irish population (McAuley, 2001), and in Western Australia - in Perth and the Bunbury region - where Dental Fluorosis prevalence is 40.2% and 33.0% among children 12-year-olds (Riordan, 2002), While the prevalence of Dental Fluorosis in current study is lower than the prevalence of Dental Fluorosis in Augusta, Georgia, in an optimally fluoridated community in the United States (80.9%) in children (Wash, 1993) and the prevalence and severity of Dental Fluorosis among Singaporean children (82.6%) (Lo & Bagramian,1996).

## **Risk factors associated with Dental Fluorosis**

### **Demographic and socio-economic status**

As clearly observed in table 3, the lowest prevalence of Dental Fluorosis is in the North governorate, and the highest is in Rafah and Mid-zone. According to Shomer *et al.* (2004) the prevalence was increased from north to the south but the highest in Khan-Younis (94%). Ministry of Health (2006) reported the highest prevalence of Dental Fluorosis in Mid-zone (34.0%) and the lowest prevalence was in the North (5.6%) which is in consistence with the results of the current study.

Furthermore, table 3 illustrates that the highest prevalence of moderate Dental Fluorosis is in Rafah and children living in Khan-Younis are the most exposed children in Gaza Strip to sever Dental Fluorosis. The differences of the prevalence of Dental Fluorosis among different governorates in Gaza Strip have reached highly statistically significant level (P- value<0.0001).

The current study found that, the children of Professional and Managerial fathers are the least exposed to Dental Fluorosis. This differences were statistically significant (P-value=0.002). However, the exposure to Dental Fluorosis of children whose fathers finished 13 years of education and more is the least (73.2%) and they have the least prevalence of severe Dental Fluorosis (6.1%). The negative association between Dental Fluorosis in children and the father's years of education was not statistically significant (P value = 0.065).

**Table 2: Summary of the subjects' Socio-demographic and economic characteristics**

<b>Characteristics</b>	<b>Count</b>	<b>%</b>
<b>Address by governorate</b>		
North	50	14.3
Gaza City	100	28.6
Mid-zone	50	14.3
Khan-Younis	100	28.6
Rafah	50	14.3
Total	350	100.0
<b>Gender</b>		
Females	199	56.9
Males	151	43.1
Total	350	100.0
<b>Fathers' occupational level</b>		
Professional/Managerial	16	4.6
Technical/clerical	52	14.9
Skilled worker Artisan	19	5.4
Partly skilled	75	21.4
Unskilled worker	18	5.1
Unemployed/Pensioner	170	48.6
Total	350	100.0
<b>Fathers' Years of Education</b>		
0-6	127	36.3
7-12	141	40.3
13+	82	23.4
Total	350	100.0
<b>Mothers' Occupational level</b>		
Householder	321	91.7
Working outside house(paid)	29	8.3
Total	350	100.0
<b>Mothers' Years of Education</b>		
1-9	215	61.4
10+	135	38.6
Total	350	100.0
<b>Current Family Monthly Income by NIS</b>		
≤1800	113	32.3
>1800	79	22.6
Missing	158	45.1
Total	350	100.0

Table 3 demonstrates that the children of working mothers outside house are less exposed to Dental Fluorosis than those whose mothers are householder. In addition, the prevalence of Dental Fluorosis is higher among the children of householder mothers. The differences of the prevalence of Dental Fluorosis among children of working outside house or householder mothers were statistically significant (P value = 0.025).

The prevalence of free children of Dental Fluorosis is higher among the children whose mothers finished between 1 and 9 years of education (22.3%) compared to that of children whose mothers finished 10 years of education and more (21.5%). This difference of the prevalence of Dental Fluorosis in children among difference groups of mother's years of education are not statistically significant (P value = 0.249).

Table 3 shows that the children in the families whose current family monthly income by NIS was 1800 or less are more exposed to Dental Fluorosis (80.1%) than children in the families whose current family monthly income more than 1800 NIS (70.9%). This difference was statistically significant (P value = 0.012).

Villa & Guerrero (1996) reached similar result in two Chilean twin cities, where the prevalence of Dental Fluorosis in low Socio-economic status children was significantly higher than in high socioeconomic status children. In addition, in Iran it was found that the fluoride intake of 4 year-old children in rural areas (0.44-0.58 mg/day) was higher than those living in urban areas (0.37-0.42 mg/day) and exposed to similar fluoride concentrations in drinking water (Zohouri & Rugg-Gunn, 2000). Rugg-Gunn *et al.* (1997) illustrated that the developmental defects of enamel in permanent teeth of Saudi 14 year-old boys was more prevalent in rural areas than urban areas. These factors may also be associated with a greater risk of malnutrition and less knowledge about the detrimental effects of high fluoride intake or excessive toothpaste ingestion in individuals in rural areas and those with a lower socio-economic status.

In contrast, another study determined the relationship between the socioeconomic status and Dental Fluorosis among Brazilian school children. Its results illustrated that parent's educational level data revealed a strong Pearson's correlation with income and no correlation was observed between Dental Fluorosis and the studied social economic variables (Maltz *et al.*, 2001).

Fluorosis is highest among who did not swallow the toothpaste during their first 7 years of age (P-value = 0.043).

In Gaza Strip, all toothpastes, that the families use now, are fluoridated. McDonagh *et al.* (2000) explained the higher Dental Fluorosis prevalence in USA than the United Kingdom, by the higher inappropriate use of fluoride supplements and fluoridated toothpastes in USA. In Colombia, 68.8% of total fluoride ingested, in 120, 4-5 year-old children in areas where fluoride concentration in drinking water was  $\leq 0.08$  ppm fluoride was from the fluoridated toothpaste (Franco *et al.*, 2005).

**Table 3: Dental Fluorosis and socio-demographic variables**

Variables	TFI score of Dental Fluorosis								P-value
			1-4		5-8		Total		
	No.	%	No.	%	No.	%	No.	%	
<i>Governorates</i>									< 0.000
North	21	42.0	29	58.0	0	0.00	50	100.0	
Gaza City	30	30.0	60	60.0	10	10.0	100	100.0	
Midzone	5	10.0	34	68.0	11	22.0	50	100.0	
Khan-Younis	16	16.0	61	61.0	23	23.0	100	100.0	
Rafah	5	10.0	38	76.0	7	14.0	50	100.0	
Total	77	22.0	222	63.4	51	14.6	350	100.0	
<i>Father's occupational level</i>									= 0.002
Professional/ Managerial	8	50.0	8	50.0	0	0	16	100.0	
Technical/clerical	6	11.5	40	76.9	6	11.5	52	100.0	
Skilled worker Artisan	6	31.6	10	52.6	3	15.8	19	100.0	
Partly skilled	23	30.7	46	61.3	6	8.0	75	100.0	
Unskilled worker	6	33.3	11	61.1	1	5.6	18	100.0	
Unemployed/Pensioner	28	16.5	107	62.9	35	20.6	170	100.0	
Total	77	22.0	222	63.4	51	14.6	350	100.0	
<i>Mother's Occupational level</i>									= 0.025
House-holder	65	20.2	207	64.5	49	15.3	321	100.0	
Working outside House(paid)	12	41.4	15	51.7	2	6.9	29	100.0	
Total	77	22.0	222	63.4	51	14.6	350	100.0	
<i>Current Family Monthly Income by NIS (groups)</i>									= 0.012
≤ 1800	54	19.9	170	62.7	47	17.3	271	100.0	
> 1800	23	29.1	52	65.8	4	5.1	79	100.0	
Total	77	22.0	222	63.4	51	14.6	350	100.0	

Variables	TFI score of Dental Fluorosis								P-value
			1-4		5-8		Total		
	No.	%	No.	%	No.	%	No.	%	
<i>Governorates</i>									< 0.000
North	21	42.0	29	58.0	0	0.00	50	100.0	
Gaza City	30	30.0	60	60.0	10	10.0	100	100.0	
Midzone	5	10.0	34	68.0	11	22.0	50	100.0	
Khan-Younis	16	16.0	61	61.0	23	23.0	100	100.0	
Rafah	5	10.0	38	76.0	7	14.0	50	100.0	
Total	77	22.0	222	63.4	51	14.6	350	100.0	
<i>Father's occupational level</i>									= 0.002
Professional/ Managerial	8	50.0	8	50.0	0	0	16	100.0	
Technical/clerical	6	11.5	40	76.9	6	11.5	52	100.0	
Skilled worker Artisan	6	31.6	10	52.6	3	15.8	19	100.0	
Partly skilled	23	30.7	46	61.3	6	8.0	75	100.0	
Unskilled worker	6	33.3	11	61.1	1	5.6	18	100.0	
Unemployed/Pensioner	28	16.5	107	62.9	35	20.6	170	100.0	
Total	77	22.0	222	63.4	51	14.6	350	100.0	
<i>Mother's Occupational level</i>									= 0.025
House-holder	65	20.2	207	64.5	49	15.3	321	100.0	
Working outside House(paid)	12	41.4	15	51.7	2	6.9	29	100.0	
Total	77	22.0	222	63.4	51	14.6	350	100.0	
<i>Current Family Monthly Income by NIS (groups)</i>									= 0.012
≤ 1800	54	19.9	170	62.7	47	17.3	271	100.0	
> 1800	23	29.1	52	65.8	4	5.1	79	100.0	
Total	77	22.0	222	63.4	51	14.6	350	100.0	

**Table 4: Use of toothpaste and Dental Fluorosis**

Variables	TFI score of Dental Fluorosis								P-value
	0		1-4		5-8		Total		
	No.	%	No.	%	No.	%	No.	%	
<i>Quantity of toothpaste (Dental Fluorosis and Toothpaste covered of the head of brush during first 7 years of child age)</i>									= 0.001
All	13	12.4	72	68.6	20	19.0	105	100.0	
Half	3	9.7	19	61.3	9	29.0	31	100.0	
Part (pea size)	18	37.5	26	54.2	4	8.3	48	100.0	
Total	34	18.5	117	63.6	33	17.9	184	100.0	
<i>Child swallowed the toothpaste (Dental Fluorosis and Child swallowed the toothpaste during his/her first 7 years of age)</i>									= 0.043
Yes	6	9.7	40	64.5	16	25.8	62	100.0	
No	23	26.1	52	59.1	13	14.8	88	100.0	
Sometimes	5	14.7	25	73.5	4	11.8	34	100.0	
Total	34	18.5	117	63.6	33	17.9	184	100.0	

### Environmental sources of pollution by fluoride

Findings of this study show that there was not any industry existing near the houses of the study children. Children who do not live near main road comprise 78.9% of study sample and 67.1% of children – in the study - their houses were not surrounded by dust. Families using open fire as heating system during winter in the study sample formalized 25.1% of the sample. Using open fire as heating system during winter (P-value = 0.001), living in houses near dust (P-value = 0.037), or near main road (P-value = 0.013), could significantly increased the occurrence and severity of Dental Fluorosis, as illustrated in Table 5.

In support for this study finding, in China, Ando *et al.* (2001) found that the total fluoride intake of students living in rural areas heavily polluted from coal was remarkably higher than those living in non-polluted rural areas (mean ( $\pm$ SD) fluoride intake: 43.2 ( $\pm$ 43.4) mg/day per person and 2.99 ( $\pm$ 1.69) mg/day per person respectively).

**Table 5: Environmental sources of pollution by fluoride**

Variables	TFI score of Dental Fluorosis								P-value
	0		1-4		5-8		Total		
	No.	%	No.	%	No.	%	No.	%	
<i>House is near dust</i>									= 0.037
Yes	34	29.6	63	54.8	18	15.7	115	100.0	
No	43	18.3	159	67.7	33	14.0	235	100.0	
Total	77	22.0	222	63.4	51	14.6	350	100.0	
<i>House is near main road</i>									= 0.013
Yes	9	12.2	48	64.9	17	23.0	74	100.0	
No	68	24.6	174	63.0	34	12.3	276	100.0	
Total	77	22.0	222	63.4	51	14.6	350	100.0	
<i>Heating system by open fire</i>									= 0.001
Yes	9	10.2	58	65.9	21	23.9	88	100.0	
No	68	26.0	164	62.6	30	11.5	262	100.0	
Total	77	22.0	222	63.4	51	14.6	350	100.0	

### **The association between dental fluorosis and fluoride concentration in drinking water**

Average fluoride concentration in 57.1% of MWDW was more than 1ppm. The highest fluoride concentration in MWDW was 4.29 ppm and it was found in the Gaza City. Table 6 shows that children who were drinking water from municipal wells where the average of fluoride concentration is 1.1 ppm and more have higher prevalence of severe Dental Fluorosis - TFI score between 5-8. There is highly statistically significant positive association between the severity of Dental Fluorosis and fluoride concentration in MWDW (P-value = 0.005).

**Table 6: Dental Fluorosis and average of fluoride concentrations in municipal wells by ppm**

Variables	TFI score of Dental Fluorosis								P-value
	0		1-4		5-8		Total		
	No.	%	No.	%	No.	%	No.	%	
Average of fluoride concentrations									= 0.005
0-1	31	20.7	107	71.3	12	8.0	150	100.0	
1.1+	46	23.0	115	57.5	39	19.5	200	100.0	
Total	77	22.0	222	63.4	51	14.6	350	100.0	

Harrison (2005) provided data from other studies illustrating that drinking water is the first primary source in elevating the fluoride intake among children and the fluoridated toothpaste is considered a second primary factor, Many previous studies confirm this fact. In Perth and the Bunbury region of Western Australia, extended residence in a fluoridated area was significant risk factors for Dental Fluorosis (Riordan, 2002). The studies in Toronto concluded that the prevalence of Dental Fluorosis may fall as the recently imposed reduction in concentration of fluorides in city water takes effect (Leake *et al.*, 2002). In the Guadiana Valley in north-western Mexico, was found that the drinking water supply comes from underground wells and is characterized by a high content of fluoride (higher than 12mg fluoride/L) and the prevalence of Dental Fluorosis among children in the school age (6-12 years) and adult was nearly 35% according to Dean index (Teresa *et al.*, 2001).

## Conclusion

High Dental Fluorosis prevalence in Gaza Strip is a result of the interaction of different risk factors. Regarding Socio-demographic and economic risk factors, children living in Mid-zone and Rafah have the highest prevalence of Dental Fluorosis, while those living in Khan-Younis are the most exposed children in Gaza Strip to Sever Dental Fluorosis. As the occupational and educational level of parents decreases, the risk of Dental Fluorosis elevates. Even bad economic status contributes in this problem. Adverse usage of fluoridated toothpaste during the first 7 years of child age affects badly Dental Fluorosis when child covers the head of brush by more than pea size of fluoridated toothpaste and swallow it. Living near main roads or using open fire as heating system during winter cause higher environmental pollution by fluoride that exposes children to high Dental Fluorosis. There is highly statistically positive relationship between fluoride concentration in drinking water and Dental Fluorosis. The study found that supplying drinking water with fluoride concentration more than 1 ppm elevates the risk of Dental Fluorosis.

Further studies have been conducted to identify the predominant source of fluoride intake among children in the Gaza Strip, to estimate the contribution of the different sources of fluoride to total

fluoride intake and to build a strategy for preventing Dental Fluorosis and securing valid information required to develop the most effective health and environmental educational programmers.

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# **Combating Poverty and Climate Change in the Occupied Palestinian Territory through community Participation**

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## ABSTRACT

Climate change is one of the main challenges facing humanity in the 21 century, which requires the pooling of expertise and human resources at all levels, along with the participation of national institutions, civil society and stakeholders to address the impacts and risks arising from this challenge. Like many developing countries, the occupied Palestinian territory (oPt) will be adversely affected by the climate change, irrespective of the fact that it is not responsible for precipitating the crisis. The oPt is vulnerable to climate change and it is anticipated that all aspects of life and development will be affected; including agriculture, food security, water resources and the associated public health risks. The most significant challenges facing the Palestinians are: lack of strategies and policies to mitigate and reduce the effects of climate change, Israeli occupation, population growth, urban sprawl, and lack of awareness of climate change amongst citizens. The community participation in decision-making processes is a major factor in making radical changes and promoting sustainable development. With this in mind the Applied Research Institutes - Jerusalem (ARIJ) implemented a project for raising awareness about climate change amongst the population. In addition ARIJ facilitated as community participation in the identification of the indicators of climate change in addition to giving recommendations regarding combating poverty and climate change in the oPt.

**Key Words:** climate change, awareness, community participation, decision-making

## Introduction

Climate change refers to long-term fluctuations in temperature, precipitation, wind, and other elements of the Earth's climate system (Beulant *et al.*, 2008). It is recognized as a major issue of global concern with serious and long-term challenges that have the potential to affect every part of the globe, including the occupied Palestinian territory (oPt). However, human influences are thought to be bringing about a rapid change in the climate, due to massive emissions of greenhouse gases. This has both direct and indirect long-term climate impacts on every region of the globe, causing alteration of oceanic and atmospheric currents that lead to shifts in precipitation patterns and changes in air temperature. In addition, a rise in the Sea Level, due to melting of the polar ice-caps and glaciers, threatens coastal regions with flooding.

According to the Intergovernmental Panel 2007 on Climate Change, global warming is already altering the world's climate. It being an impact felt in all sectors of society, through changes in temperature and precipitation along with changes in the frequency and intensity of extreme climatic events, the average global temperature is projected to rise between 1.4°C to 5.8°C by the end of the 21st Century (IPCC, 2007), and according to Middle East and North Africa (MENA) regions, climate change will make the weather hotter and drier; the increase in annual average temperature (MENA, 2009). Climate change will have a negative impact on the quality of groundwater especially in coastal zones and sea level is expected to rise in many coastal towns, and the increase of temperature which will augment evapo-transpiration reducing infiltration and aquifers recharge, In addition to the decrease of the annual average rate of precipitation in MENA region reaching between 10 - 20% (MENA, 2009).

The impacts of climate change are likely to negatively affect progress toward development in the oPt in a number of key areas including agriculture and food security, water resources, coastal zones, public health, climate related disaster risk management and natural resources management. Climate change will thus constrain the ability of the Palestinian Authority (PA) to reach poverty reduction and sustainable development objectives consistent with the United Nations (UN) Millennium Development Goals (MDGs) (Palestinian Climate change Adaptation Strategy, 2010).

This paper is one of the studies on community participation in climate change adaptation process in the oPt. It explores the connection between the challenge that climate change poses to our environments and communities, whilst also considering how to involve communities in developing and implementing adaptation plans. Properly planned and implemented participation processes will allow communities to have a real voice in shaping their future and will lead to better adaptation plans.

In the year 2009, ARIJ implemented a project for raising awareness about climate change amongst the population in the oPt as well as community participation in the identification of the indicators of climate change. This also involved community participation in giving recommendations regarding combating poverty and climate change in the oPt.

Moreover, the purpose of the workshops was to raise awareness about climate change, the link between poverty and climate change, and to advocate for better policies regarding combating poverty and climate change in the oPt. Final integrated policy recommendations were developed in a concluding workshop with findings directed to the related ministries via publications in newspapers and official letters.

## **Climate change in the oPt**

Like many developing countries, the oPt will be adversely affected by climate change irrespective of the fact that it isn't responsible for precipitating the crisis. The oPt is very vulnerable to climate change and it is anticipated that all aspects of life and development will be affected including agricultural and food security, water resources, coastal zones and all the associated public health risks. The most significant environmental consequences of climate change for Palestinians in the oPt are likely to be; a decrease in the total amount of precipitation with unpredictable seasonal variations, significant warming, a decrease in agricultural productivity, and droughts.

The green areas in the oPt are extremely limited with forests covering only 3.94% of the total area of the West Bank and 0.55% of the Gaza Strip (ARIJ GIS database, 2010). Nonetheless, it is acknowledged that forests protect the environment by moderating climate, improving air quality, conserving water, and harboring wildlife. They play an important role in climate control by moderating the effects of sun, wind, and rain. Unfortunately, the Palestinian natural ecosystems have become a casualty of the Israeli Occupation, due to the systematic uprooting of both natural and planted trees, demolition of fertile agricultural land, and the exploitation of scarce water resources.

The well established and continuing practices of the Israeli Occupation Authority have created a unique situation in the oPt which has significantly contributed to the degradation of the Palestinian environment and accelerated the process of climate vulnerability for the Palestinian people. Under Israeli occupation, new sets of rules affecting the environment and natural resources were imposed to ensure a good standard of living for the Israeli settlers.

Water resources in the oPt are already under significant pressure from rapid demographic growth, economic development and Israeli policies, but they are predicted to become scarcer as climate change causes a decrease in precipitation. Consequently the Israelis held full control over the Palestinian water resources and their utilization of the Palestinian water resources has been anything but a rational and equitable allocation system. Currently, they are exploiting more than 80% of the annual safe yield of the groundwater basins in the West Bank, whereas the quantity of water consumed by Palestinians constitutes around 20% of the annual safe yield (ARIJ, 2005).

They have also exacerbated the problem of land deterioration by making some areas accessible to Palestinians and other areas inaccessible. Under these conditions management and conservation of natural resources is a very difficult job and the prolonged years of Israeli Occupation have resulted in the desertification of large areas in the Palestinian Territory. Indicators of desertification appear clearly in the Eastern Slopes, which are characterized by steep slopes where agricultural activity is predominantly limited to animal grazing. The closure of 85% of these zones by the Israeli Occupying Authorities for military purposes has led to severe overgrazing of the remaining 15% that is accessible to Palestinian herders (ARIJ GIS database, 2010). Overgrazing has resulted in the loss of the vegetation cover, and intensive desertification.

The construction of the Segregation Wall has further compounded these problems with tens of thousands of trees having been uprooted in the West Bank. In addition to this, the Segregation Wall acts as a physical barrier to the terrestrial ecosystem disrupting wildlife corridors and, hence, wildlife mobility. Over 442,751 trees have been uprooted by the Israeli Occupation Forces between January 2000 and September 2009 (ARIJ GIS database, 2010). This will have a destructive effect on the oPt's climate, by disrupting the natural carbon sequestration process, in which carbon dioxide (CO<sub>2</sub>) from the atmosphere is absorbed by trees, plants and crops through photosynthesis, and is stored as carbon in biomass (tree trunks, branches, and roots) and soils. Trees that sequester carbon, when subjected to anthropogenic disturbances, can suddenly or gradually release the carbon back into the atmosphere. Practices that increase carbon losses and decrease sequestration tend to damage the quality of soil, water, air, wildlife habitat, and the ecosystem in general. Moreover, the practices methods of control exercised by the Israeli Occupation Authorities have systematically hindered the development of Palestinian society leading to increased level of poverty, environment degradation and a number of obstacles towards sustainable development in the oPt.

## Simulation and experiment

Although climate change is a global phenomenon, its negative impacts are more severely felt by poor people and developing countries. They are more vulnerable because of their high dependence on natural resources, and their limited capacity to cope with climate variability and extremes.

The impacts of climate change affect the vulnerability of poor communities. It is widely held that climate change will further reduce access to drinking water, negatively affect the health of poor people, and will pose a real threat to food security in many countries in Africa, Asia, and Latin America. In some areas where livelihood choices are limited, decreasing crop yields threaten famines, or where loss of landmass in coastal areas is anticipated, migration might be the only solution. The macroeconomic costs of the impacts of climate change are highly uncertain, but very likely have the potential to threaten development in many countries (Poverty and climate change report, 2003)

Developing countries are expected to suffer the most from the negative impacts of climate change. This is due to the economic importance of climate-sensitive sectors (for example, agriculture and fisheries) for these countries, and to their limited human, institutional, and financial capacity to anticipate and respond to the direct and indirect effects of climate change.

In general, the vulnerability is highest for least developed countries in the tropical and subtropical areas. Hence, the countries with the fewest resources are likely to bear the greatest burden of climate change in terms of loss of life and relative effect on investment and the economy.

In order to address and face all of the risks associated from climate change it was very important to take the initiative and start to prepare to face the reality of climate change and its effects on our society. It was with this sentiment in mind that the project entitled “Campaigning for Combating Poverty and Climate Change in the oPt” came into implementation by ARIJ. The main objectives of this project being:

- Raising the awareness among the people about climate change, its problems and effects, and the link between poverty and climate change.
- Advocate for better policies regarding combating poverty and climate change.
- Provide practical solutions for reducing the effects of climate change on our lives.

The project was conducted in all the West Bank Governorates, and it included eight awareness workshops during the period July 2009 and November 2009 with the participation of a wide variety of population including civil society communities, universities, locally active institutions and individual activists. In addition there was conducted a final workshop to present the recommendations created by governmental workshops and to develop an integrated recommendations regarding combating poverty and climate change from all participated stakeholders and activists.

Preceding these workshops required networking, preparation meetings, data collection on a governorate level, preparation of presentations, and preparing the awareness material including: the presentation, the leaflet (see Figure 1), the poster (see Figure 2) and Press Release in Radio and Newspaper to raise the awareness among the Palestinian people about Climate Change.

The awareness campaign engaged with the participation of a wide variety of the population including civil society communities, universities, locally active institutions and members of the poverty coalition in the oPt and individual activists. The level of participation varied from one

governorate to another, and they were very interested in the issue of climate change and poverty and their contributions were very fruitful.

## **Methodology used in the workshops**

The methodology used in the awareness workshops depended mainly on the community participation process. The community awareness workshops were divided into six sessions: (1) Session 1: included an introduction about the project objective and activities and about the objective of these workshops. A brief about the poverty coalition in the oPt and the relation between climate change and the poverty. Next, some statistics were given about the poverty rates in the oPt. (2) Session 2: a presentation about climate change was given, covering climate change, the causes of climate change, its effects on our life, environment and natural resources, the factors leading to climate change in the oPt, and finally some practices that we can make as individuals to reduce the emission of the global warming gases which are the main causes of climate change. (3) Session 3: presents a section of a documentary film entitled “home” which gives an over view of climate change and its problems on the world level. (4) Session 4: Brainstorming session; working with all the participants to shape the way in which participants think about climate change as well as to determine from their point of view, the climate change indicators in their governorate, (5) Session 5: Dividing the participants into several working groups according to the indicators of climate change which were previously mentioned in the discussion. Each group debated the causes of their particular indicator and the problems resulting from it. They then and then attempted to find solutions to solve these problems through suggesting some practical steps or solutions that could be done through ARIJ implemented projects (6) Session 6: Reconvene the large group and share the results of each group each of the visions and collapse all the results into one. Then, determine the final recommendations which all the participants have agreed upon.

The same methodology was used also in the final workshop but at the stakeholders level and was divided into three sessions: (1) Session 1: a brief description about the project, its goals, and the activities implemented during the project’s period was presented for the participants. (2) Session 2: presenting the results which we got from all the awareness workshops. (3) Session 3: after that we opened the discussion to the floor in order to get their feed back about these results and finally to get the final recommendations regarding combating poverty and climate change in Palestine.

## **Discussion and result analysis**

‘Community participation’ can be defined as the involvement of people in the community in projects to solve their own problems (WHO report). People can’t be forced to participate but should be given the opportunity where possible. This is a basic human right and a fundamental principle of democracy. Community participation can take place during needs assessment, planning, mobilising, training, implementing, monitoring and evaluation activities of any project (WHO report).



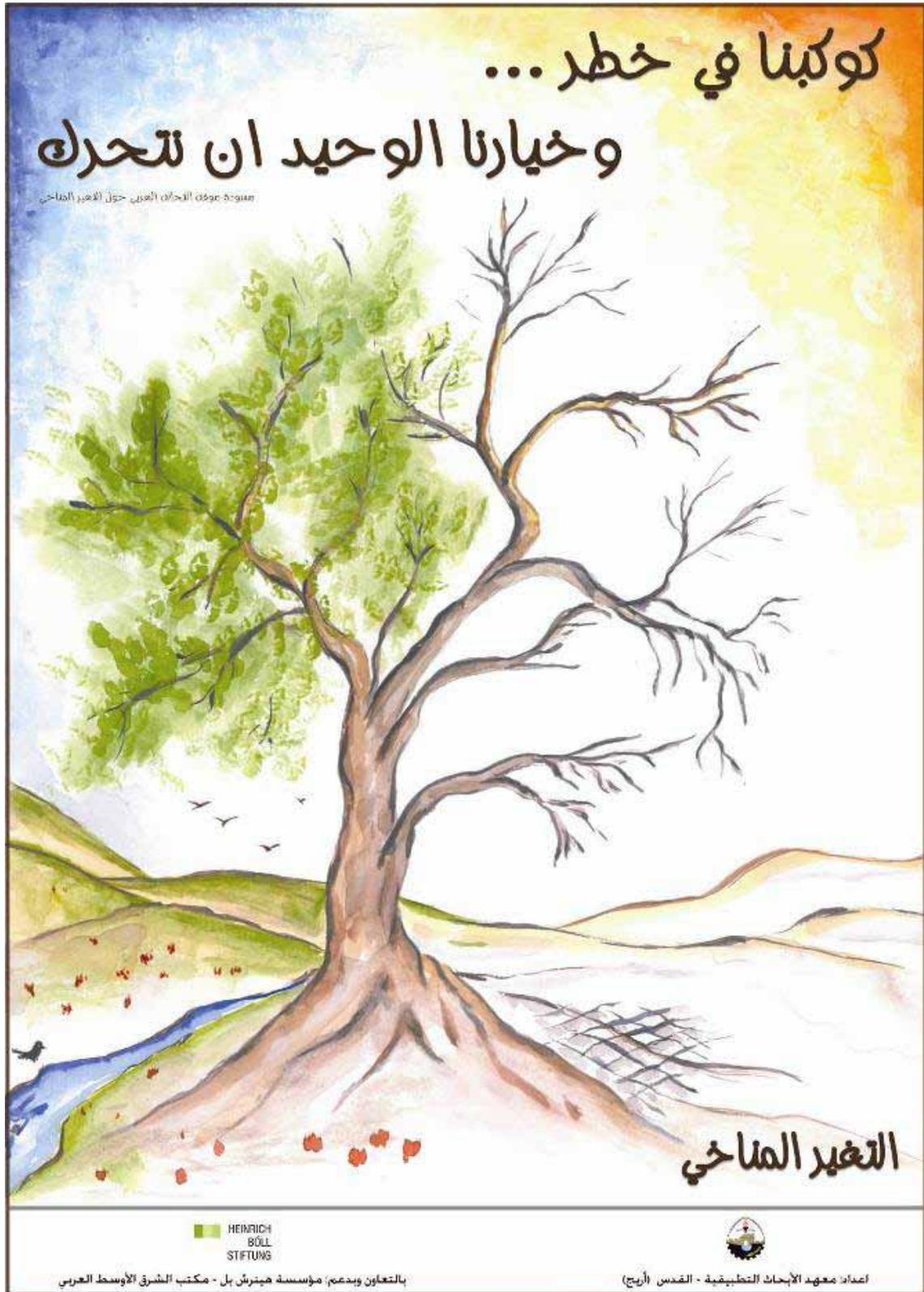


Figure 2: Climate Change Poster

Participation in planning reflects the type of governance that is inclusive in the country and thus actively strengthens and supports democratic values. Communities must become aware not only that they could be facing problems from climate change but also by participating in the development of adaptation strategies that they can play a part in the solution to these problems. The challenge is to connect the actions needed to deal with climate change to people's everyday needs and priorities.

The support from the stakeholders and residents for climate change adaptation plans achieved through participation is crucial to sustainable development. These plans are kept alive by communities and are successfully implemented, managed and maintained over a long period of time and thus are related to the needs of future generations.

Community activities that have been developed from the bottom up could become a cornerstone in the transformation of our country that is necessary in adapting to climate change (GRaBS, 2010).

The participation process was successfully implemented and the awareness workshops achieved their aims. The Participants' interaction and contribution in the conducted discussion was very good. Participants were stimulated to reflect on climate adaptation and possible solutions, and their perspective and interest yielded a range of suggestions and creative design proposals for adapting to climate change. They also provided good recommendations covering all aspects of the problems of climate change indicators.

The Following main indicators of climate change in the West Bank were made by the participants:

1. Climatic conditions which include: Season overlap, Low precipitation and bad distribution of rainfall, High Temperatures and drought, Storm Winds and Frosts.
2. The Scarcity of water sources and its pollution
3. Desertification and drought
4. Land degradation and soil erosion
5. Biodiversity Degradation; deterioration of plant cover and biomass
6. Decreasing area of agricultural land and its production capacity
7. The spread of diseases and epidemics
8. The increasing rate of unemployment and thereby increasing the poverty rate and associated socio-economic problems

The participants mentioned that the current water crisis in the West Bank is not a result of climate change but mainly the result of unsustainable water extraction from the Israeli side and the Israeli control over the Palestinian resources. Also the control over the Palestinian water resources should be the main issue to be highlighted. If there is no Palestinian control over the resources, the adaptation strategy or program will not succeed. In addition to the Israeli practices and restrictions in the West Bank which caused agricultural areas being abandoned and this increase the risk of desertification, and wastewater and solid waste management problems. All of these factors encourage the occurrence of climate change indicators in the West Bank.

The participants identified a number of solutions and Recommendations that may help in there point of view in solving the climate change problem in the West Bank, these recommendations

mainly centred on enhancing and improving water resource management, developing an integrated climate change adaptation strategic plan, a national plan to combat desertification and drought, national capacity building programs to enhance the capacity of the Palestinians to cope with current and future climate change, and the need for regulations and laws that enhance energy efficiency. With more details:

1. Development of an integrated climate change Adaptation Strategic plan
2. National Plan to Combat Desertification and Drought
3. Adaptive land use planning
4. Rehabilitation of water sources
5. Local increases in rainfall interception capacity and water harvesting projects
6. Adoption of a national project for the greening of Palestine
7. Effective land use planning system
8. Selection of crops and ruminants tolerant to heat and drought
9. Change in cropping and livestock patterns for productivity gains
10. Raise the environmental awareness and better practices among citizens
11. Resolve Palestinian water rights over the surface water and groundwater resources
12. The Palestinians should get their sovereignty over all of their water resources
13. Remove and close all the random dumping sites and establish sanitary landfills and solid waste reuse stations
14. The establishment of sewage networks and wastewater treatment plants and reuse treated wastewater in agriculture and industry
15. Organize and control the establishment of industrial factories among the residential areas
16. Encourage the use of renewable energy technology

However, all the participants agreed that an end to the Israeli occupation is a necessary condition for effective national planning.

## Conclusion

This paper has described ARIJ's experience in implementing a project regarding raising awareness among Palestinian people about the climate change, its problems and effects. It also details a community participation process in the identification of the climate change indicators in the oPt which provided practical solutions and recommendations regarding climate change in the oPt.

Community engagement is a key element in a democratic, equitable, innovative and effective response to climate change both as a mechanism for maximising the diversity of voices and ideas informing policies and strategies and as a basis for achieving sustainable changes in the actions and behaviours of communities, industries, households and individuals.

Effective community engagement is particularly important for addressing the challenges of climate change which require rapid and substantial changes to local, national and global systems and behaviours in order to achieve adapt to climate change.

The main recommendations that the participation mentioned mainly centred on enhancing and improving water resource management, developing an integrated climate change adaptation strategic plan, national capacity building programs to enhance the capacity of the Palestinians

to cope with current and future climate change, effective land use planning system, Change in cropping and livestock patterns for productivity gains, close all the random dumping sites and establish sanitary landfills and solid waste reuse stations, establishment of sewage networks and wastewater treatment plants and reuse treated wastewater in agriculture and industry and Encourage the use of renewable energy technology.

Palestine is already suffering the consequences of climate change and will continue to do so in the foreseeable future. Despite the constraints of living under a system of occupation we recognize the necessity of doing our best to take actions to ameliorate the probable affects of climate change in the oPt. However until we have sovereign control over our land and natural resources it is not viable for us to realize all to these necessary adaptations. We believe it is all of our responsibility to work together on national, regional and global level to tackle the very real threat of climate change. After all the impacts of climate change do not recognize political or geo political boundaries.

The oPt not only have to put in place mitigations measures to reduce the risk of progressive alteration of our climate, but also have to act to adapt to changes in climate that are already occurring.

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# **Overview of the Search for reform of Environmental Studies in the Higher Education System**

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## ABSTRACT

The paper will discuss and present work done in the search for reform of Environmental Studies in the Higher Education System including the Bologna Process, and Globalization and Higher Education. Discussions will cover teaching–learning interactions and reforms in higher education including the need for reform and its implementation, teacher’s capacities and expertise, courses offered and research nature, teaching - learning environment, learning spaces/facilities, stakeholders interaction, governance, academic standards and education reforms, higher education under conflict and military occupation, higher education and institutional diversity, higher education and environmental excellence, and higher education and socio-economic development. Adaptation of the lessons learned on the Palestinian case revealed that the continued Israeli military occupation of Palestine and the stringent economic growth represent the highest threats to Palestinian environmental higher education system reform.

**Keywords:** Reform, environmental studies, higher education, teaching-learning environment, Palestine

## Introduction

Almost everybody sees education as essential to development, but until recently very few of those responsible for formulating education policy for the developing world have acknowledged the value of higher education (Bloom, 2002).

The central link between education and development in the Middle East (Arab region) was summarized by UNDP as follows: despite a rich and time tested intellectual tradition, and notwithstanding the region’s tremendous human capital, the potential of people in the Arab region is constrained by barriers to knowledge acquisition, dissemination, production and utilization (UNDP 2002; Brookings Institution 2007 and 2008)

While the purpose of universities is to help society meet its skills needs to build a sustainable national competitive advantage for the future; these skills on the other hand need to be (a) carefully chosen and effectively and efficiently passed to students and (b) intellectual, professional and practical, and transferable, to fulfill society’s demand in years to come. Therefore, the issue is not the number of graduates and/or jobs available or secured, more precisely, graduates quality and skills which arranged to help society’s current and future sustainable development.

One of the lessons learned from other experiences in the world in analyzing teaching–learning interactions and reforms in higher education and we benefited from in this project is that successful institutional leadership and management need to be a continuous process in which all related and relevant parties need to be there and learning need to be by linking theory to practice.

It was noted that being involved in the whole development process, which was characterized by cycles of action and reflection, made both students and teaching staff become more adept at adjusting and adapting along the way. People are generally resistant to being ‘reoriented’ unless they regard the changes being proposed in organizational structure, mission, staffing, incentives, accountability, etc., as serving some compelling or transcendent purpose (Uphoff *et al.* 1991; Whyte 1991; Vernooy *et al.* 2008).

In this paper we think that we could benefit from letting all relevant parties be collectively involved in the reform or development process of environmental higher education system by presenting lessons learned and the needed teaching–learning interactions.

## **The search for reform: Lessons learned**

In search for the reform of environmental studies in higher education two major processes and phenomenon are involved and we could learn from: the bologna process and globalization.

### **The Bologna Process**

The European Higher Education Area (EHEA) is the objective of the Bologna process - to create more comparable, compatible and coherent systems of higher education in Europe. Under the Lisbon Recognition Convention of the Council of Europe, degrees and study periods are recognized mutually. Article 2 of the first Protocol to the European Convention on Human Rights obliges all signatory parties to guarantee the right to education.

To increase the development of modules, courses and curricula at all levels with ‘European’ content, orientation or organization, a Bologna process follow-up seminar reached an European shared vision on the implications and prospects of curricular integration and found that curricular integration (inter-institutional cooperation, mobility schemes and integrated programs of study, training and research) is a necessary condition, a priority, and a valuable instrument for awarding joint degrees by higher education institutions either at the national or regional level (Mantova 2003).

It was suggested that Bologna Follow-Up Group (BFUG) to take a lead role in ensuring coherence across the different strands affected by learning outcomes. It was also recognized that the pace and nature of change will not be uniform across all countries or all disciplines and accordingly continuing dialogue to achieve a common language and a shared understanding of that language is needed among various stakeholders (Edimburgo, 2004).

Fontes (2003) reported that further involvement of students is needed at all levels of decision making, this involvement should not only be legally permitted but effectively encouraged by providing the means necessary for active participation both in the formal and informal approaches.

### **Globalization and higher education**

The term ‘globalization’ is a complex cultural and social theory construct and a convenient euphemism concealing contested meanings and dominant perspectives and ideologies. It was suggested that globalization, political and economic systems, and the competitive market forces have generated a massive growth in the knowledge industries that are having profound differential effects on educational institutions and nations in general (Zajda and Geo-JaJa 2009).

## General implications

UNESCO-IIEP (1999) indicated that the potential effects of globalization are many and far-reaching, due to this phenomenon's scale and nature. It was also stated that globalization has major implications for regional and national economies, which, in turn, affect economic growth potential, resource available, work requirements, and the role of the state and consequently, it has major impact on the development of education systems, which have not been assessed. Among the foreseen implications of globalization were: the transformation of culture, the widespread use of information technology, and the increased decentralization and privatization of higher education.

After presenting three main points:

1. Higher education is essential to promoting sustainable human development and economic growth. It is no longer a luxury that only rich countries can afford, but an absolute necessity for all countries, and especially for poor countries.
2. The pressures of globalization make it urgent that we devote substantially more resources to the tertiary education sector, and that we also reform it at both the level of individual institutions and the system as a whole.
3. Good ideas are not enough – focusing on implementation is at least as important as policy design. The harsh realities of taking an idea to the field and bringing it to scale must be considered in the design of policy.

Bloom (2002) argued that globalization exerts new pressures on higher education, making reform essential. But ideas on reform are not enough – and here's another contradiction relating to both development and higher education: the policy community spends an inordinate amount of time coming up with clever ideas for reform, but very little time working out how to implement the policies effectively. This, of course, applies to most development priority areas.

## One system

It is important to remember that one higher education system cannot fit all the needs of nations of this world. There might be a desire in developing countries to build new universities using US or EU universities as models. This cannot work for developing countries including Palestine simply because what the US, EU, or elsewhere in the developed world want and need from their higher education programs is different from that of developing countries. It is better to base higher education on local needs and use and benefit from lessons learned elsewhere.

## Non-Educational needs

Not only educational needs but also differences in culture, demographic characteristics, and national motivations play an important role in the success of higher education programs. In a review of globalization experiences of American business schools and American universities' success

in opening branches worldwide Lovett (2010) indicated that it was clear that demography and culture, not politics, placed limits on the ability of American business schools to clone themselves successfully abroad.

### **National development implications**

Bennell and Pearce (2003) illustrated that the internationalization of higher education has far-reaching implications for the development of higher education in the developing and transitional countries. They found that national institutions will be faced with increasingly intense competition from foreign providers, which, without appropriate protective measures by the institutions themselves as well as the governments, could seriously affect their status and survival in the medium to long term.

### **Globalization and education reform**

It was shown that a complex nexus is taking place between globalization, ideology and education reforms— where, on the one hand, “ globalization is perceived as positive element in achieving democratization and progressive pedagogy which is equated with equality, inclusion, equity, tolerance and human rights”, while on the other hand, “globalization is perceived (by some critics at least) to be a totalizing force that is widening the socio economic gap between the rich and the poor, and bringing power, domination and control by corporate bodies and powerful organizations “ (Zajda, 2010).

Therefore, Zajda, (2010) concluded that we need to continue to explore critically the new challenges confronting the global village in the provision of authentic democracy, social justice and cross-cultural values that genuinely promote a transformative pedagogy. We need to focus on the crucial issues at the centre of current and on-going education reforms, if genuine culture of learning, and transformation, characterized by wisdom, compassion and intercultural understanding, is to become a reality, rather than rhetoric.

### **Teaching–Learning interactions for reforms in environmental higher education**

There are many interacting issues for reforms in environmental higher education. The following is a brief discussion of the most important ones in general and to Palestine in specific.

#### **The need for reform and its implementation**

As higher education sector serves the public interest, the systems of higher education, its governance, its role in developing science and technology, and its interrelation with general education are important issues to be continuously looked at and upgraded as a country’s development goes on.

The traditional forms of higher education put a high premium on continuity, on the careful accretion and testing of knowledge, in which teaching and learning are conducted within a well-understood and respected framework of institutional and teacher-student relationships. Within such stable

and assured frames, major advances in knowledge and the techniques for acquiring it could be confidently secured (Gornitzka et. al., 2005). In Palestine the political and consequent socio-economic contexts within which higher education institutions work have great importance and influence on the quality, turbulence, and performance of the sector.

All higher education institutions, both public and private, both nonprofit and for-profit, and from state colleges to research universities to community colleges to a wide variety of technical and professional schools, serve a public purpose. Considerable variation in quality, purpose, and aspirations exists in each of these sectors (Shapiro 2003). However, public purpose develop and change with time and accordingly higher education need to cope with such change and reform.

It is also important to recall that any higher education institution gains social legitimacy only by fulfilling the specific responsibility of providing the next generation with the capacities, beliefs, and commitments thought necessary to ensure society's goals.

It was stated that to achieve world excellence in science and technology, public must promote and defend two complementary and indivisible freedoms: the freedom of scientists to investigate and the freedom of entrepreneurs to innovate and market their products to the world (PDS, 2002).

Rowley and Sherman (2001) indicated that the future of academic institutions will be determined by highly astute, well-informed administrators who are capable of making the right choices.

Two main issues are of concern when discussing higher education reform: the extent to which reform and change is needed, and what changes are expected in the short, medium, and long term. Accordingly, strategic planning should cover teacher's capacities and expertise, courses offered, learning environment, learning facilities, institution governance, and stakeholders' participation and involvement. These factors, changes, and issues are briefly talked about below.

### **Teachers' capacities and expertise**

Driel *et al.* (2001) found that reform efforts in the past have often been unsuccessful because they failed to take teachers' existing knowledge, beliefs, and attitudes into account. They recommended long-term professional development programs are needed to achieve this objective including multi-method designs of (a) learning in networks, (b) peer coaching, (c) collaborative action research, and (d) the use of cases. In examining the students' satisfaction in higher education Butt and Rehman (2010) found that teachers' expertise is the most influential factor among all the variables, therefore it requires special attention from policymakers and institutes.

Deshields *et al.* (2005) found that faculty performance and classes were the key factors which determined the quality of college experience of students, which in turn led to satisfaction.

## **Funding and financing**

Concerning sources of funds and quality effects in higher education, Brown (2001) suggested that a greater reliance on private subsidies is associated with higher measures of teacher quality. Consistent with this, he found that a greater reliance on public subsidies leads to lower teacher quality ratings.

In analyzing the rise in total financial resources for higher education where there has been a significant shift in the share of resources coming from tuition and fees and a decline in the share coming from state appropriations, Berger and Kostal (2002) simulations of policy options illustrated the difficulty of maintaining enrollment levels in the face of tuition fee increases. They indicated that if tuition fees continue to rise, states are faced with reducing supply through lower state appropriations, or attempting to maintain current supply by increasing the amount of regulation in higher education.

Eaton (2002) described that distance or distributed learning raises a strategic and financial challenge for every type of higher education institution. Advancements in technology and expansion of markets for distributed learning pose questions for college and university presidents, regardless of their institutional mission.

## **Courses offered and research nature**

The nation's faculties have built up an enormous store of materials and ideas that provide the overall structure and content of their courses. Given the new technological capacity to convert this capital into instructional programs to be delivered over the internet, private interests have mobilized the financial capital needed to capture a new revenue stream from students unable to study on campus (Shapiro, 2003). For the copyright, two issues of concern were discussed:

- the area of copyright: material, one could assume faculty ownership and
- the area of patents: one could assume university ownership.

Stes *et al.* (2010) revealed that more attention should be given to studies researching behavioral outcomes, thereby drawing not only on self-reports of participants, but also measuring actual changes in performance. In examining research into teaching, learning and assessment in higher education in terms of structure and agency, Ashwin (2008) argued that although issues of structure and agency are seen as crucial in social theory, there has been very little focus on them and they were very little discussed in research associated with teaching, learning and assessment in higher education.

## Teaching - Learning environment

Ashwin (2009) indicated that while the importance of the dynamic nature of teaching–learning interactions is clearly recognized in texts aimed at improving teaching–learning processes in higher education, the interactive aspects of such processes are currently put in the background of research in this area. He also noted that there are two mainstream approaches to analyzing teaching–learning processes in higher education:

- The ‘Approaches to Learning and Teaching’ perspective: which has given a clear indication of how students’ and academics’ perceptions of teaching–learning environments are consistently related to the quality of their learning and teaching and to the quality of students’ learning outcomes.
- The ‘Social Practice’ perspectives: which has provided insights into the issues that students face in understanding the cultural context of their programs of study

The 21st Century Learning Environment will blur the line between on- and off-campus experiences and remove barriers to learning and research—greatly improving the quality of education for students globally. It was clear that students are comfortable with new technologies and expect to use them in the education environment (Wilén-Daugenti, 2007).

Lesch (2009) described that nearly all the discussions about contemporary education which are now taking place seem to concern the possible attempt to reform schools as they now stand. Seldom do serious discussions take place concerning what effective learning is and how that process may or may not be tied to the process of schooling. Learning and schooling may not only be entirely different endeavors, it is also possible that the latter may on occasion be an actual impediment to the former.

The Internet has already enabled the transformation of higher education by streamlining campus administrative processes, enhancing facilities such as dorms and classrooms, enabling digital libraries, expanding access to distance learning, and creating more-engaging learning environments through video and simulations. In this environment, learners have complete access to any higher-education resource, including experts, lectures, content, courseware, collaborative dialogs, information exchanges, hands-on learning, and research—no matter where they are located (Wilén-Daugenti, 2007).

It was indicated that web-based collaborative learning either as life-long learning, or distance learning, and/or informal learning will become a popular learning approach in the higher education field along with the development of a web-based environment (Jianhua and Akahori, 2001).

Accordingly, the main learning environment challenge to higher education institutions is how they will adapt to and use the surge of new technologies to stay relevant, manage in an environment

where students have unlimited access to information, can easily collaborate with others no matter where they are located, and will tap into expertise outside the campus walls to enhance and customize their learning.

In answering the question: Does the technology affect how faculty members teach and how students learn?”, St.Clair and Martin (2005) indicated that it all funnels down to a course that an instructor teaches with the goal of students learning using technology tools as appropriate.

### **Learning spaces/facilities**

Webber and Ehrenberg (2010) found that student service expenditures influence graduation and persistence rates and their marginal effects are higher for students at institutions with lower entrance test scores and higher Pell Grant expenditures per student. They also suggested that reallocating some funding from instruction to student services may enhance persistence and graduation rates at those institutions whose rates are currently below the medians in the sample

The Center for Teaching and Technology (2006) found that as we have come to understand more about learners, how people learn, and technology, our notions of effective learning spaces will change. Increasingly and with time, those spaces are flexible and networked, bringing together formal and informal activities in a seamless environment that acknowledges that learning can occur anyplace, at any time, in either physical or virtual spaces. The effective design of learning spaces-whether a classroom, a laboratory, a library, or an informal space-can enhance learning (ELI, 2006). More and more we see the power of built pedagogy (the ability of space to define how one teaches) in colleges and universities (Oblinger, 2006).

### **Stakeholders interaction (participation/involvement)**

Mayo *et al.* (2004) illustrated that conflicting family/work demands, financial issues and academic concerns were the factors identified by students as possible reasons for attrition.

In discussing the possibilities and contradictions of the interaction between sustainable development and higher education, Gough and Scott (2007) argued that sustainable development presents universities with a wide range of opportunities to fulfil their proper functions in teaching and research, that higher education has an essential role if any sort of sustainable development is to be achieved, but that the realization of this shared potential is likely to be fraught with pitfalls.

### **Governance**

Governance in general covers the relationship between government and higher education, funding, steering mechanisms, quality and accreditation. Sayed (2000) indicated that the debate about higher education governance is reflective of positional and organizational locations. Those outside direct state apparatuses may perceive certain forms of regulation as control, while the state may perceive such regulation to be supervision. The politics of policy is thus about the positionality of individuals

and groups. It was noted that differentiation, which denotes the presence of community colleges, has a democratizing effect: it increases overall enrollment in postsecondary institutions as well as decreases the gap in enrollment between students from different social strata (Roksa, 2008).

Byrd (2001) indicated that there is increasing evidence that higher education is in a process of transformation, where institutions of higher education are becoming more business-like, more like virtual and corporate universities, and are heavily engaged in retooling their products. Global universities, virtual universities, and corporate universities are together adapting new technologies to academic needs. In consequence, higher education is becoming more affordable, is moving away from buildings and campuses, is focusing on developing the critical thinking skills of students, and is developing superstar faculty.

It was argued that centralization and decentralization reforms in education reflect a neo-liberal ideology at work, they do not necessarily capture a complexity of forces fuelling educational and policy change. Academic standards, performance and quality of schooling continue to dominate the reform agenda globally, especially the performance league tables. At the same time, there are also politically determined curricular reforms affecting the nature and the content of history school textbooks (Zajda, 2010).

### **Academic standards and educational reforms**

It has been argued that the politics of education reforms surrounding national curricula, standards, excellence and quality, as well as outcomes-based curriculum reforms have ‘largely come from Northern, often World Bank, ideologies’ (Zajda, 2010; Watson, 2000; World Bank, 1999; Zajda, 2005 a&b; Zajda and Geo-JaJa 2009). At the same time, others argue that high stakes testing reforms, driven by political and cultural ideology and concerns for efficiency and economic productivity, serve to impede the development of real equality of educational opportunity, particularly for the least advantaged students (Zajda, 2010; Moses and Nanna 2007).

### **Higher education under conflict and military occupation**

Since 1967 and until present, more than 1,300 Palestinians schools, universities, and colleges have been disrupted by Israeli Army imposed curfews, and closures in the Palestinian Territory. This in addition to many students being tortured, held in detention, or under arrest, and/or in jails.

A report by Strategic Foresight Group has mentioned the academic cost of conflict in the Middle East. After the 2003 US war in Iraq, there has been a deliberate targeting of educational establishments by militants. In 2007, 353 academics were assassinated. Almost 800,000 children are currently out of school, and over 3,000 academics have fled the country. Over 30% of children and 40% of university students stay at home due to fear, and paucity of schools near them (Wikipedia, 2010).

In the Lebanon 2006 war, Lebanese children were some of the worst affected, where 33% of all civilian deaths were children and 390,000 children were displaced. 40,000 children had their

education disrupted during the war, with over 300 schools having been damaged (Wikipedia, 2010).

It is important to mention that by putting these pressures on faculty and students, a brain drain process goes on and the best quality of the country's academic and research capacities leave for outside areas looking for better socio-economic conditions and political stability. This issue will hinder the success and implementation of any higher education reform plan.

### **Higher education and institutional diversity**

Diversity has been identified in the higher education literature as one of the major factors associated with the positive performance of higher education systems. Well planned and directed institutional diversity in higher education systems represents an important element of policy making. The following advantages of institutional diversity were identified (Birnbaum, 1983; VanVught, 2009):

1. Increased diversity in a higher education system is an important strategy to meet student needs.
2. Diversity provides incentives for social mobility.
3. Diversity is supposed to meet the needs of the labor market
4. Diversity serves the political needs of interest groups.
5. Diversity permits the crucial combination of élite and mass higher education.
6. Diversity is assumed to increase the level of effectiveness of higher education institutions.
7. Diversity is assumed to offer opportunities for experimenting with innovation.

### **Higher education and environmental excellence**

Higher education is one of the nation's most valuable assets and it is the reference for natural and human resources development. Colleges and universities continue to be stewards of environmental research, education, and innovation. Colleges and universities as a sector are committed to human better public health, environmental protection and conservation, and compliance with environmental laws and teaching base there programs to achieve this objective (CSHEMA et. al., 2002). Higher education programs at colleges and universities would, among others, help in the following directions:

1. Identifying regulations that need to be tailored to the higher education community.
2. Creating performance-based environmental standards that encourage pollution prevention and protect the environment.
3. Creating interpretive guidance for the regulated community and for federal, state and local regulators to enhance consistency and understanding of compliance expectations, and
4. Expanding compliance assistance to address specific situations on a national basis.

### **Higher education and socio-economic development**

Higher education should be the milestone for any society's socio-economic development. If this sector is operating under limited conditions and being unable to serve and provide the requirements for country's socio-economic development, it will act negatively, i.e., hold back development.

Shapiro (2003) indicated that universities, like other social institutions and even individuals, ought to serve interests that include but move beyond narrow self-serving concerns as both a responsive servant and a thoughtful critic. In other words, universities should not serve our own interests alone. He noted that this is one of those ideas that, while applauded in principle, is easily lost in the challenge of meeting one's day-to-day responsibilities.

### **Adaptation of lessons learned to the Palestinian case**

To adapt lessons learned from environmental higher education system reform related risks and threats to the Palestinian case, a simple matrix of higher education reform related threats against the impacts or responses expected from these threats was formed (see Table 1). Based on the available data and author's experience and judgment, related impacts were given a scale from 1 (very low) to 5 (very high). Then the sum of scales for each threat and each impact was estimated.

As listed in Table 1; the highest sums for the higher education reform related threats revealed that the following six threats – listed in order have the highest sum of impact weights:

- Continued Israeli Military Occupation and Related Activities
- Stringent Economic Growth
- Increase in Graduate unemployment rates
- Increasing Palestinian Population Growth
- Re-humanizing the University (Emphasizing humanities majors)

The highest sums for the impacts or responses connected with the higher education reform related threats revealed that the following five impacts - listed in order have the highest sum of weights (see Table 1):

- Decrease Funding and Financing
- Worsen Academic Standards
- Program Development Decline
- Worsen University Infrastructure
- Decrease in Extracurricular Activities

It is clear that the continued military occupation of Palestinian land and natural resources along with its related activities represent and continue to be the highest threat to Palestinian environmental higher education reform followed by and interrelated with stringent economic growth. As the decrease in funding and financing, worsening of academic standards and decline in program development got the highest sum of impacts, it indicates that reform of Palestinian environmental higher education system is not an easy job to do and need attention and involvement from the highest level of the government and decision making.

### **Concluding remarks**

Based on the analysis made in this paper, it was concluded that:

- reforms in environmental higher education system is a multidisciplinary–multifunctional important ongoing process in which all local and international lessons and experiences and learning-teaching interactions should be taken in consideration,

- the specificity of local demography and culture is a major driver to be considered in searching for such reforms,
- the continued military occupation of Palestinian land and natural resources along with its related activities represent and continue to be the highest threat to Palestinian environmental higher education reform,
- the decrease in funding and financing, worsening of academic standards and decline in program development got the highest sum of impacts from related threats and risks.

**Table 1: Matrix of Environmental Higher Education Related Threats and their Impacts**

Environmental Higher Education Reform Related Threats	Impact/Response																							
	Worsen University Infrastructure	Decreased Demand on Higher Education	Decrease Knowledge Dissemination	Decline in institutional Competitiveness	Technical capacity Decrease	Worsen Environmental Excellence	People's Livelihood Decrease	Computer /Internet Application Decline	Worsen Laboratories	Program Development Decline	Worsen Academic Standards	Decrease Funding and Financing	Worsen Stakeholders Interaction	Worsen Learning Spaces/Facilities	Research Decline	Worse quality of Courses Offered	Worsen Teaching - Learning Environment	Worsen Teachers' Capacities and Expertise	Worsen Teaching Practices	Decrease in Extracurricular Activities	Enhance Field Training	Weaken Institutional Capabilities	Worsen Skills and Tools	Decrease students Knowledge uptake
	5	4	5	5	4	5	5	4	4	5	5	4	4	5	5	5	5	5	5	5	5	4	4	5
Continued Israeli Military Occupation and Related Activities	5	5	5	5	4	5	5	4	5	5	5	5	5	5	5	5	5	4	4	5	5	5	4	4
Stringent Economic Growth	4	3	5	5	3	4	4	4	4	4	5	4	5	4	4	4	4	4	4	5	5	4	4	4
Increasing Palestinian Population Growth	4	3	4	4	3	4	4	4	4	4	4	4	4	4	4	5	4	4	4	5	5	4	4	4
Continued Colonization of Land and Resources	3	3	3	3	2	3	4	3	3	3	2	4	3	4	2	2	4	3	3	3	3	3	3	3
Poor Sector Governance	3	4	4	3	3	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3	4	5	4	4
Potential increase in Natural Resources Pollution	4	3	4	4	3	4	2	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
lacking in strategic vision	4	3	4	4	3	4	2	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Poor student enrollment practice	4	3	4	4	3	4	2	4	4	4	4	4	4	4	4	4	4	4	4	3	3	3	4	4
High Institutional Diversity	3	2	4	3	2	3	3	3	4	3	3	4	4	4	3	3	2	2	3	3	3	3	4	4
Increase in Graduate unemployment rates	5	4	5	5	4	5	1	5	5	5	5	5	5	5	4	4	4	4	4	4	4	5	4	4
Unqualified Board of Trustees	3	3	2	2	2	2	1	3	2	3	3	3	3	2	2	2	2	2	2	3	2	2	2	2
Increase in emerging technologies Applications	3	3	2	2	1	3	1	3	2	3	3	4	3	3	2	3	3	3	2	3	2	2	3	4
Increase in Tuition Fees	5	4	5	5	4	5	1	4	5	5	5	4	3	4	4	4	4	4	4	5	5	4	3	4
Rehumanizing the University	5	3	5	5	4	5	4	3	5	5	5	4	5	5	5	5	5	5	5	5	5	5	5	5
Limited commitment to free expression	5	3	4	4	3	4	2	5	5	5	5	5	4	4	4	4	4	4	4	4	4	4	4	4
Limited Private sector involvement	5	3	4	4	3	4	2	5	5	5	5	5	4	4	4	4	4	4	4	4	4	4	4	4
Higher education given low Priority by Government	5	4	4	4	4	5	5	4	5	5	5	5	5	5	5	5	4	4	4	5	5	5	5	4

Note: 5 = Very high, 4 = high, 3 = medium 2 = Low, 1 = Very Low

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# **Developing a GIS-based Suitability Map for Rainwater Harvesting in the West Bank, Palestine**

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## ABSTRACT

In arid and semi-arid regions, the availability of adequate water of appropriate quality has become a limiting factor for development. Dry spells are a direct consequence of spatial and temporal variability of rainfall, and these jeopardize the replenishment of different water resources in the West Bank, Palestine. Rainwater harvesting (RWH) is an unconventional water source that is increasingly adopted in the West Bank. The potential of RWH (e.g. cisterns) to mitigate the spatial and temporal variability of rainfall has been confirmed in the region. Its implementation is promoted by local communities and non-governmental organizations to alleviate temporal and spatial water scarcity for domestic, crop and livestock production and support the overall water resources management in the West Bank. This paper aims to develop RWH suitability map for the West Bank. In this study, RWH suitability map is developed based on a combination of spatial weighted factors of landuse, soil, topography (slope), and runoff coefficient. Model Builder of ArcMap 9.3, that enables a weighted overlay of thematic datasets, is used to create the suitability map of RWH for the West Bank. Results indicate that about 40% and 11% are suitable and highly suitable for RWH, respectively. Details of the proposed method as well as the suitability map produced are presented in this paper. The implementation of the obtained results is envisaged to support any governmental policy shifts towards wide spread adoption of RWH in the West Bank.

**Keywords:** Rainwater harvesting; Geographic information system; Suitability map, West Bank.

## Introduction

Rainwater harvesting (RWH) is a general term, which describes the practice of collection, storage, and use of rainwater runoff for both domestic and agricultural purposes (Siegert 1994; Gould and Nissen-Petersen 1999).

Gould and Nissen-Petersen (1999) categorized RWH systems according to the type of catchment surface used. These types are roof catchment systems, rock catchment systems, ground catchment systems, and check or earth dams. According to the type of catchment surface used, it is classified into infield RWH (IRWH), ex-field RWH (XRWH), and domestic RWH (DRWH). DRWH systems collect water from rooftops, courtyards, compacted or treated surfaces, store it in tanks (cisterns) for domestic uses. IRWH systems use part of the target area as the catchment area, while XRWH systems use an uncultivated area as its catchment area (Mwenge Kahinda *et al.*, 2008). DRWH is widely practiced at household level in most of the West Bank rural areas.

In arid and semi-arid regions, RWH has been used for many years to enhance water productivity (for both agricultural and domestic uses) by mitigating temporal and spatial variability of rainfall (Boers *et al.*, 1986; Bruins *et al.*, 1986; Reij *et al.*, 1988; Critchley *et al.*, 1991; Abu-Awwad and Shatanawi 1997; van Wesemael *et al.*, 1998; Oweis *et al.*, 1999; Li *et al.*, 2000; Li and Gong 2002; Rosegrant *et al.*, 2002; Ngigi *et al.*, 2005; Ngigi 2006; Oweis and Hachum 2006; Rockström and Barron 2007; Mwenge Kahinda *et al.*, 2007a; Mwenge Kahinda *et al.*, 2007b; Makurira *et al.*, 2009). Shadeed and Lange (2010) have confirmed the potential of RWH to bridge the supply-demand gap in the Faria catchment located in the northeastern part of the West Bank.

RWH is an ancient technology that is gaining popularity in a new way. Its history can be traced back to biblical times. Extensive rainwater harvesting apparatuses existed 4 000 years ago in Palestine and Greece (Evenari *et al.*, 1971; Critchley *et al.*, 1991). In India, simple stone rubble structures for impounding rainwater date back to the third millennium BC. This was also a common technique throughout the Mediterranean and Middle East. Water collected from roofs and other hard surfaces was stored in underground reservoirs (cisterns) with masonry domes (Agarwal and Narain, 1997). On slopes, rural rainwater harvesting techniques have provided supplementary water for rain-fed agriculture in arid and semi-arid regions (Yair, 1983; Giráldez *et al.*, 1988; Tabor 1995; Lavee *et al.*, 1997).

RWH is commonly used in Spain, northern Africa, and arid and semi-arid parts of India to meet the water needs of families and their livestock (Chapman 1978; Samra *et al.*, 1996; Joshua *et al.*, 2008). In arid and semi-arid regions, rainfall produces discontinuous runoff that in many cases never reaches the valley bottom. Therefore, suitable sites where runoff is produced are limited and relatively small (Lavee and Yair, 1990; Brown and Dunkerley, 1996). Lavee *et al.* (1997) have shown that rock outcrops produce runoff that tends to infiltrate further down slope in the colluvial mantle during the majority of events. These rock outcrops and thin, stony soils show a spatial distribution that depends on the topography and land use (Poesen *et al.*, 1998).

In Western Europe, America, and Australia, RWH has often been the primary water source for drinking water. In all three continents it continues to be an important water source for isolated homesteads and farms (Agarwal and Narain, 1997; Khastagir and Jayasuriya, 2010). Recently, growing scarcity and intersectoral competition for water between all users in arid and semi-arid regions, along with groundwater depletion and problems facing major surface water control systems, have raised interest in restoring water harvesting systems that capture rainwater wherever it falls (Kerr and Pangare, 2001).

RWH has various constructive benefits. It is inexpensive and highly decentralized, empowering individuals and communities to manage their water. It is environmentally safe and can be reasonably utilized. It provides a reliable renewable resource with special management and little investment. The harvested water can be transported with little energy. In agriculture, comparing to the 10% increase in food production from irrigation, RWH has demonstrated the potential of increasing food production by 100%. Generally, on 80% of the world's agricultural land area, rain-fed agriculture is practiced and it generates 65%-70% of the world's staple foods. For instance, in Africa more than 95% of the farmland is rain-fed, and almost 90% is rain-fed in Latin America (UNEP, 2009).

FAO (2003 in Mwenge Kahinda *et al.*, 2008) lists six key factors when identifying RWH sites: climate (rainfall), hydrology (runoff generation potential), topography (slope), agronomy (crop characteristics), soils (texture and structure) and socio-economic (population density, work force, people's priority, experience with RWH, land tenure, water laws, accessibility and related costs). A number of studies present methods for assessing RWH suitability of a given area. Those studies commonly use physical factors such as rainfall, land cover/use, soil characteristics and topography for the assessment of suitability. For instance, Mbilinyi *et al.* (2006) used rainfall, soil depth, soil texture, differential global positioning system points, aerial photos, ground truthing and

topographic maps while Mati *et al.* (2006) used baseline thematic maps (rainfall, topography, soils, population density and land use) to produce composite maps that show attributes or “development domains” that serve as indicators of suitability for targeted RWH interventions. Mwenge Kahinda *et al.* (2008), developed suitability map for rainwater harvesting in South Africa based on physical, ecological and socio-economic attributes.

This paper presents a GIS-based model, which combines landuse, soil, topography, and runoff coefficient, to develop the suitability map for RWH in the West Bank, Palestine. The developed map will be of great importance to verify the adoption of RWH as one of the proposed water resources management options to bridge the supply-demand gap in the West Bank, which is an example of an area facing severe water scarcity.

## Description of the Study Area

The West Bank, Palestine is located in the Middle East, west of Jordan (see Figure 1). It has a surface area of 5,640 km<sup>2</sup>. The West Bank has a varied topography with ground surface elevations between 1,022 m above mean sea level in Tall Asur in Hebron in the south and 410 m below mean sea level near Jericho (adjacent to the Dead Sea) (UNEP, 2003). The summits of the West Bank Mountains delineate catchment lines and the water divide separating the western and the eastern catchments. The Jordan Valley is part of a long and deep depression of the earth’s crust, widely known as the Jordan Rift, running along the edge of the country separating it from Jordan (ARIJ, 2000).

The West Bank is mostly composed of limestone hills, brown lithosols and loessial arid brown soils cover the eastern slopes and grassland, with pockets of cultivation spreading over the steep slopes. Fertile soils are found in the plains. Soil cover is generally thin. Over all, about 12 percent of the land is desert, eroded or saline (UNEP, 2003).

The structural geology of the West Bank is dominated by a series of regional, parallel, southwest-northeast trending folds dissected by faults associated with the Jordan Rift Valley. The fault turns towards the northwest near Jericho. Some faults in West Bank act as conduits and some others represent barriers to groundwater flows.

In the catchments of the West Bank, surface runoff is mostly intermittent and constituted nearly 2.2% of the total equivalent rainfall (Rofe and Raffety, 1965).

The West Bank climate may be broadly described as a Mediterranean type, where it varies between hot dry in summer to wet cold in winter with short transitional seasons. Because of the wind, humidity, latitude and differences in altitude, there are considerable number of micro-climatic patterns. The area experiences extreme seasonal variations in climate. Large rainfall variations also occur from year to year. Consecutive years of relatively high or low annual rainfall have an enormous effect on the region and, in the case of dry years, present the greatest challenge to managing the region’s precious water resources.



**Figure 1: Regional Location Map of West Bank**

The rainy season usually begins in November and ends at the end of March. Rainfall is concentrated over a short period, with more than 60% of the annual rainfall commonly occurring in less than two months. Rain tends to fall in intense storms. This result in tremendous runoff during a few months and the country remains dry for almost the rest of the year. In general, rainfall is characterized by a high variation both temporary and spatially. In Nablus, for example, a minimum of less than 315 mm/season (1951/52) and a maximum of more than 1387 mm/season (1991/92) have been recorded, whereas the long term annual average is 642 mm. Rainfall decreases from north to south and from high to low altitudes. The yearly rainfall is as low as 100 mm in the Jordan valley, located in the rain shadow of the mountain ridge, to as high as 700 mm in the semi-coastal region.

The land cover map of the West Bank is classified into seven classes; built-up areas (5%), woodland/forest (0.7%), Israeli settlements (1.4%), arable land (14.31%), rough grazing (61.7%), irrigated farming (2.63%) and permanent crops (14.3%). Four soil textures exist in the West Bank; clay, clay loam, loamy, and sandy loam.

## Spatial data layers

The best available datasets at national level of soil, land cover, DEM, and rainfall layers were first obtained and compiled in a GIS-based database (MoP, 1997). As the overall methods work in the raster environment with grid format layers, vector themes were converted into grid themes of cell size 25m×25m. Figure 2 shows the average annual rainfall distribution in the West Bank. Figure 3 depicts the land cover of the West Bank. Soil texture and slope are extracted from the soil and DEM layers respectively (Figure 4 and Figure 5, respectively).

Shadeed and Masri (2010) derived a spatial distributed CN for the entire West Bank. From which the spatial distribution of annual runoff (Figure 6) was obtained using the SCS-CN method. For the purpose of this study, spatial distribution of runoff coefficient (RC) (Figure 7) for the entire West Bank is obtained by dividing the annual rainfall average layer by annual runoff layer.

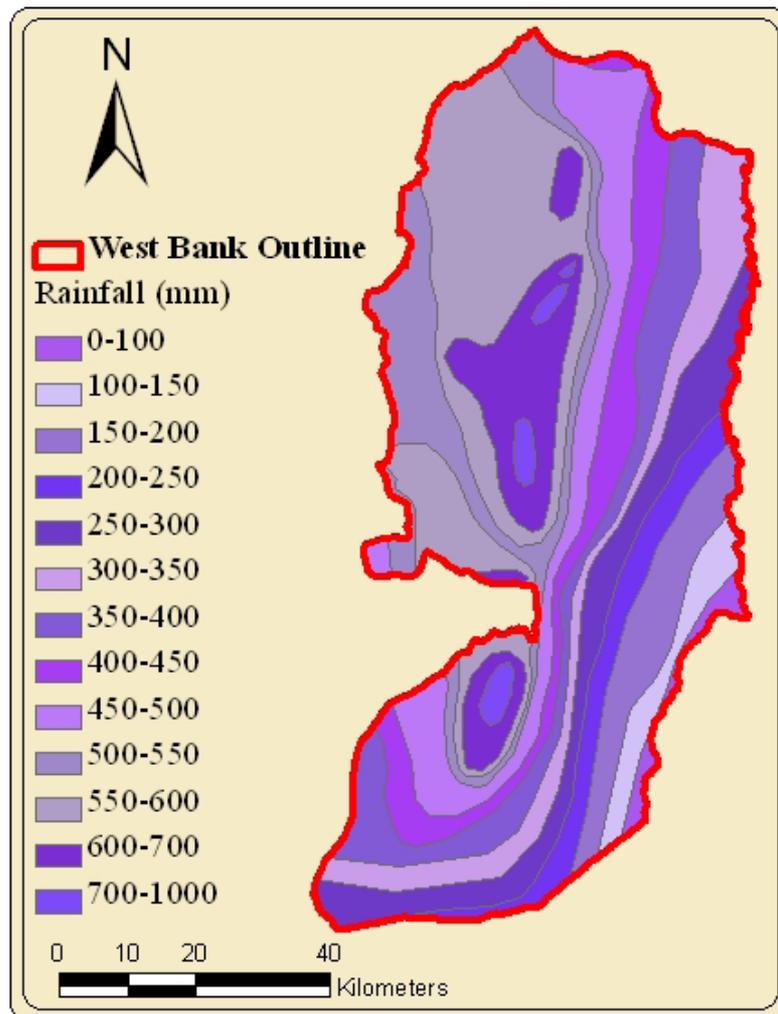


Figure 2: The Average Annual Rainfall Distribution in the West Bank

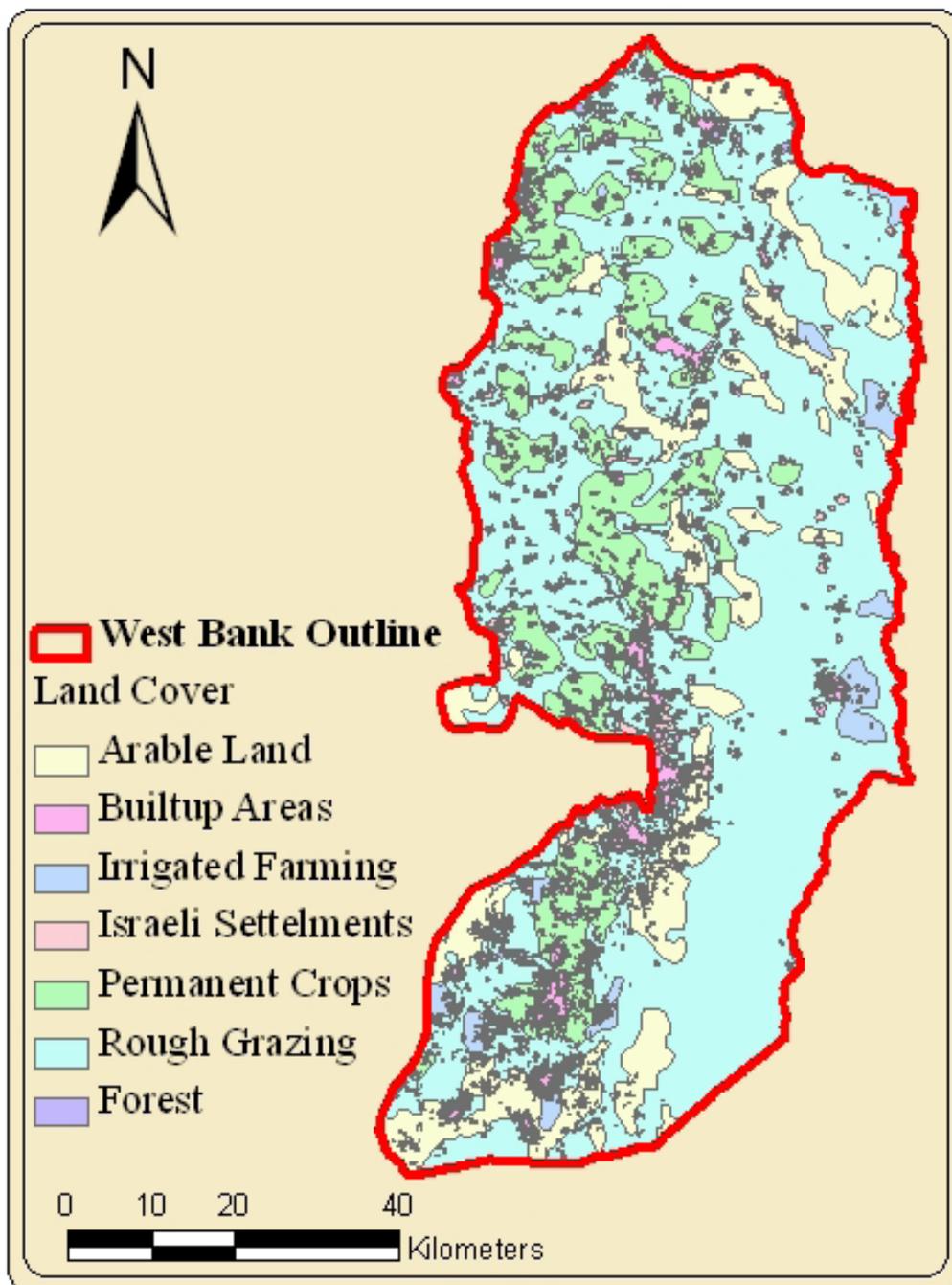


Figure 3: Land Cover Distribution in the West Bank

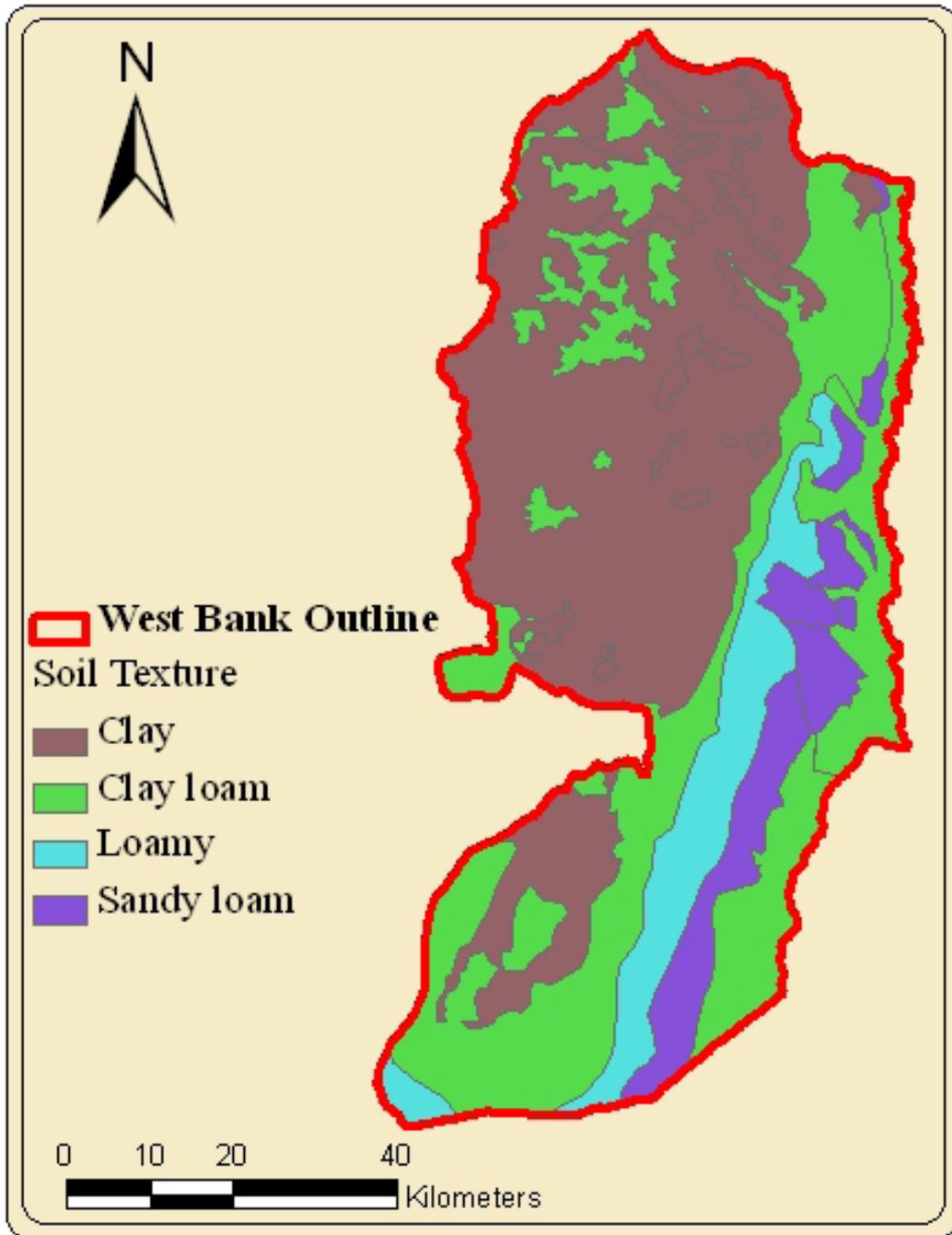


Figure 4: Soil Texture Distribution in the West Bank

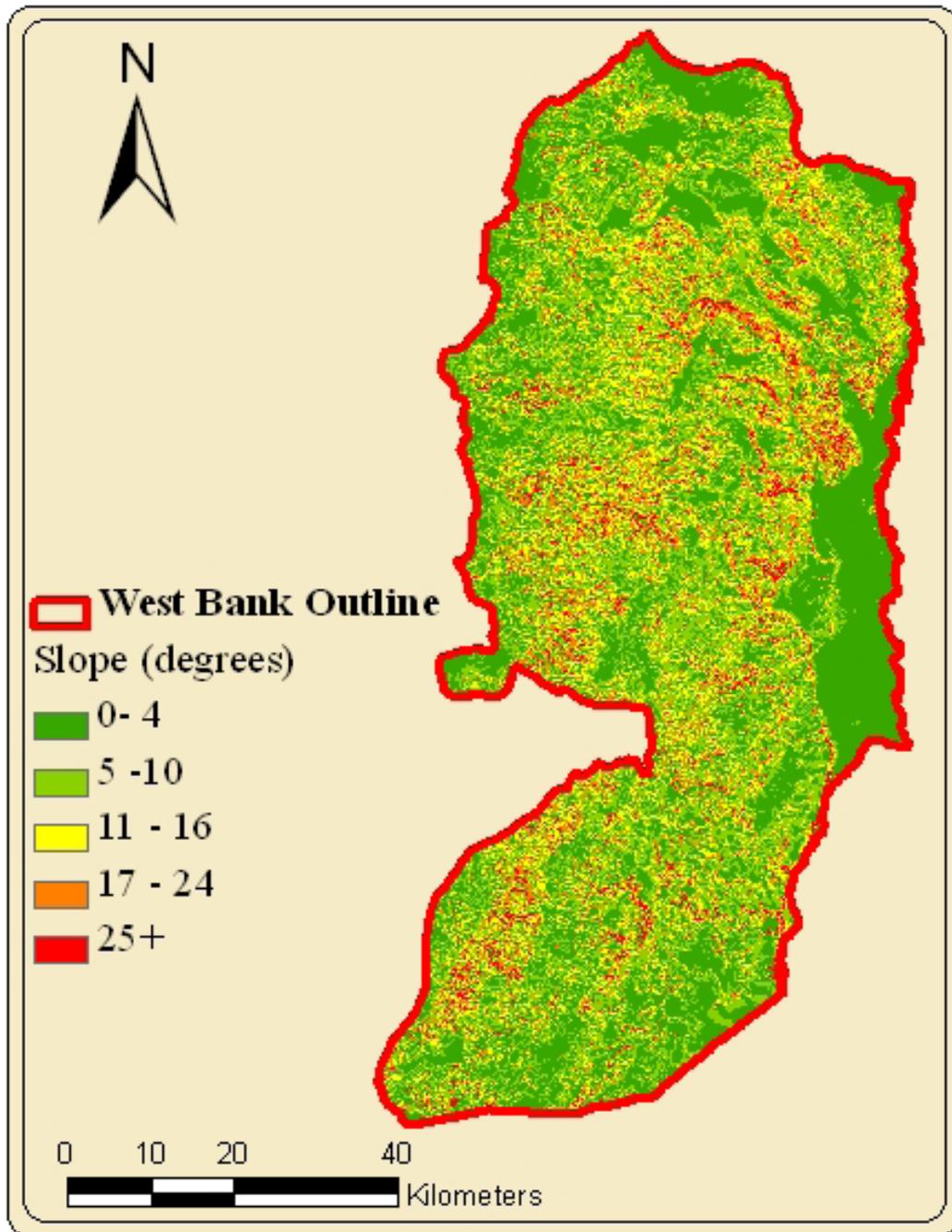


Figure 5: Slope Distribution in the West Bank

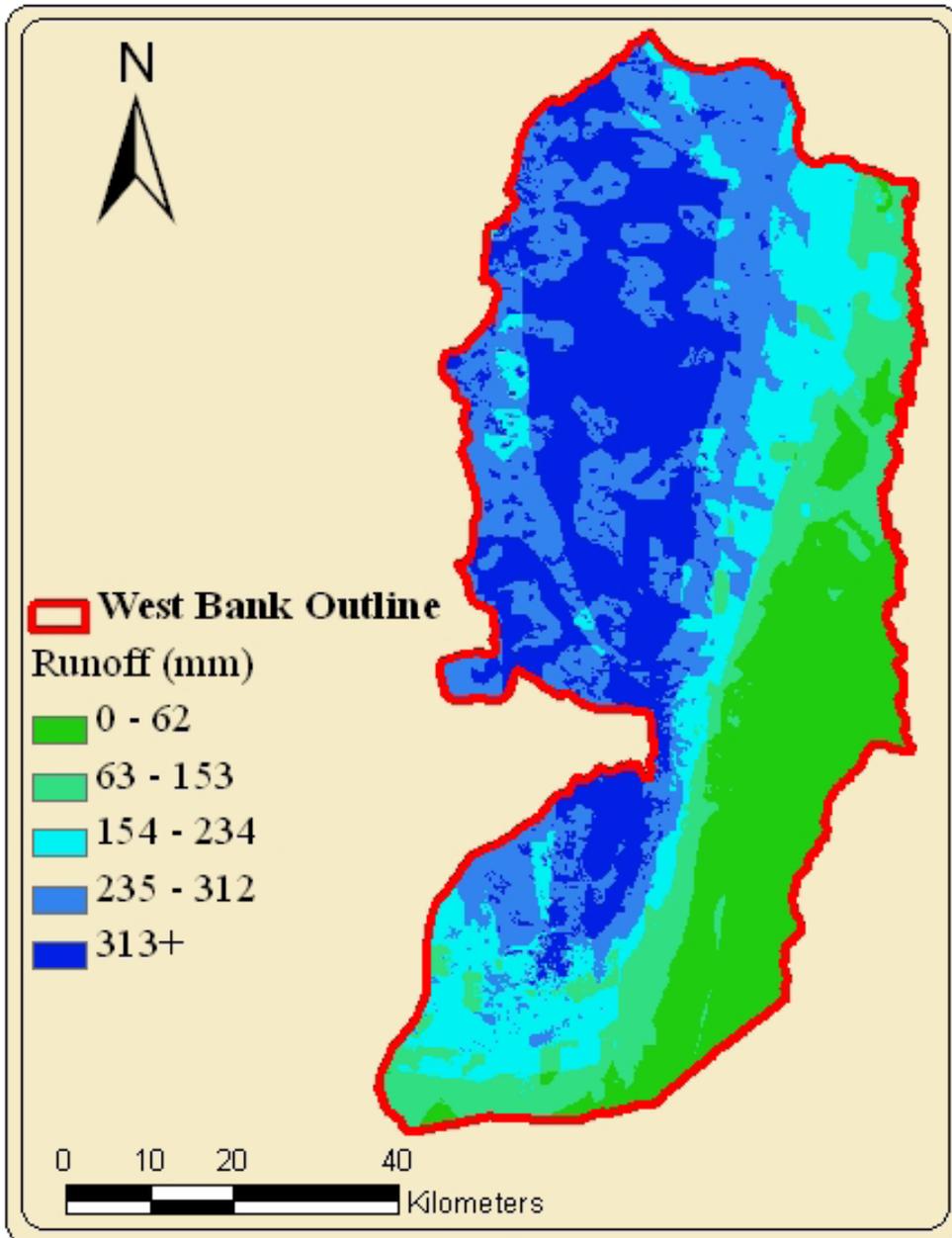
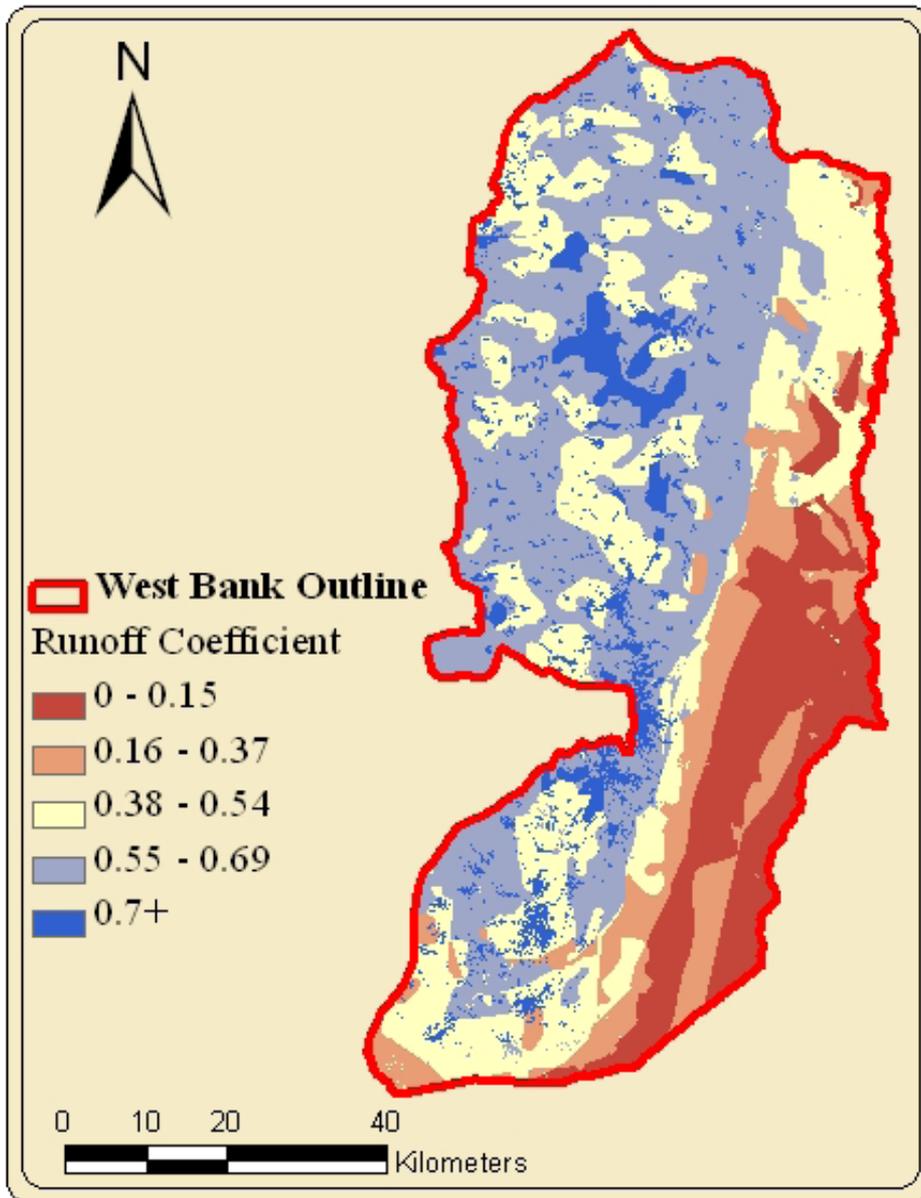


Figure 6: The Annual Runoff Distribution in the West Bank



**Figure 7: Runoff Coefficient Distribution in the West Bank**

Different suitability values (weights) were subjectively assigned to the land cover (L), soil texture (ST), slope (S), and runoff coefficient (RC) layers. The weight of each layer reflects its importance in RWH potential. Assigned weights are as presented in Table 1. The input layers (L, ST, S, and RC) classes in the dataset were ranked according to their suitability to RWH. User-specified cell values (suitability) of each layer were reclassified from 1 to maximum value equals the number of different classes for each layer as presented in Tables 2 through 5. The most suitable parameters to RWH were classified as the number of different classes, while the least suitable were classified as 1. To customize the development of RWH suitability map, the conversion to grid theme (with the same coordinate extent; Palestine 1923, Palestine Grid) and the reclassification was done during the data processing using Model Builder of ArcMap 9.3.

**Table 1: Assigned Weights for Different Factors**

Layer	Weight
L-Landuse	0.2
ST-Soil Texture	0.15
S-Slope	0.25
RC-Runoff Coefficient	0.4

**Table 2: Land Cover Classes Suitability Ranking**

Class	Rank
Arable Land (supporting grains)	4
Built-up Areas	7
Irrigated Farming (supporting vegetables)	1
Israeli Settlements	2
Permanent Crops (grapes, olives, citrus, and other fruits trees)	3
Rough Grazing/Subsistence Farming	6
Woodland/Forest	5

**Table 3: Soil Texture Suitability Ranking**

Texture	Rank
Clay	4
Clay loam	3
Loamy	2
Sandy loam	1

**Table 4: Slope (degrees) Suitability Ranking**

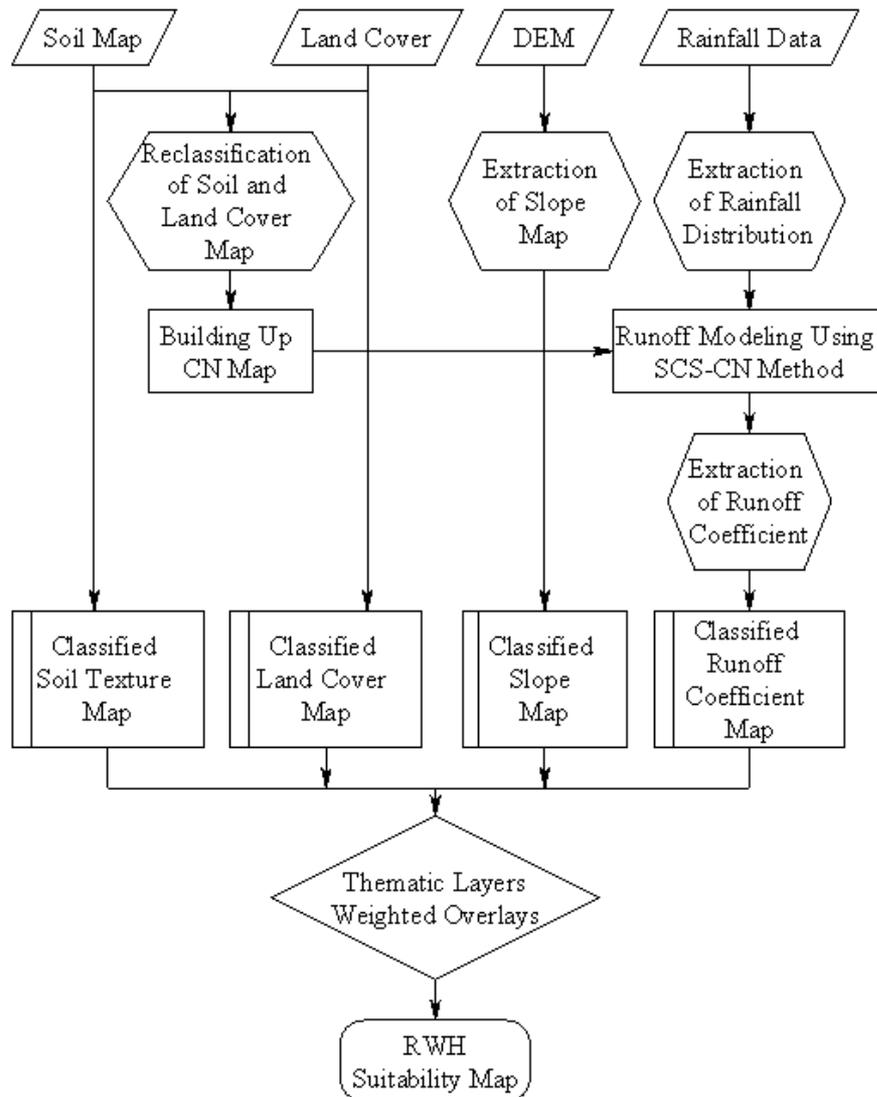
Range	Rank
0-4	1
5-10	2
11-16	3
17-24	4
25+	5

**Table 5: Runoff Coefficient Suitability Ranking**

Range	Rank
0-0.15	1
0.16-0.37	2
0.38-0.54	3
0.55-0.69	4
0.7+	5

### Developing the RWH model

The chart of Figure 8 depicts the overall methodology utilized in this paper for developing a GIS-based suitability map for RWH in the West Bank.



**Figure 8: Methodology of the Study**

Depending on the assigned input layer weights, RWH model was developed from a weighted overlay process (WOP) of the soil texture, land cover, slope, and runoff coefficient with different weights for all the layers (see Table 1).

The WOP allows the combination of data from several input grids by converting their cell values to a common scale, assigning a weight to each grid, and then aggregating the weighted cell values together. The WOP, also known as the multi-criteria evaluation is a weighted linear method commonly used in GIS-based decision making (Store and Jokimäki, 2003). Each layer is multiplied by its weight and the results are summed according to the following equation (Malczewski, 1999):

$$A_j = \sum_{i=1}^n W_i \cdot S_{ij} \quad \text{Eq .....(1)}$$

Where:

$A_j$  is the final cell suitability score index,  $S_{ij}$  is the suitability of the  $i$ th cell with respect to the  $j$ th layer, and weight  $W_i$  is a normalized weight so that  $\sum W_i = 1$ . The weights enable the solution to reflect the importance of the input layer relative to each other.

## Results and Discussion

Based on WOP, RWH suitability map was generated. The developed suitability map indicates that the most suitable areas for RWH are mainly located in the western part of the West Bank (Figure 9). The eastern part was found to be the least suitable. This can be attributed to rainfall distribution in the West Bank which increased north-west and decreased south-east. Sparse of highly suitable areas are located in the middle mountains of the West Bank where also the rainfall is relatively high and thus the runoff coefficient (see Figure 7).

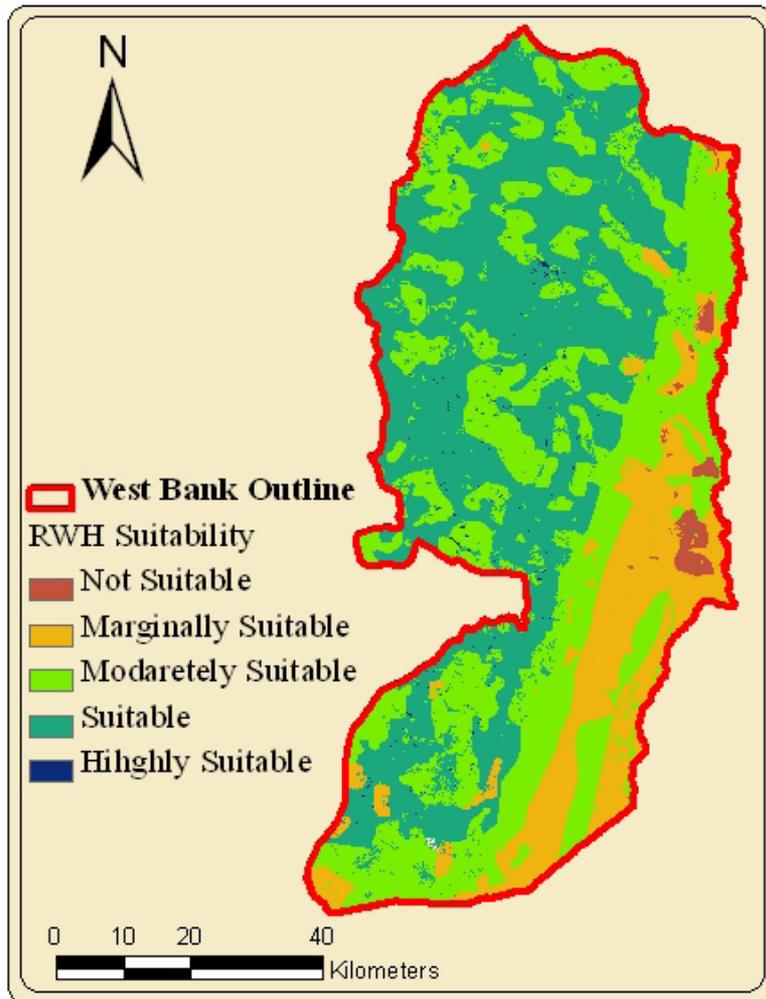


Figure 9: RWH Suitability Map for the West Bank

Table 6 presents percentages of RWH suitability for the West Bank. Based on Table 6, suitable areas were found to cover about 43% of the West Bank.

**Table 12: Percentages of RWH Suitability in the West Bank**

Class	%
Not Suitable	1.17
Marginally Suitable	15.34
Moderately Suitable	40.17
Suitable	43.09
Highly Suitable	0.23

## Conclusions

The study aimed at developing a GIS-based RWH suitability map that indicates the areas of the West Bank suitable for RWH. The developed RWH suitability map combines through a WOP of the land cover, soil texture, slope, and runoff coefficient layers.

The major advantage of employing GIS in developing RWH suitability map is that a high degree of customizability can be attained. It enables the user to add, remove layers and change the relative importance weights of the layers. It should be noted that determining the weights is eventually a personal decision which is the best compromise among competing interests. It is therefore advisable to perform a sensitivity analysis by varying the weightings in order to provide insights into the generated RWH suitability map. The results should therefore be interpreted in terms of how the WOP can guide policy formulation. As with every modeling undertaking in the West Bank, the quality of the final results is influenced by the quality of the input data.

Considering the resolution of the datasets used in this study, its results are quite satisfactory for the West Bank to which it has been applied. The developed RWH suitability map do not have the required resolution to query details of known areas but it provides a country-scale valuable information for decision makers to develop and implement a strategy that guides the adoption of RWH in the West Bank. This will enhance the development of a comprehensive water resources management strategy to bridge the increasing supply-demand gap in the region.

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# **Environmental Education for Engineers: Selecting the Syllabus**

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## ABSTRACT

The requirement to consider environmental impacts in infrastructure developments is now mandatory in many countries. The jargon and aims of environmentalists can be perceived as being separate to the standard practice of civil engineers. This can lead to confusion and at worst, conflict within the team. This paper describes the processes behind selecting the syllabus for a post-graduate module introducing environmental assessment to civil engineers and discussed some of the underlying principles that supported the structure of the course.

The subjects included in the course included basic ecological concepts, introducing why they were important and useful as well as describing what they are. The syllabus did include a strong thread of awareness-raising so that students understood and accepted the relevance of environmental interventions rather than regarding them as an imposition. Awareness-raising however is difficult to assess and “soft” conceptual issues are not common in the more scientific teaching of engineering, making the experience unusual for the students. The breadth of material covered at this introductory level can mean that it can become shallow learning rather than the deeper understanding required to ensure that the concepts influence the development of infrastructure rather than continuing to be seen as an add-on to the design and construction process. The paper includes the views of students as well as the staff designing and delivering the material.

**Key Words:** curriculum, environment, engineering, Loughborough University

## Introduction

The development of material for new courses draws on a variety of sources and expertise. For specialized courses or training in new subjects, the amount of teaching material already available to the lecturer is limited. This also applies when teaching is being applied across disciplines, where curricula developed for one audience may not be directly suitable for a group of students from another discipline. This paper sets out a case study of the processes and rationale behind the development of a module on environmental issues specifically for engineers and related professionals, who may lack awareness of some of the core principles that underpin the study of ecology and environmental management. This is based on a review of the literature, discussions with colleagues at Loughborough University and students and critical reflection.

## Glossary

Within the context of this case study, a programme is a course of learning consisting of a series of discrete core and optional modules on specific topics. A module may consist of a series of lectures and laboratory work or a set of distance learning notes. Both the overall programme and the individual modules are defined by course aims and a series of short, measureable statements called learning outcomes. The curriculum is a statement of the whole course (so includes *how* students will learn) whilst the syllabus is a list of the subjects covered (*what* students will learn).

## Models of Curriculum Development

### A systems approach to learning

Learning can be modelled as a system, with inputs, actions and outcomes (Romiszowski, 1981). The inputs include the students and their current skills, knowledge and attitudes, the course content and the course delivery. After the activities, the actual outcomes can be measured and the success of the course measured. If the desired outcomes are not met, the inputs can be adjusted.

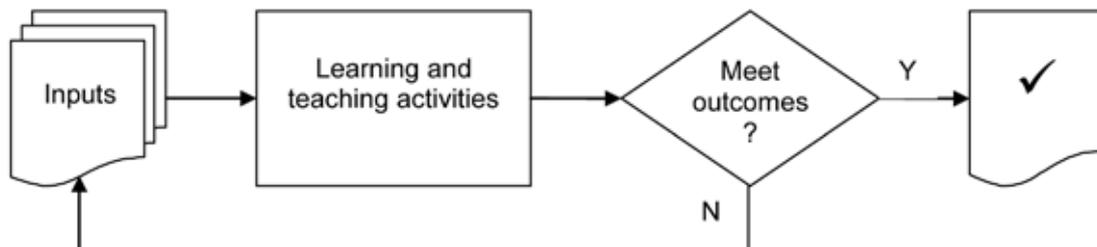


Figure 1: A simplified model of learning

American educational psychologist Jerome Bruner proposed that learning activities build on what the students already know, allowing them to construct their own knowledge, but that this process is not necessarily linear (GTC, 2006). He proposed that curricula should start with an intuitive introduction to basic the ideas and structures of a subject, but these should be re-visited repeatedly until the student fully understands them – a “spiral curriculum”. Successive stages can move from “learning by doing” through learning using images to learning by words and numbers, as the underlying principles become accepted and understood. On a postgraduate course the students may have extensive existing knowledge, but this can vary across a wide range, depending on their individual experiences to date.

In order to construct a course, the inputs can be broken down into further components, so for example the decisions required are:

- (1) “What are the needs in relation to the product of the training programme?”
- (2) What are the aims and objectives?
- (3) What content should be included?
- (4) How should the content be organized?
- (5) What educational strategies should be adopted?
- (6) What teaching methods should be used?
- (7) How should assessment be carried out?
- (8) How should details of the curriculum be communicated?
- (9) What educational environment or climate should be fostered?
- (10) How should the process be managed?”

(Harden, 1986)

These only relate to the inputs provided by the teacher, so the other essential input to consider is the target group of students, and their existing skills, knowledge and attitudes. Their perspective can be different from the teachers. Whereas teachers may view the process chronologically (setting objectives, running teaching activities then assessment), the students focus on the assessment, their

performance in this being supported by learning. (Stefani, 2009).

## Developing the curriculum

Curriculum development – developing the inputs - also follows a cycle. Setting the outcomes and assessments are early stages of the process, as shown in figure 2.

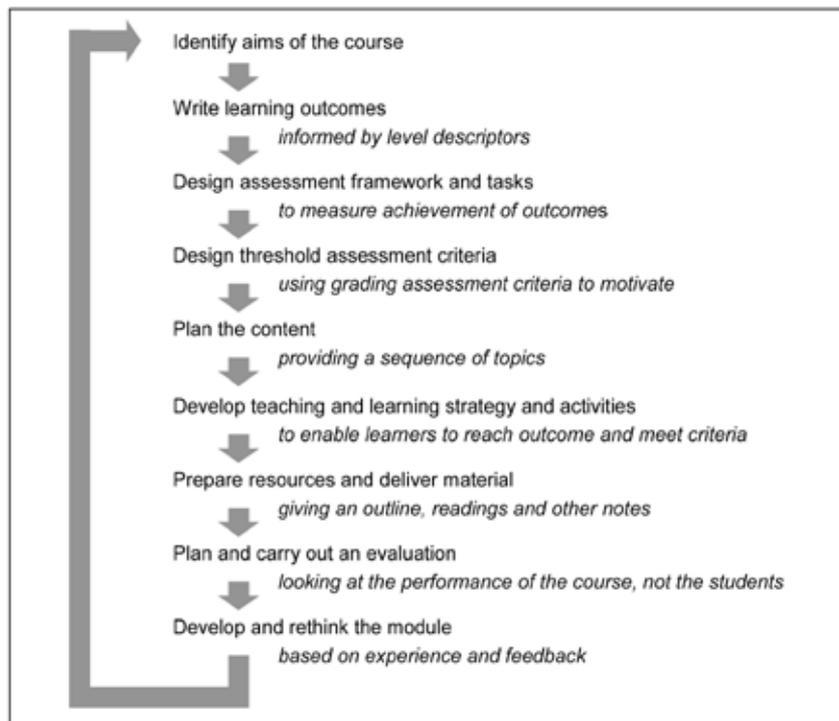


Figure 2: Learning Outcomes process at module level (based on BCU, 2011 and Stephani, 2008)

The desired outputs can be defined in terms of learning outcomes, objectives, competencies or goals and may specific or fairly general. The outputs can also be defined in relation to the inputs, with a syllabus setting out the content. Biggs (quoted in Stefani 2009) emphasized the need to ensure that all these activities are ‘aligned’, with learning and assessment synchronized. Learning outcomes are well established tools for summarizing course content. Properly aligned, these indicate the content of the course as well as how it is assessed. Bloom’s Taxonomy gives teachers guidance on levels of complexity and the means of demonstrating the acquisition of increasingly “deep” skills, but the criteria for selecting specific outcomes are not so clear.

Stefani (in Fry *et al.* 2009) expands a model of curriculum development proposed by Cowan and Harding (1986) (figure 3). This starts with “assessment” (rather than bolting this on at the end), which influences the learning which in turn results in teaching activities. “Decisions” are a key stage, based on evaluation of the course (not the assessment of students). All these stages are centred on the “aims” and are set within wider constraints and resources. “How” to assess, teach and evaluate can be based on existing methods and do not (normally) require bespoke solutions. This is a dynamic model, with the aims being adjusted based on decisions resulting from the evaluation.

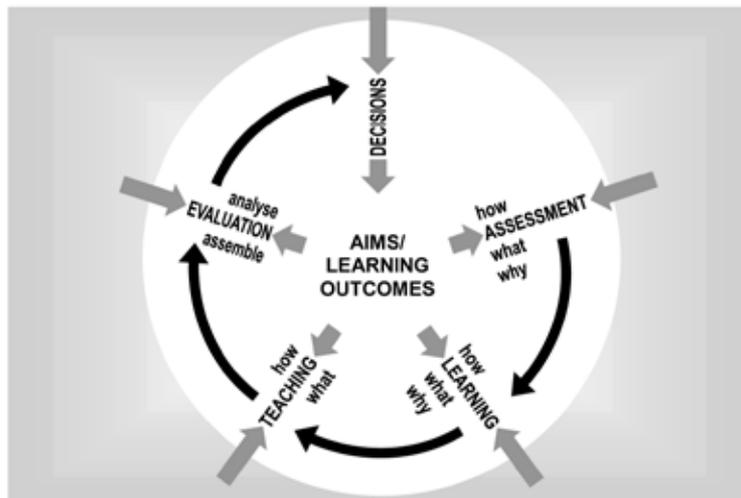


Figure 3: “Logical” model of curriculum development (Cowan and Harding 1986)

### Developing the course material

The freedom to vary these inputs and outputs will depend on the context, constraints and resources. At school and undergraduate level, the cohort of students is normally well defined and reasonably uniform. Adult learners are more likely to have a wide range of existing skills, knowledge and attitudes. At school and undergraduate level the outcomes are externally defined, so the teacher or lecturer has reasonably fixed boundaries. At undergraduate level in the UK, courses have to comply with Subject Benchmark Statements, which are written at a national level by academics, professional bodies and representatives of “industry”. These in turn conform to Level Descriptors or Graduate Profiles, which are generic across subjects and relate to intellectual, practical and transferable skills. These are set by the university but are based on national recommendations. Professional bodies may also have separate criteria that have to be met if the course is going to be accredited and lead to a professional as well as an academic qualification. These various standards and benchmarks address the first three of Harden’s Ten Questions listed above, leaving the teacher to plan the detail of delivery, starting and finishing with the learning outcomes.

At specialist, post-graduate level many of these regulations do not apply, simultaneously freeing up the lecturer to vary inputs and outputs (within reason) but reducing the guidance available with respect to course content, in terms of both breadth and depth. The students also have less assurance of the quality and relevance of the content of the course. Some restrictions still apply, such as limits to resources, including the knowledge, motivation and interests of the lecturer. The freedom brings an extra dimension to the development of the course and increases uncertainty in selecting and delivering the correct learning outcomes.

### What to teach?

“Most of us, when asked to teach a topic, start by thinking about the content. Questions such as ‘what do I know that I can tell them?’ or ‘who are the best authors or references

for this subject?’ dominate our thinking. This is only natural because we, as academics, trade in understanding, insights, analysis, synthesis and creativity, but our currency is knowledge, information, facts, data.”

(Butcher *et al* 2006)

Dunn *et al* (1985, quoted in Dent and Harden 2009) identified a range of approaches to identify curriculum needs, namely:

- asking “wise men” – senior teachers and senior practitioners – to reach a consensus;
- consultation with the stakeholders – including non-specialists;
- looking at errors and mistakes in existing practice;
- examining case studies of good and bad (professional) practice;
- undertaking task analysis, where components of the professional’s job are studied; or
- analysing good performance to identify areas that are worth passing on.

This list does not specifically mention the students themselves, both in terms of their existing knowledge and also their motives for study. It also assumes that what is done in practice is the state of the art, neglecting the role of “new” knowledge.

Butcher *et al* (2006) adapt earlier work by Harden (1986) to identify four categories of content:

- Mainstream; directly contributing to the one or more planned learning outcomes. Actual selection can be on familiarity, enjoyment, resource availability, research related or influenced by the other categories;
- Precursor; core material that is required before other material can be presented, so relates to the sequence of teaching;
- Opportunistic; core material that also provides additional insights. Some students will be able to take the significance to a further stage; and
- Supportive; the use of case studies or real life examples to illustrate core material but learning the specific “facts” in the case study are not a required outcome.

Butcher *et al* (2006) also discuss how much to teach, identifying:

- Essential material (perhaps delivered directly);
- Material that should be covered (perhaps through reading or other directed activities). These first two categories should provide enough material to allow the average student to reach a reasonable standard in the time allocated;
- Material that could be covered; and
- Material that is nice to know.

These two sets of four categories are not synonymous, precursor material may be essential and some supportive material should be included.

## **Environmental assessment for engineers – a case study**

### **The context**

This paper provides a case study on the processes that underpinned the selection of content for a specialised module on the “environment” for engineers. The institutional culture influences what

is taught (Stefani 2009), so in the development of the course under discussion, the content and method of delivery of the material were influenced and constrained by the background and context of the institution and the students.

## **The Water, Engineering and Development Centre (WEDC)**

WEDC's approach is both focused and wide-ranging. It focuses on the delivery of infrastructure services, such as water and sanitation, to people in low - and middle – income countries. It has a history of producing practical answers rather than discussing theoretical approaches; most of the teaching staff have a background of working for NGOs or consultants. This emphasis on “research that matters” is part of Loughborough University's wider culture, which has strong history of “learning through doing” and many links with industry. Within this institutional climate and the remit of the Centre, the subjects are covered from a multidisciplinary perspective, with the following areas being included;

- Social (including gender)
- Health and hygiene
- Technical
- Economic
- Financial
- Institutional
- Environmental

The balance between these disciplines will vary depending on the subject being taught, but all teaching will include elements of these. For example, a module on wastewater treatment is mainly technical, but includes economic, institutional and environment aspects. Teaching on gender will address technical and economic as well as social responses. This can lead to courses becoming too general as the boundaries are ill-defined. The MSc courses are accredited by the Joint Board of Moderators (on behalf of the Institution of Civil Engineers and others) and by the Chartered Instituted of Water and Environmental Managers, but their requirements do not address the level of detail required to create a syllabus at module level.

## **The history of the environment module**

The WEDC MSc programme in Water and Environmental Management has a history going back to 1980. The importance of environmental issues has grown over this time, with the original subject matter in this area being a series of ad hoc (scientific) topics on pollution, climate change and other impacts, according to the lecturer's interest and experience. This area of teaching expanded and developed over time to eventually form a pair of modules, one on practical environmental monitoring (especially for drinking water and wastewater) and one on the formal assessment of environmental impacts. (Ince pers com). After an adjustment to the whole programme, prompted by staff changes, these two modules were reduced to a single module on environmental assessment. The growing general awareness of environmental issues within society meant that some of the introductory topics (such as the reasons for climate change), were seen as less important than promoting a structured approach to the subject of environmental assessment. However, the adjustment to the course content meant that some of the practical monitoring and assessment skills

that had been taught were now omitted, leaving just the environmental assessment theory, often without a specific context. In response to both student feedback and a review by staff, the whole module was revised.

## The students

The starting point for the redevelopment of the course was to consider the student perspective, both what they already knew and what they would need in the future. This was made slightly more complex as the module was also an option on another university MSc programme, in Analytical Chemistry. The chemistry students tended to have a specialised knowledge on some scientific issues, but a lower awareness of social and ecological concepts. Broadly, the students were from engineering or science backgrounds, but with a variety of other experiences, especially for the mature students who had been working in development for a number of years.

The students studying this module were not destined for a career as “pure” environmentalists. The Analytical Chemists had a specialized role within an Environmental Assessment relating to water testing, whilst the Water and Environmental Managers would have a general role, in coordinating projects (which would include an environmental assessment), designing infrastructure (which could have adverse impacts) or responding to adverse impacts on the environment by others (such as pollution).

## Global spread

The students were from various countries, both high and low-income. Whilst the WEDC MScs focus on low-income countries and many students will be working in such a context, some students will work in industrialized nations and need to be aware of the range of issues that may be encountered. Practical implications of this meant that a wide variety of environmental contexts (e.g. different habitats), problems (e.g. different sorts of pollution) and solutions (including legislative approaches) needed to be addressed.

## Developing the content

The aim of the module set the direction for the teaching materials, stating:

“The aim of this module is for participants to develop a broad understanding of both the needs for and the mechanisms of environmental assessment and management, with emphasis on aquatic environments, in low- and middle-income countries. “

(Loughborough University 2011)

The requirement for the low- and middle-income country focus is clear and the emphasis on aquatic environments demonstrates that it is part of a wider programme based on water management, but this still leaves the choice of syllabus open to interpretation.

## Selecting the syllabus

In Dunn *et al.*'s list, quoted above, a starting point for selecting material is to ask “wise men” (and women) or to ask a range of stakeholders. This would be good for an environmental assessment course for environmentalists, but environmental assessment *for engineers* is not so straightforward. Allen (2001) notes that:

“Interdisciplinarity is a demanding ‘non-discipline’ and especially difficult because anyone adopting the approach is at risk of attracting the very sharp and even destructive analysis of elements of their argument by scientists with more specific disciplinary expertise in a particular episteme. Unfortunately, while there are referees in scientific ‘disciplinary’ games, albeit narrow, often biased and much questioned, there are no referees at all in ‘interdisciplinary’ games. Yet firms, governments and other entities which get things done have to address problems which are inherently interdisciplinary. Their ‘referees’ are market performances and political success, whether sanctioned by democratic process or not.”

In selecting material to teach on a course on environmental assessment for engineers, the range of topics that could be included was wide, as environmental assessment is a subject in its own right. The challenge on this course was to balance the breadth of material with enough detail to make it practical and demanding enough at a postgraduate level. Textbooks that covered the whole range of issues being considered were very general. More specific texts were available, but went into too much detail for a three-week course or only looked at one context (e.g. environmental regulations in the EU).

Figure 4 represents the overlap between environmental issues and engineering, with the dark shaded area being the essential issues that engineers should know about the environment. This is not necessarily the same as the essential issues that environmentalists should know about engineering. An example of this is the “green” and “brown” environments. Green environments are the pristine and unpolluted natural environments and the brown environments are polluted and degraded. Engineers have a role in preventing or remediating brown environments and less of a role in nature conservation. Thus pollution is an essential component and nature conservation is only “nice to know” for engineers, whilst both topics would be essential for environmentalists.

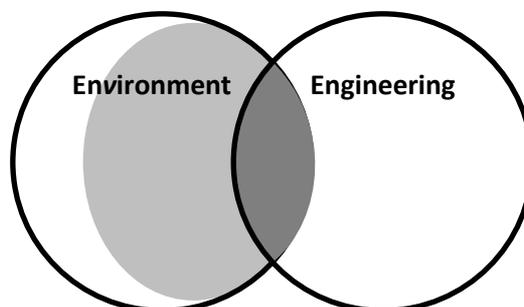


Figure 4: Subject boundaries

## Starting from the basics

Lev Vygotsky (Thompson 2001) promoted the idea of a “Zone of Proximal Learning”, where learners move from what they know to what they do not yet know. Too wide a zone and this becomes increasingly difficult to cross. Thus the precursors bridge to the essential content, but have to start from where the students’ abilities and interests currently are. By relating some environmental concepts to engineering or chemistry concepts, the route to constructing new knowledge can be facilitated. Thompson notes that, with adults, personal relevance of content, involvement of the learner in the process of learning and deeper understanding of underlying concepts form a favourable intersection between a constructivist approach to learning and some adult learning principles.

The process of omitting some standard environmental subjects meant not covering basic topics such as evolution, cell biology or climate change, as they were not directly relevant to later topics. However there are some basic environmental concepts that are precursors to other topics (shaded light grey in figure 4). Brunner not only advocated a spiral curriculum, he also emphasized the need to introduce structure, patterns and fundamental principles at an early stage, so that the learner can begin to arrange their own learning and build on strong foundations (GTC 2006). The specialized language used by environmentalists had to be introduced in order that the students could access some concepts (Felley and Reed 1997). An example of this is the construction of an understanding of the biotic index, which is a system whereby a survey of the biodiversity of aquatic species in a river can be used as an indicator of water quality. This is based on the idea that certain species will be expected to be found in pristine rivers. This in turn rests on the idea of habitats, as different species will occur in different places, which in turn is founded on the concepts of food chains, ecosystems, cycles (water, nitrogen), succession, biomes, system dynamics and biodiversity.

## Setting learning outcomes

Two examples, defining “taxonomy” and defining “the environment” demonstrate contrasting approaches to introducing new concepts to the students. One was short but strongly directed; the other was longer, discursive and left the student to construct their own definitions.

Taxonomy using the binomial system is a basic concept that is introduced to school children studying biology. However engineers and chemists may have missed this out if they specialized early in their careers, so it needs to be introduced. This basic environmental concept could be treated just as knowledge – a series of facts that the students have to learn. A learning outcome could just ask the students to *define* the binomial system, *outline* its history or *describe* the various levels of kingdoms, families, genera and species. These activities are not complex and would give them a foundation in the topic, but not really going to make them better engineers or chemists. However asking them to *defend* the need for having such system requires them to make critical judgements rather than just recalling information. They need to know why the binomial system is used and illustrate the need to use names such as *Phragmites australis* or *Typha* spp but they do not need the same level of expertise in species identification as an environmentalist. This concept can be made relevant by comparing it to other subject specific nomenclature systems such as the periodic table used in chemistry or geological rock types.

The need to be concise could have led to précising information to fit it into the time available, which could have led to a wide but shallow course, cramming in lots of facts but not getting to any advanced analytical level. One such area could have been the definition of “the environment”. A standard definition could have been presented and accepted in a matter of minutes. This would fulfil a basic learning outcome such as “*define* the environment” but rather than repeat a standard definition, the outcome selected was “*discuss* concepts and classification of ‘the environment’”.

A series of differing perspectives from different points in history, different stages of development, different ecologies and different commentators were presented so that students could compare these views, construct their own models and adapt the concepts to their own situation. This is especially needed when the standards in a high-income country are irrelevant in a poor country suffering from chronic pollution and with few resources to address the problem. At MSc level the students require the ability to discern suitable environmental standards rather than being confined to a single viewpoint. The conceptual understanding of “the environment” rather recalling a dictionary definition was considered a threshold concept, a core idea that enables the student to change the way they picture the subject and move to a higher level (Meyer and Land 2003). A similar approach was used later in the course with the concept of “pollution”.

## A global perspective

The global perspective taken by the programme could also lead to a lack of depth; a course for UK students planning to work in the UK would be able to look at UK ecology, UK legislation and technical solutions being used in the UK in depth. A course with a global remit could not hope to cover this level of detail for the home nation of each student, but the underlying principles can be covered. Varieties of individual aquatic habitats are initially complex, so the underlying principle of habitats was introduced using global biomes, such as deserts and rainforests, where the influence of climate results in distinct ecosystems. Once this underlying concept was in place, specific ecosystems could be discussed in more detail with the students still being aware that this is only a few examples amongst the many possible situations. The topic of biomes was not required to meet the modules aims but helped introduce a more complex concept, so it is what Butcher et al. (2006) called supportive content.

Another of Butcher et al.’s categories was opportunistic material, where core material offers additional insights. For this course grey literature was used in preference to standard textbooks for several reasons. The culture within WEDC is to address practical issues rather than theoretical ones, so examples were drawn from organizations working directly in the area, such as International Union for Conservation of Nature or World Wild Fund for Nature. The material was selected from different countries and from different stages of the environmental assessment process (e.g. the State of the Environment reporting system for South Africa, the requirements for scoping Environmental Impact Assessments for wastewater treatment plants in Egypt). These examples were opportunistic in that they were easy to source, but with a wealth of material available, the skill was in rejecting, selecting and arranging the material in a manner that demonstrated the mainstream learning across a range of situations without being obscured by the local context.

## Feedback

At the end of the module, the students complete a structured feedback form. This includes two free text boxes for their positive and negative comments. Comments were made on content, delivery and assessment (which are all related and need to be aligned) but only those relating specifically to course content are shown in box 1.

### Box 1: Student feedback

#### What did you like about this module?

- Coming from a chemistry background, I was worried that the material would be too advanced and confusing to understand. However, throughout the module I felt that the work was at an appropriate but challenging level. The lecture format of a handout book with class discussions was one that I wasn't used to but I found it very useful. Because we were coming up with ideas, it didn't feel like work!
- A lot of examples have been considered.
- I found the module very useful and practical which is what it needs to be.
- Gained a good all round knowledge of environmental assessment, found it very interesting.
- Content enjoyable to learn
- I also enjoyed the walk and the practical sessions.
- Also good examples were used.
- The inclusion of practical sessions has enhanced my knowledge.
- I loved the module because it was applicable to my country.
- It was very practical and broadened my knowledge.

#### How could this module best be improved?

- Field work and group work should be encouraged and discussions using case studies.
- The notes had too many things which weren't relevant to the assessment which made it difficult to revise for it

## Failures

The final comment in box 1 reinforces one of the challenges faced in assembling the content for this module. A large amount of apparently shallow material can obscure the underlying principles and prevent the student from using and applying the material. Much of this relates to the need to provide precursor material in order that the main learning objectives can be achieved. The precursor material is required to bring everybody up to a common understanding and to ensure that threshold concepts are understood, but, from a student perspective, it is all “new knowledge” and therefore part of the course. A similar problem occurs with opportunistic and supportive content, when the students focus on the content of the examples and expect to reproduce it in assessments when in fact this level of detail is not required.

## Lessons Learnt

In reviewing the literature for this paper and consulting with specialists in the field, advice on selecting content for a new course was conspicuous by its absence. The advice on curriculum design assumes that the aim and content of the course is given and the focus moves onto giving this content a structure, through learning outcomes. Once these are in place, delivery mechanisms can then be designed.

Dunn et al. (1985, quoted in Dent and Harden 2009) gave a few suggestions of how this process of material selection can be facilitated, but Allen (2001) identified the problem with interdisciplinary subjects, where experts draw up the rules for separate disciplines but the real world requires people to work across these (artificial) boundaries. Dunn's suggestions also include looking at existing work practice, which would be difficult in newly emerging, specialist areas, although the interaction between engineers and environment is no longer a fringe subject, especially within the water sector. A source of guidance that is not in Dunn's list is students. One of Dunn's co-authors picks this up at a later date (Harden 2011), noting;

“Students are important players: It is important not to underestimate students' potential input to the curriculum. They are important stakeholders; they can make important contributions to curriculum planning and they can be drivers for change. Collaborative and peer-to-peer learning and students' input to the generation of learning resources can be important and will become increasingly so. When thinking about student-centred and independent learning, it is important to have as the aim directed self-learning rather than self-directed learning. In [*Dron J. (2007) Control and Constraint in E-Learning: Choosing When to Choose. Hershey: Idea Group Publishing*] the author made the important point that one of the main challenges for the teacher is to decide at the different stages in students' development how much control students should be given over their own learning.”

Thus there are strengths and limitations of involving students in curriculum development, as they are unable to comment on the areas they are not even aware of and may ask for more content on areas that they are aware of but that may not be significant.

This lack of advice on selecting content can be liberating as well as limiting. Just as there is no “right” answer, there is also no “wrong” answer, just areas to consider. Noting the history of the WEDC MSc programme, the module on Environmental Assessment has evolved over time. The current content is still not ideal, as there are areas that could still be improved, even after the latest re-write, but recognizing that there is need for improvement is an important lesson in curriculum development. Returning to the system in figure 1, the feedback loop is not an addition to the process, but a core feature. Harden's (1986) list of ten questions is linear but there is a need to look at the aims at the end of the course to ensure it was fit for its purpose and will continue so. The feedback should not only relate to the components of the course, such as delivery methods or individual learning outcomes, but also to the overall aims and purpose, as shown in figure 3, with its definite decision stage. Improving teaching techniques or adjusting assessment methods can fine tune the course but regular, formal reflection by the lecturer on course content is necessary to ensure that the aims are still fit for purpose and that the content does not drift over time.

## Acknowledgments

I would like to thank Carol Newbold and Di Beale from the Loughborough University Teaching Centre, for providing information, support and encouragement, Margaret Ince and Mike Smith of WEDC for their insights into this topic and the students on the Environmental Assessment module for providing their feedback.

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## **E-learning – Experience from the “Energy Academy” Distance Training Programme**

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## ABSTRACT

Academic and professional education programmes currently available in the areas of energy and environment cannot fully satisfy market demands. Furthermore, closed and isolated systems, such as islands, face additional problems due to geographical discontinuity. The role and the potential of e-learning in both instructor-led (synchronous) and online (asynchronous) course delivery in such isolated systems are investigated. The discussion focuses on the "Energy Academy", a distance learning programme of continuous education and training on Renewable Energy Sources (RES) and Energy Savings for local administration officials and for persons involved in the formulation of energy and environmental policies in the Aegean islands of Greece. The programme has been developed by the Environmental & Energy Management Research Unit, School of Chemical Engineering - National Technical University of Athens, and Ios-Aegean Energy Agency, a nonprofit organization focusing on increasing the islands' energy production from RES and promoting energy efficient technologies and practices. The main characteristics of the programme and of the web platform that supports it are presented. From the experience gained during the first two years, it could be said that the programme has come to fill a training need and satisfy an existing demand. The increasing number of participants and the programme's evaluation by them, have shown that it has achieved its goals, at a great extent. Some failings, however, like the high dropout rate and the rather low percentage of the target audience in the participants, should be taken into account for the programme's continuation.

**Key Words:** Blended training, environmental education, Energy Academy.

## Introduction

The evolution and the continuous changes of the statutory and financial framework in the areas of energy and environment can not be fully covered by the academic and professional education programmes currently available. Hence, in addition to them, there is a need for life-long learning programmes addressed to all involved in those sectors, in order to fully satisfy market demands. Furthermore, closed and isolated systems, such as islands, face additional problems due to geographical discontinuity and difficulties in accessing knowledge.

Distance learning, which offers knowledge to students who are not physically present in a traditional educational setting such as a classroom, can be very helpful under these circumstances. Chung (2006) notes that an online lecture offers a series of advantages over traditional lecture delivery. His study suggests that students believe that on-line lectures are as effective as, or sometimes even more effective than, in-class lectures due to:

- Capability to pace oneself listening to the lecture
- Capability to replay parts of the lecture
- Finding the most suitable time to listen to the lecture for better concentration.

Although e-learning may increase access flexibility, eliminate geographical barriers and improve convenience as well as effectiveness for individualized and collaborative learning, it suffers from a number of drawbacks such as lack of peer contact and social interaction, high initial costs for

preparing multimedia content materials, substantial costs for system maintenance and updating, as well as the need for flexible tutorial support (Wu *et al.*, 2010). Various concerns have also been raised regarding internet connection reliability and, for specific individuals, a need for more natural communication (Makropoulos *et al.*, 2009). Cantoni *et al.* (2004) also point out that a classroom teacher can receive and analyze a number of visual cues from their audience in order to adjust the lecture so as to meet the needs of the class.

Blended learning appears to be the solution to these problems because it mixes synchronous and asynchronous course delivery (Buzzetto-More and Sweat-Guy, 2006). As synchronous, one can describe a mode of delivery where all participants are “present” at the same time, such as live lectures, in-class discussions and active group work. Asynchronous mode of course delivery consists mainly of web-based educational technologies such as online course modules, assignments, discussion boards, and other web-assisted learning tools, where participants access course materials on their own schedule. The degree to which the design of blended learning courses uses traditional classroom and online learning environments varies largely depending on the subject matter and the overall nature of a course. Regardless of that, such courses may be expected to be delivered in both an asynchronous and synchronous manner, and are becoming increasingly widespread in today’s society (Wu *et al.*, 2010). Blended learning has been described as “the most prominent instructional delivery solution” since it provides the academic world with the flexibility of fully online learning along with crucial collaboration achieved through face-to-face student-student and student-instructor interaction (Mitchell and Forer, 2010).

The aim of this paper is to investigate the usefulness of both synchronous and asynchronous course delivery as a tool for training professionals. The experience gained from the operation of the “Energy Academy”, a distance training programme for local administration officials and for persons involved in the shaping of energy and environmental policies, will be used as the basis for this analysis.

### **The “Energy Academy” programme**

“Energy Academy” is a continuous distance training programme in RES and Energy Savings, addressed to local authority organization officers, regional administration officers, engineers, researchers, investors, university and technological institute graduates as well as to all those involved in formulating energy policies for islands. The main concerns of the programme are new technologies and their statutory framework. The programme has been organized by the Environmental & Energy Management Research Unit, an educational and research unit at the School of Chemical Engineering - National Technical University of Athens, and Ios-Aegean Energy Agency, a nonprofit organization focusing on increasing the islands’ energy production from RES, as well as promoting energy efficient technologies and practices. The programme was funded by Ios-Aegean Energy Agency, but the cost has been kept at a very low level, since most of the development work, as well as the teaching, have been offered free of charge.

The main incentive for the development of this programme was the signing of the Pact of Islands, a political commitment of European islands to developing Local Sustainable Energy Action Plans

and identifying bankable green projects, by 11 Greek island municipalities. Implementation of the above commitment presupposes the existence of well trained technical and administrative personnel in energy and environmental issues. Within this educational framework, the aim of Energy Academy is:

- The training of a large number of people towards obtaining a general knowledge about RES, energy savings, new technologies and the statutory framework around them.
- The development of trainees' skills in participating in the energy planning process at local level through the writing of a thesis and the exchange of experiences.

In June 2011, the programme has completed its second year of operation. During its first two years, the following topics were covered:

- European policies and financing in energy
- The electricity market: Statutory framework and licensing in the islands
- Wind energy: Capacity, penetration and land use
- Cost-benefit analysis in energy investments
- Desalination with RES
- Hybrid renewable energy systems
- Energy management in buildings
- Integrated biomass management – Energy production at local level
- Monitoring greenhouse gas emissions and selecting actions for their reduction at local level
- Decentralized power generation from RES and smart grids

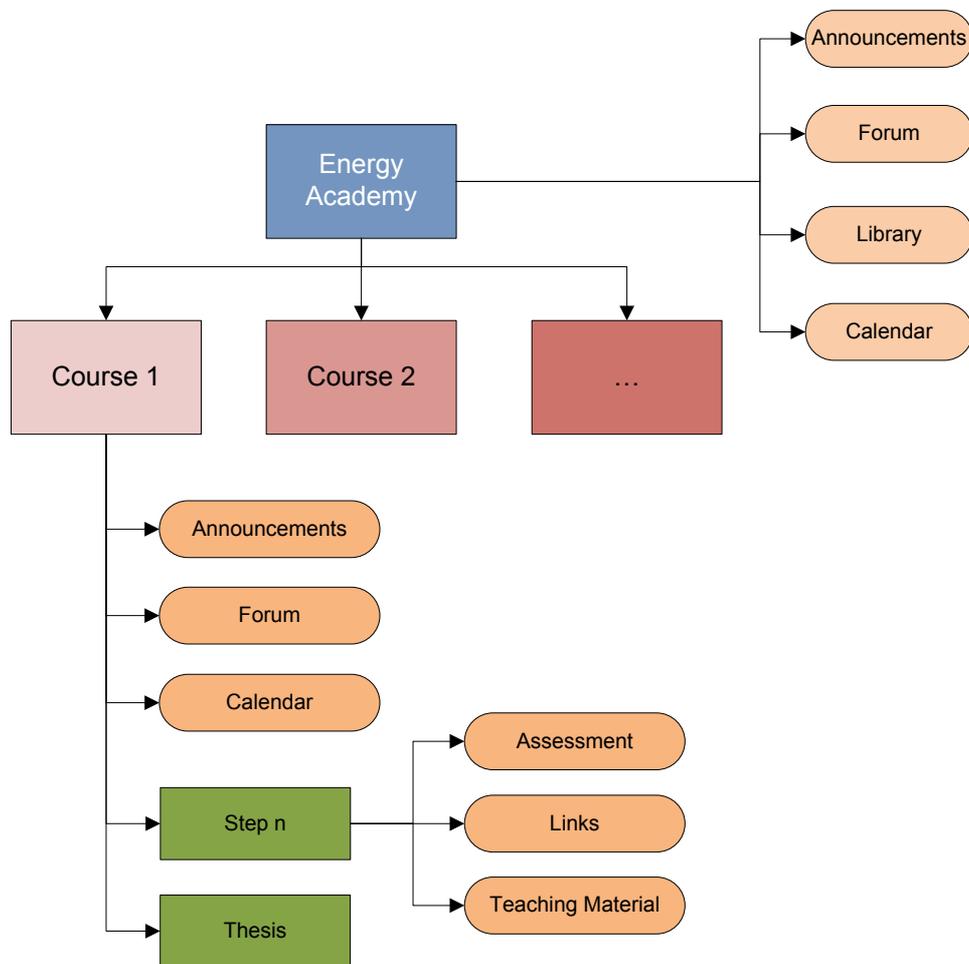
A student is considered to have successfully completed the programme, if he has dealt with all courses, comprising the annual curriculum, and has answered successfully four on-line assessments for every one of those courses. In this case, he will be awarded an attendance certificate for the programme. Additionally, he can write a thesis for each course. If the thesis is successful in at least one of the courses, the student will be awarded a training certificate for the respective course.

All the material of the programme is uploaded in the programme's website, which is accessible at the following address: <http://environ.chemeng.ntua.gr/energyacademy>. The programme's initial website structure is shown in Figure 1. The programme has an announcements module, a library, a discussion forum and a calendar, accessible to all participants, students and instructors. It consists of a number of courses, each one having its own announcements module, calendar and discussion forum. Every course is divided into a number of steps, each of which includes teaching material, assessment material and useful links. Furthermore, it has a thesis section, where the students can find all the details concerning the thesis they have to prepare.

Apart from the online activities, the annual timetable includes three face to face meetings:

- Kick off meeting: It takes place before the start of the programme. In this meeting, instructors, administrators and students meet each other and introductory lectures are given for every course.

- Intermediate meeting: It takes place after the completion of the first two steps in all courses. The students' progress is monitored and the topics of the theses are presented.
- Final meeting: It takes place after the completion of the study programme. The programme's results are commented upon and the certificates are awarded to the students who have successfully completed the programme.



**Figure 1: The Energy Academy initial website structure**

## Results of the programme's implementation

### Participants background

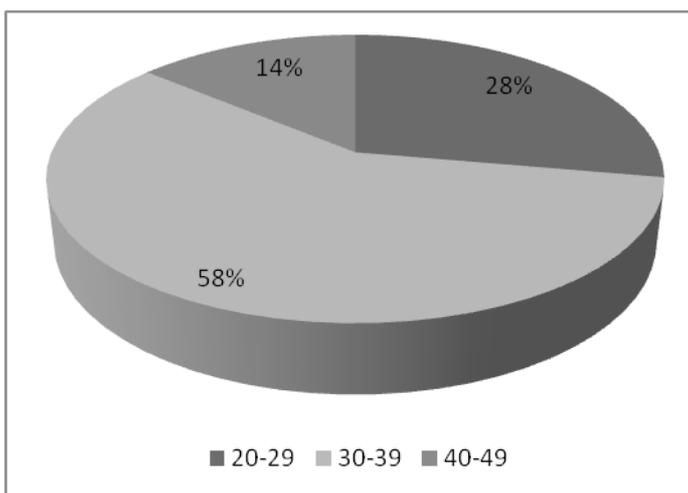
During the first two years of operation, over 150 persons were interested in participating in the training programme. The number of participants who were registered and have completed the programme, by receiving at least an attendance certificate, are presented in Table 1. The number of registered participants increased while the dropout rate decreased significantly during the second year of operation but still remains at a high level. The high dropout rates are mainly due to the fact that the students, especially those of the first year of operation, were not prepared for such a

demanding programme while it was easy for them to drop out when they faced the first difficulties, since there were no fees.

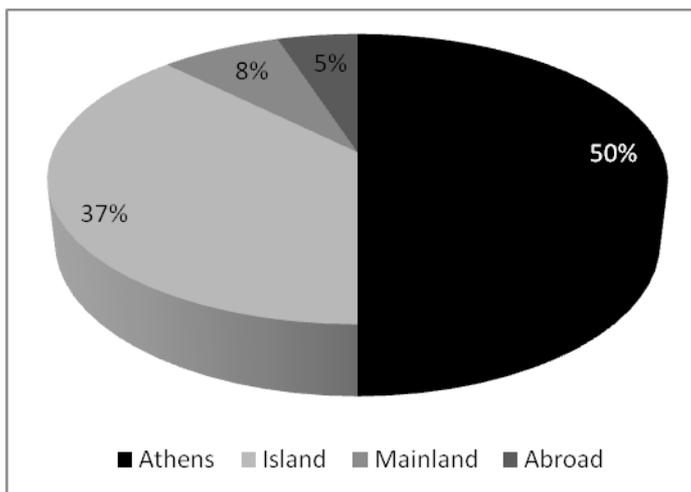
**Table 1: Number of participants**

	2009-2010	2010-2011
Registration	32	78
Successful Completion	13	44
Dropout Rate	59.3%	43.5%

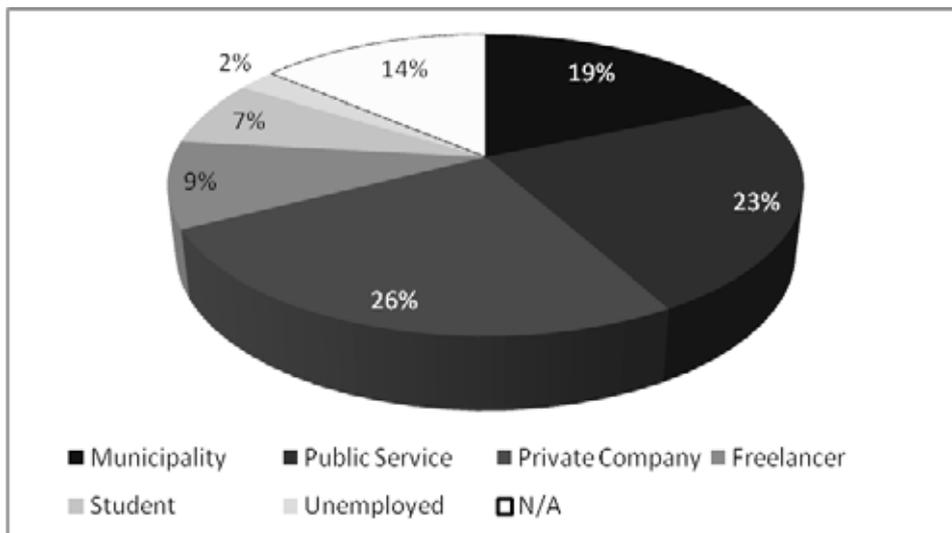
The participants were asked to complete a detailed curriculum vitae before the beginning of the courses and an online evaluation survey after their completion. The following statistics refer to users who have successfully completed the programme. Their age distribution shows that the programme attracts rather young employees who have some knowledge on computers (Figure 2).



**Figure 2: Age distribution of the participants**



**Figure 3: Place of residence of the participants**



**Figure 4: Occupation of the participants**

The majority of participants come from the capital city of Greece, Athens, or from other big cities of mainland Greece. However, a significant percentage (37%) lives in remote island regions and a much lower percentage lives abroad (Figure 3). The high percentage of participants from Athens is expected since almost half of the country’s population lives in the Greater Athens area. The percentage of remote island participants, although lower than the respective of Athens, is quite satisfactory, if one considers the remote islands’ population as compared to that of Athens.

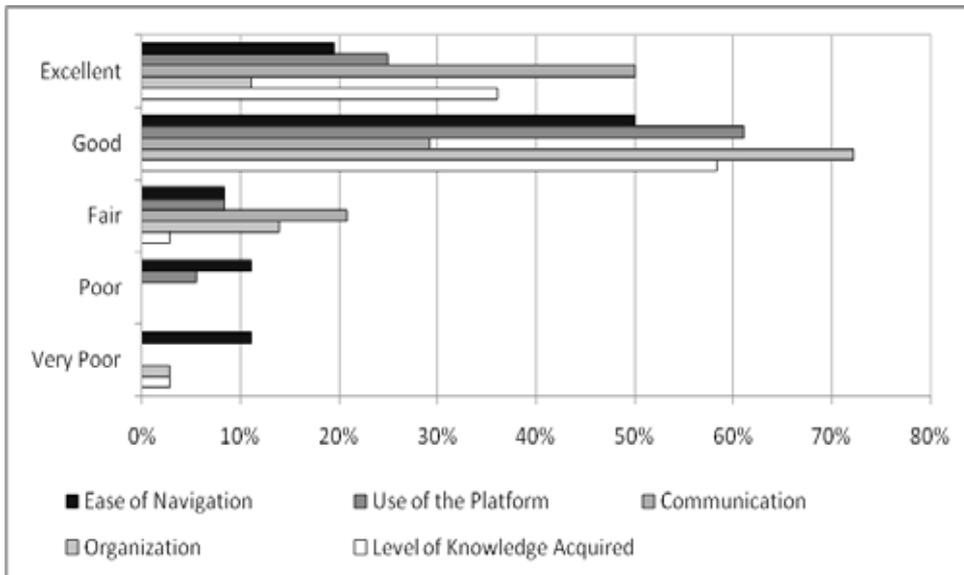
Regarding the professional occupation of the participants, almost 70% of them are employed in the public and private sector (Figure 4). However, only 20% are employed in municipalities, which indicates that further effort should be made in order to achieve the initial target set. Nevertheless, all of those participants are island municipalities employees, which constitute the primary target of the programme.

### **Programme evaluation by the participants**

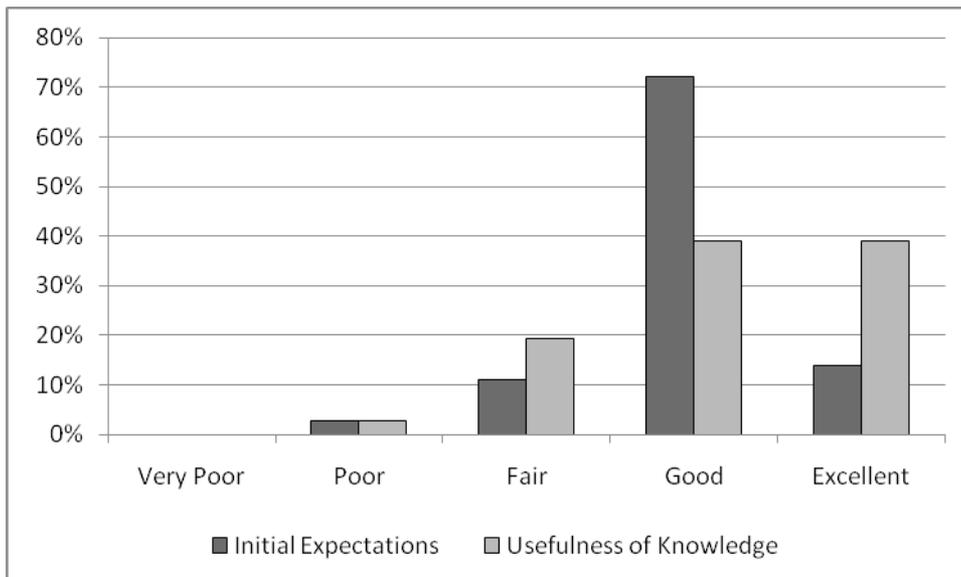
The design, organization and the overall level of the programme have been assessed by the participants through an online questionnaire. It should be noted that the programme was designed focusing on islands and their characteristics without prior analysis of the potential participants background and expectations.

Figure 5 shows that the overall assessment of the programme is positive. The most critical issue was the ease of website navigation, which has led to the redesigning of the structure, presented in Figure 1, towards a much simpler scheme.

When the participants were asked whether they have obtained useful knowledge, more than 85% answered that they obtained more than they expected. Furthermore, more than 65% of the participants think that it is possible to use the knowledge acquired in their job (Figure 6).



**Figure 5: Rating of the e-Learning programme and the platform**



**Figure 6: Evaluation of knowledge acquired**

## Lesson learned

Looking at the variation of daily logins during a year (Figure 7) one can observe that logins increased considerably as the date of the overall evaluation of students was approaching while they remained at a low level (20-40 daily logins) for the rest of the period. We may therefore conclude that the platform does not operate as an open community of professionals who discuss the problems they face, but mainly as a tool for receiving the material and submitting the assessments. Hence, participants should be encouraged to use the platform in order to increase the interaction between them.

At the same time, based on logins' variation on a weekly basis (Figure 8), a reduction is observed during the weekends. This is the opposite of what it was expected, taking into account that all participants have a job and they have more free time during the weekends.

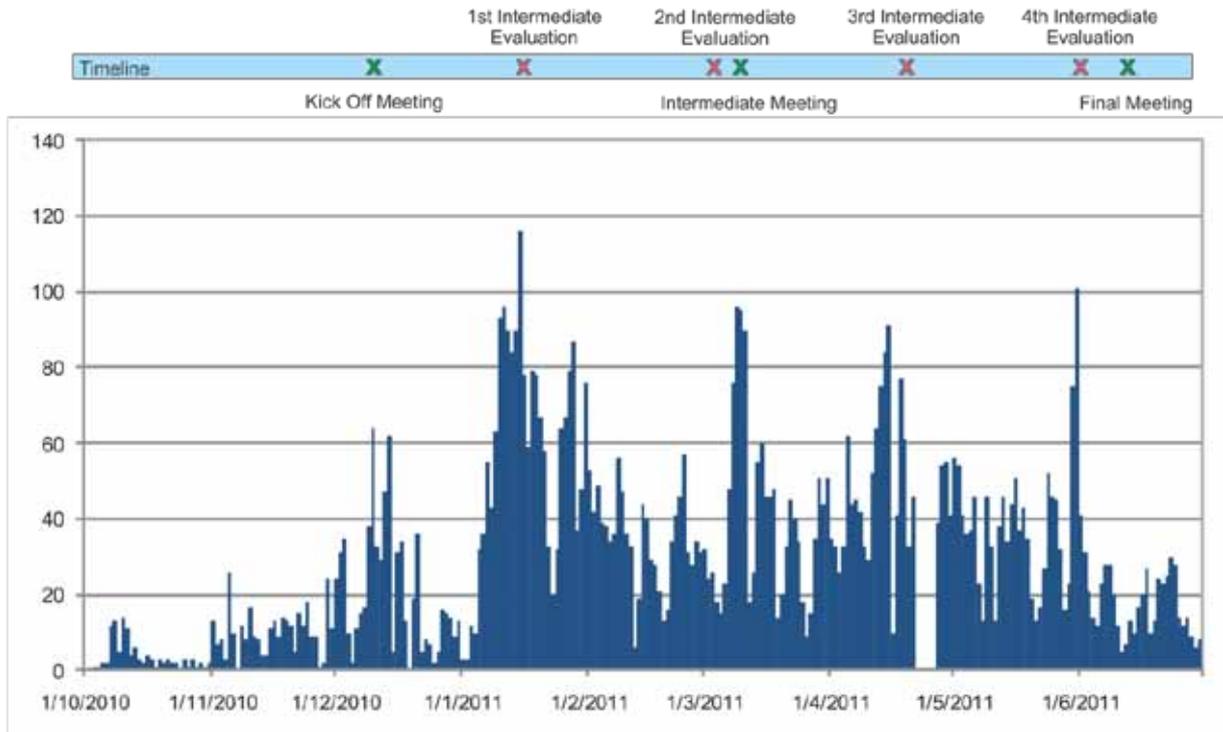


Figure 7: Daily logins during the second year of operation

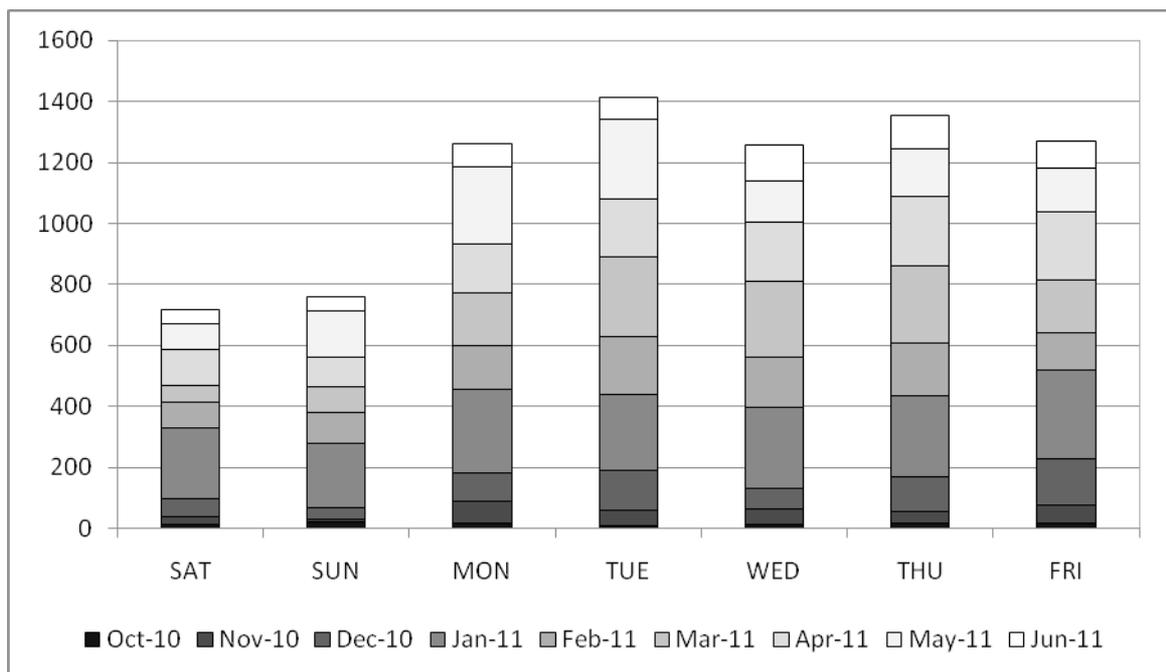


Figure 8: Login record on a weekly basis

Furthermore on the basis of the programme’s evaluation by the students and their demand for simple website navigation, the structure presented in Figure 1 was re-designed after the intermediate meeting. The number of modules concerning individual courses has been reduced. Specifically, the announcements module, calendar and discussion forum for the particular courses have been deleted (Figure 9) and their content has been transferred to the corresponding central modules. This change has resulted to a substantial increase of participants’ involvement, an indication of which is the triplication of the number of posts in the central forum.

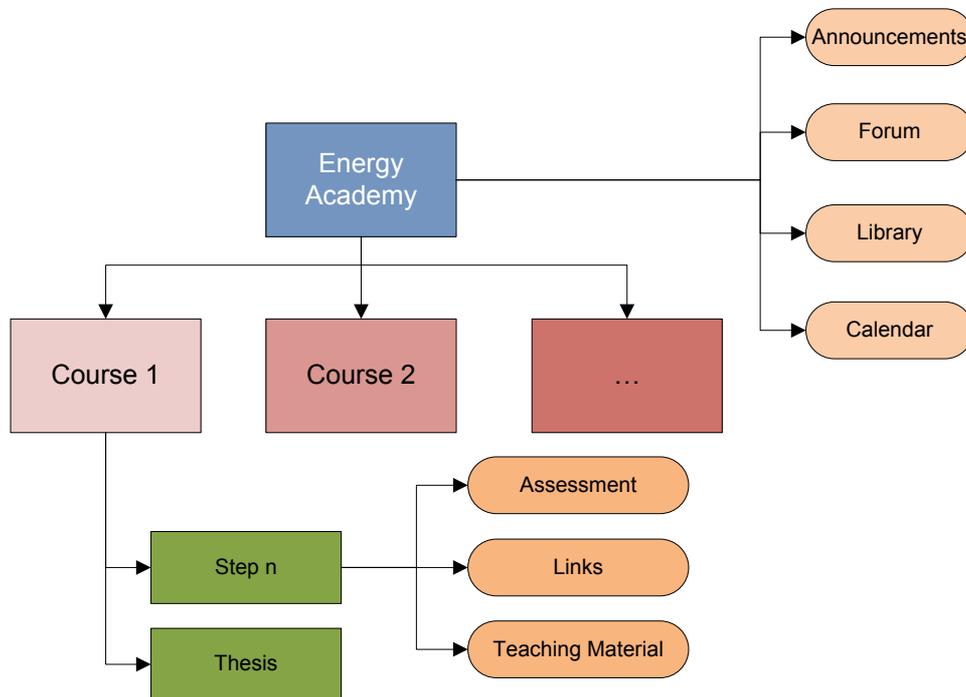


Figure 9: The new Energy Academy website structure

## Conclusion

The objective of this paper was to examine the usefulness of both synchronous and asynchronous courses delivery as a tool for training professionals. The experience gained from the operation of the “Energy Academy”, a distance training programme for local administration officials and for persons involved in the shaping of energy and environmental policies, has been used at the basis for this analysis. The main findings may be summarized as follows:

- The programme was well-received. The number of participants who registered and the ratio of those who completed the programme successfully show a substantial increase in the second year of the programme’s operation, as compared to the first. The higher participation rate in the second year is mainly due to word of mouth promotion and more advertising. On the other hand, the lower dropout rate on the second year is mainly due to the fact that new students, having learnt from past experience, were more prepared to face the difficulties of the programme.

- Twenty percent of the programme's participants were island municipalities' employees, which constitute the main target group of the programme. This is a significant percentage, but efforts should be made to increase it.
- The participants used the platform mainly as a tool for receiving the educational material and submitting the assessments. Efforts should be made to increase its use, as an open community of professionals who discuss the problems they face, in order to improve the interaction between them.
- A number of improvements have come as a result of the programme's evaluation by the participants. The most important of those was the participants' demand for simple web-site navigation, which has led to the redesigning of the website structure.

On the basis of all the above it could be said that the programme has come to fill a training need and satisfy an existing demand. The number of participants, their profile and the programme's evaluation by them, have shown that it has achieved its goals, at a great extent. However, some failings (high dropout rate, rather low percentage of the target audience in the participants) should be taken into account for the programme's successful continuation.

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## **Flushing of Total organic carbon (TOC) in Jericho Sub-basin springs and the formation of THMs in Jericho drinking water**

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2. Palestine Technical University/Khadory

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## ABSTRACT

Jericho springs group (Ein Sultan, Ein Dyuk, Ein Nuwemah), and Wadi Quilt springs group (Fara, Fawar, Quilt) are the major domestic water sources for Jericho area. The catchment area of these two springs group locates in the mountain area where high urbanized areas locate. In this area treated wastewater from Al Bereh municipality, and raw wastewater from Israeli settlements are discharging into Wadi Al Quilt drainage system. The average concentration of the dissolved organic carbon (DOC) of the stream wastewater was about 16 mg/L, and after mixing with springs fresh water along the Wadi drainage system, the DOC concentration decrease to about 6 mg/L. Rainwater, flooding water and wastewater infiltrate into the underground through the high fractured, and verkarsted carbonate rockes. The pheratic upper aquifer receive 400 mm recharge in the western part and less than 200 mm in the eastern part During winter months and after heavy rainfall the DOC compounds are flushing out from the unsaturated zone, so high concentrations are measured in the groundwater of the two groups, during this period the DOC-concentration ranges between 3 and 5 mg/L for Wadi Quilt Group, and increase in Jericho group with up to 18 mg/L. The highest concentrations are measured during January in Ein Sultan and Ein Duke water, which indicat that the two springs could be related to one hydrogeological system, where Ein Al Nuwemah contain 2.7 mg/L Free chlorine concentration in water networks of Jericho city, and Aqbat Jaber Refugee camp are below the 0.5 mg/L. Variations of DOC concentration in Jericho spring water needs special attention during the winter months. The total concentration of THMs in both networks is less than 100 µg/L, this is due to the low dose of free chlorine concentration added to the water, by optimizing this dose, it is to expect that the THMs concentration will rise dramatically.

**Key Words:** TOC in groundwater, Jericho, formation of THMs in drinking water

## Introduction

Jericho locates in the Jordan Valley at about 370 m below sea level. It extends from 10 km to the north of the Dead Sea, and 7 km to the west of Jordan River (Fig. 1). This area related to semi-arid/arid climate zone. The average annual precipitation is about 250 mm (PWA, 2010,). The location of the area by the end of the eastern slope of Ramallah-Jerusalem anticline in the west makes it an excelent catchments area for surface- anf groundwater. Two major spring groups issue in this area, and these asre Group I (Sultan, Dyuk, Nuwemeh), and Group II (Quilt, Fara, Fawar). The two groups drain annually about 14 MCM of fresh water from the upper carbonate aquifer, which is part of the Eastern Basin, where the regional groundwater flow eastwards (Figure 1) (PWA,2010) Pollution of water resources in the Occupied Palestinian Territories is a major challenge facing domestic water suppliers. For examples, Jericho spring group (Ein Sultan, Ein Dyuk, Ein Nueimah) supply Jericho city with domestic water, and Wadi Quilt springs group (Ein Fara, Ein Fawar, and Ein Quilt) supply Aqbat Jaber Refeguee camp, where water transfer through 12 km open canal to the sand-filter treatment plant.

The catchment area of both spring groups is about 176 <sup>2</sup>km The catchment area stretch from Jericho city in the east to Jerusalem Al Bereh area in the west. Urban areas like Jerusalem, Al Ram, Al Bereh and many Palestinian villages locate within the border of this catchment area. Treated

wastewater from Al Bereh treatment plant (6000 <sup>3</sup>m/y), and uncountable volume of raw wastewater originate from Al Ram, South Jerusalem, Palestinian villages and illegal Israeli settlements flow in the Wadi (Samhan. et al, 2011).

Chlorine does is added in regular base to the water network. Chlorine dose is added periodically before pumping into the distribution network This implicates the evidence for the presence of free chlorine in the drinking water within the distribution system (Jericho Manucapility, 2011).

The objective of this study is to evaluate the TOC concentration in spring's water during winter and summer seasons in addition to measure the classical Trihalomethens (THMs) in houses tap water within the boundary of Jericho municipality.

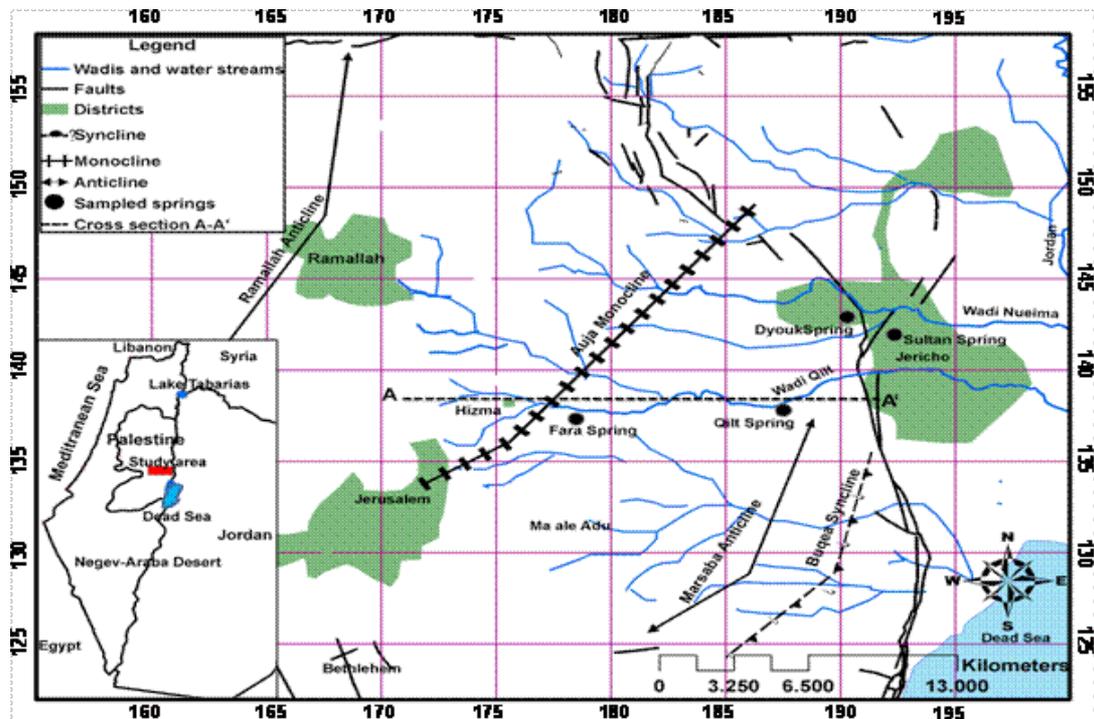


Figure 1: general location map for the study area, including the two spring groups

## Hydrogeology

Wadi Al Quilt is one of major natural drainage systems that drain surface water from the mountain the west to the Jordan River in the east. This drainage system cross Jericho sub-basin, where the recharge of the Plio-Pleistocene shallow aquifer system depends on the infiltration rate through the wadi flooding (Sbah, 2009). Annually about 300 mm of the rainfall infiltrate through the high fractured, and verkarsted carbonate aquifer system in the western part of the catchment area, and less than 50 mm in the eastern part (Marei, et al, 2010) Flooding water flow sporadiklly after heavy rainfall during the winter months, this range between 3 and 12 MCM/a (PWA, 2010). Flooding water and the marginal water (treated and un treated waste water) infiltrate through the thin soil horizon (less than 0.5 m) and through the wadi floor and stored in the unsaturated zone (Khayat, 2008, Guttman, 1998)

The Upper Aquifer system of the Mountain Aquifer drain water in form of springs along different structural features. This aquifer consists of high karstified, and fractured limestone, dolomite, chalk and marl of Cenomanian-Turonian ages. Chalk formation of Senonian age covers the eastern flank of the mountains, and acting as impermeable layer for the groundwater flow regime, so groundwater recharge takes place in the crests of the mountains (Hoetzi, 2007, Marei, et al, 2011).

The thickness of the Upper Aquifer ranges between 170 m in the western part, and reaches 200 m in Jerusalem. From lower to upper part, this aquifer includes the Hebron, Bethlehem, and Jerusalem formations. The outlets of saturated part of this sub-aquifer are in the Jericho springs (Sultan, Dyuk, Nuwemeh) and in Wadi Al Quilt group (Faraa, Fawar, Quilt springs) (Rofe and Raffety, 1963, 1965; Hoetzi, et al 2007). The annual precipitation amount in the main recharge zones for the aquifer in Jerusalem and Ramallah mountains is about 540 mm (PWA, 2010).

## Methods and material

One of the methods used in this study is using Na/Cl ratio of groundwater as an indicator for water pollution. This is normally applied to identify source/sources of pollution, this ratio is about 0.86 in rainwater, as well as in fresh water of the calcareous mountain aquifer where human activities are still very limited (Marei and Vengosh, 2002). This ratio reaches 1 or more, when urban wastewater mixed with fresh groundwater, so this ratio could be considered as an indicator for groundwater pollution. Previous studies show that high DOC concentration of 25 mg/L was measured in Jericho spring group (Khayat et al, 2008). Dagher, 2005 measured the DOC in Wadi Quilt spring group, which was less than 5 mg/L, in the other hand the BOD concentration in the partially treated wastewater ranges between 20 and 136 mg/L.

Two sampling campaigns were carried out during August 2009 and April 2010. Groundwater samples were collected from Ein Sultan, Ein Dyuk, Ein Nuwemeh, and Al Quilt Canal. The sampling sites for the three springs were direct at the spring niche, and for Al Quilt canal before entering the sand infiltration basin and after the infiltration filtration basin. Raw water was filtered through washed 0.45 µm pore-diameter membrane filters to remove particulates prior to analysis. Filtrate was then decanted into a 50 ml glass vial with Teflon caps, and stored at 4 °C in the dark until the TOC, and TN analysis. For majoring the major ions, a prewashed polyethylene bottles were used for collecting water samples, also these samples were transported in cooling boxes and stored at 4 °C until analysis.

To study the THMs concentration in drinking water, samples were collected from household tap water, during the two stages of sampling campaign, where 60 water samples were collected from both sites (Table 1, and Figure 1). For this purpose water samples were collected in 30 ml amber glass vials with Teflon lined caps, tap water was allowed to run 5 minutes before sampling. Before the vial was filled up with water, 2 mg of the dechlorination reagent sodium thiosulphate were first added to the vials in order to quench free residual chlorine, and then vials were sealed and kept at

4 C for analysis within the next 10 days (Johnson et al, 1986).

**Table 1: Sampling program for THMs measurements**

Community	10 October 2009	10 January 2010	Analysis Method
Jericho	15 samples	15 samples	USEB method no. 551.1
Aqbat Jaber Refugee Camp	15 samples	15 samples	Head Space Analyzer

Electrical conductivity, pH, temperature and dissolved oxygen are measured in the field by using WTW-Multi electrodes instrument. Residual chlorine is determined using portable HACH-spectrophotometer. TOC and TN are analyzed by using N/C 2000 analyzer from Analytic Jena AG with an auto sampler. The first sampling campaign from 10 October 2009 were sent to Water Technology Center in Karlsruhe/Germany, where USEB method no. 551.1 “determination of chlorination of chlorinated disinfection by-product in water by liquid-liquid extraction and gas chromatography with capture detection method” was used. Samples from the second sampling campaign were sent to the Laboratory of Jordan Royal Scientific Society/ Amman, where Head Space Analyzer Occupied with Gas Chromatography-Electron Capture Detector was used.

## Results and Discussion

Some physical and chemical properties of raw groundwater in Jericho area are illustrated in Table 2.

The pH-value of the all water samples are above 7 units which reflect the characteristic of the carbonate aquifer system, only a measurement with pH value of 6.3 at 02.08.2009 indicates a strange change, that we could not find an interpretation. Groundwater temperature is range between 21 and 24 C. The electrical conductivity ranges between 549 and 788 uS/cm, which are typical for fresh groundwater from the carbonate aquifer. The chloride content of spring water range between 33 and 69 mg/L, and for Al Quilt canal between 48 and 76 mg/L, these values are relatively high for water drain from the carbonate aquifer (Marei et. Al 2010), and indicate that additional source/ sources of salts are added to the aquifer system, and these could be originate from the wastewater (treated or untreated) that drain all over the year in the Wadi Quilt.

**Table 2: Some physical and chemical properties of domestic water sources in Jericho city, and Quilt canal**

Site	Date	pH	Tem C	Ec. uS/cm	Cl mg/l	Na mg/l	Br mg/l	TOC mg/L	TN mg/L
Ein Sultan	1.08.2009	6.3	24	658	55	54	0.5	1.5	4.8
Ein Sultan	1.10.2009	7.2	21	690	33	25	0.5	2.2	6.4
Ein Sultan	1.01.2010	7.4	21	788	67	69	0.6	18.4	7.2
Ein sultan	1.04.2010	7.4	22	779	83	22	2.1	3.3	5.3
Ein Dyuk	1.08.2009	7.1	21	680	54	52	0.6	2.3	4.3
Ein Dyuk	1.10.2009	7.2	22	683	50	21	0.6	4.9	5.3
Ein Dyuk	1.01.2010	7.2	21	754	69	72	0.6	14.4	7.1
Ein Dyuk	1.04.2010	7.3	22	721	73	21	2.0	1.3	5.7
Ein Nuwemah	1.08.2009	7.2	23	682	55	58	0.5	2.4	4.9
Ein Nuwemah	1.10.2009	7.2	22	683	33	24	0.6	3.5	5.4
Ein Nuwemah	1.01.2010	7.4	21	747	66	69	0.6	2.9	6.8
Ein Nuwemah	1.04.2010	7.4	21	714	59	22	2.3	2.1	5.5
Al Quilt (B)	1.08.2009	8.5	33	446	48	54	0.4	1.6	2.8
Al Quilt (B)	1.10.2009	8,3	23	456	58	30	0.5	2.9	3.1
Al Quilt (B)	1.01.2010	8.5	22	657	60	60	0.5	5.2	5.0
Al Quilt (B)	1.04.2010	7.9	22	549	76	16	1.5	1.2	4.2
Al Quilt (A)	1.08.2009	8.4	27	490	48	46	0.4	0.2	2.8
Al Quilt (A)	1.10.2009	8.1	22	519	56	29	0.4	3.1	3.8
Al Quilt (A)	1.01.2010	8.1	21	616	51	51	0.5	4.9	4.2
Al Quilt (A)	1.04.2010	8.0	21	551	62	15	1.5	3.3	3.8

## Springs response to rainfall events

The data shows that most of the anthropogenic related measurements show the highest trends in January 2010 (Figure 2). The pollutants are flushed out under the impact of heavy rainfall events in the winter season at two stages, the first stage flushing of pollutants from the secondary porosity (fractures, joints and karst), this take place after starting the rainy season, where high Na/Cl ratios in the same period exceed 1.5. The second stage is washing out the pollutants from the sediments (small pore space, and primary permeability) therefore, even the chloride content was restricted to that chloride coming from the sewage, and the chloride shows a ted increase in January.

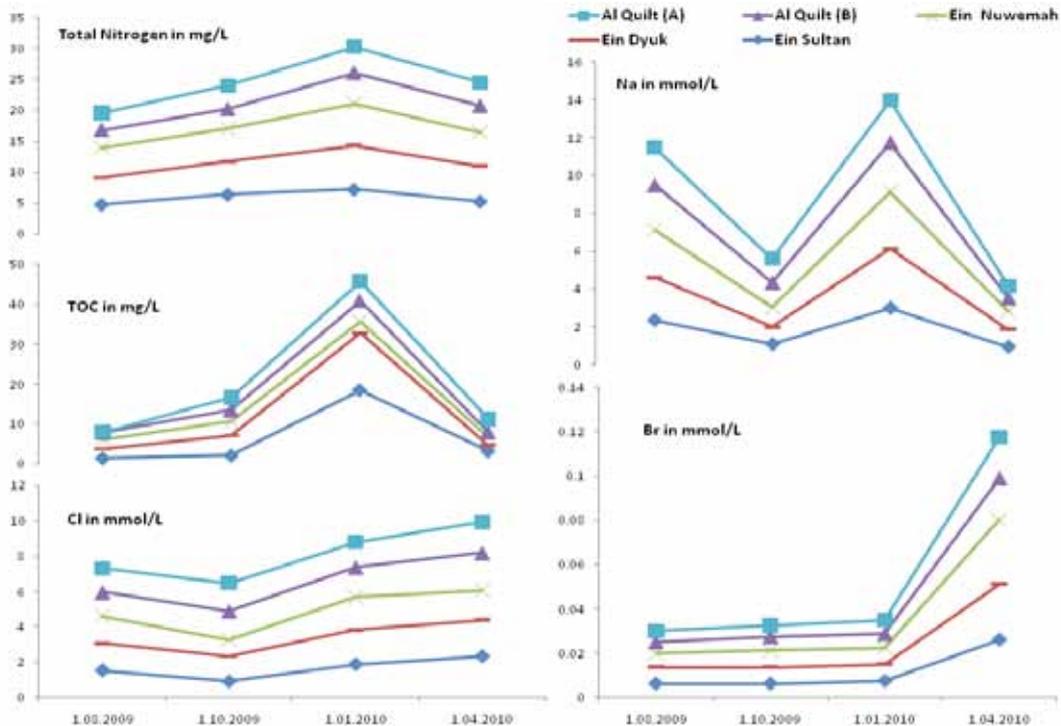


Figure 2: TN, TOC, Cl, Na, and Br concentrations in springs water and Wadi Quilt canal

At the end of the winter season in April, where extreme rainfall events took places during this year ( xx mm), infiltration of rainfalls act as a pressure piston to flush out the solutes content in the aquifer, but with more energy. The impact of rain events in April were much stronger, and have the ability to flush out the aquifer material including bromide and chloride together (Fig 3 a,b). The Na/Cl molar ratio is relatively closed to natural concentration of the mountain aquifer (0.86), and this case the increases in chloride concentration is related to the evaporation process.

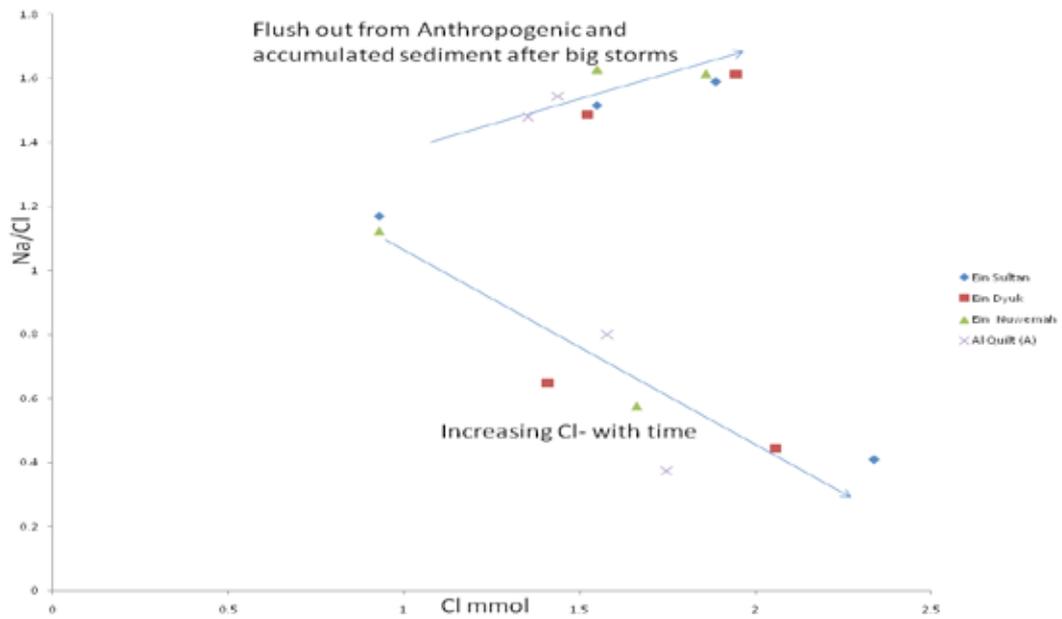


Figure 3a: Na/Cl molar ratios versus Chloride.

### Variation in THMs and DOC content

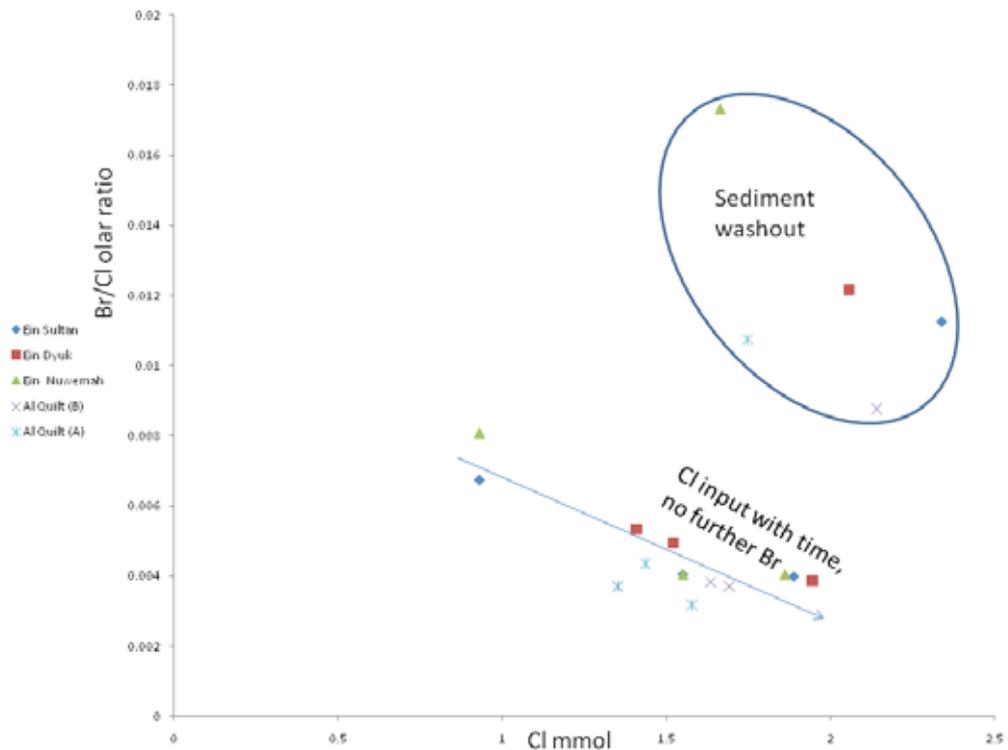


Figure 3b: Br/Cl molar ratios versus Chloride in mmol/L.

The concentrations of TOC are range between 1.5 and 18.4 mg/L for the spring water, and between 0.2 and 5.2 for Wadi Quilt canal, the variation of water canal is related to the fact that water flow about 12 km in an open canal, and the fact that Israeli settlement drain its raw waste water sporadically into the upper wadi drainage system, and this mixed with water of Wadi Quilt spring group The highest TOC values were recorded in Ein Sultan, and Ein Dyuk spring during January 2010, and these values decrease in August, October, and in April to less than 4 mg/L, this is due to the fact that during rainy season, condute system of the aquifer transfer pollutants in a short period the spring niche, where after the rainy season water drain from the low permeabil media. The concentration of the total Nitrogen TN shows the same trend. It is to expect, that organic compounds accumulate during summer and autumn seasons in the unsaturated zone and in between wadi sediments, and then leached during winter months, consequently TN increase during winter months, where washing out and transport conditions become optimal in addition to the nitrification process of organic compounds due to the presence of fresh water (Figure 2).

The concentrations of TOC and TN in Wadi Quilt canal behave totally different. There was no clear trend or seasonal variation in the concentration Wadi Quil water even there was no indication about the efficiency of the sand filter where there was no remarkable difference between concentration before (B) purification with sand filter or after purification (A). This might refers to the fact that the sand filter are poorly clean and full with organic matter residues settling down from the prevoues filtration process (Figure 2).

### **Chlorine residual (Total and Free)**

Chlorine doses and chlorine residual are key factors for formation THMs in drinking water. The chlorination of drinking water took place direct on the sources of water, which means at Ein Sultan spring site for Jericho city, and after the sand purification filter for Aqbat Jabber Refugee camp. Water samples W3 – W27 were collected from water network in Jericho city, pH-value, temperature, total chlorine and free chlorine (Figure 4). Table 3, and 4 summarize the results of total and residual chlorine in Jericho, and Aqbat Jaber water net works.

**Table 3: Physical properties and residual chlorine from Jericho distribution system**

Summer period (October 2009)						Winter period (January 2010)				
Sample	pH	EC	Temp	Total Cl <sub>2</sub>	Free Cl <sub>2</sub>	pH	EC	Temp	Total Cl <sub>2</sub>	Free Cl <sub>2</sub>
	-	µs/cm	°C	mg/L	mg/L	-	µs/cm	°C	mg/L	mg/L
W3	7.2	705	22	0.28	0.25	7.4	790	21	0.32	0.29
W13	7.5	684	23	0.24	0.19	7.5	785	22	<DL	<DL
W14	7.4	682	32	0.13	0.10	7.3	804	22	<DL	<DL
W15	7.4	688	23	0.17	0.14	7.5	807	21	0.20	0.20
W16	7.5	683	29	<DL	<DL	7.3	750	19	0.30	0.26
W17	7.6	680	30	<DL	<DL	7.4	749	21	0.30	0.27
W18	7.4	687	23	<DL	<DL	7.2	753	27	<DL	<DL
W19	7.3	687	32	<DL	<DL	7.3	759	28	0.20	0.13
W20	7.4	685	22	<DL	<DL	7.4	750	27	0.32	0.24
W21	7.4	686	24	0.14	0.13	7.5	747	26	0.19	0.17
W22	7.8	609	27	0.14	0.14	7.4	726	28	<DL	<DL
W23	7.5	687	23	0.10	<DL	7.4	732	23	0.39	0.30
W24	7.5	687	26	<DL	<DL	7.2	720	25	0.27	0.25
W25	7.6	684	33	0.10	<DL	7.3	739	26	0.34	0.32
W26	7.5	688	33	0.1	0.1	7.2	742	25	0.30	0.31
W27	7.4	685	29	0.10	<DL	7.4	745	28	0.37	0.32
Average				0.15	0.15				0.29	0.25

<DL: below Detection Limit

**Table 4: Physical properties and residual chlorine from Aqbat Jabber distribution system**

Summer Period (October 2009)						Winter Period (January 2010)				
Sample	pH	EC	Temp	Total Cl <sub>2</sub>	Free Cl <sub>2</sub>	pH	EC	Temp	Total Cl <sub>2</sub>	Free Cl <sub>2</sub>
	-	µs/cm	°C	mg/L	mg/L	-	µs/cm	°C	mg/L	mg/L
W4	8.1	519	25	0.30	0.28	8.1	534	23	0.25	0.23
W5	7.3	1784	28	0.26	0.23	7.6	1890	24	0.19	0.18
W6	7.2	1773	27	0.24	0.22	7.4	1902	26	0.19	0.12
W7	7.5	1797	30	0.27	0.26	7.6	1902	29	<DL	<DL
W8	6.9	1725	31	0.28	0.27	7.6	1914	31	<DL	<DL
W9	7.3	1666	30	0.22	0.21	7.3	1799	27	0.19	0.18
W10	7.4	1907	35	<DL	<DL	7.6	1999	28	<DL	<DL
W11	7.2	1790	31	0.20	0.20	7.4	1927	27	0.18	0.16
W12	7.5	1873	35	<DL	<DL	7.6	1918	28	0.22	0.19
W28	7.9	1128	21	0.21	0.21	7.4	1960	23	0.19	0.12
W29	7.6	1560	29	<DL	<DL	7.3	1951	23	0.24	0.16
W30	7.4	1648	30	<DL	<DL	7.5	1976	29	0.19	0.12
W31	7.4	1571	26	0.23	0.20	7.6	1961	23	0.17	0.16
W32	7.5	1506	27	0.14	<DL	7.7	1850	22	<DL	<DL
W33	7.5	1618	32	0.19	0.10	7.5	1877	25	<DL	<DL
W34	8.1	1553	26	0.22	<DL	7.3	1899	24	<DL	<DL

<DL: below Detection Limit

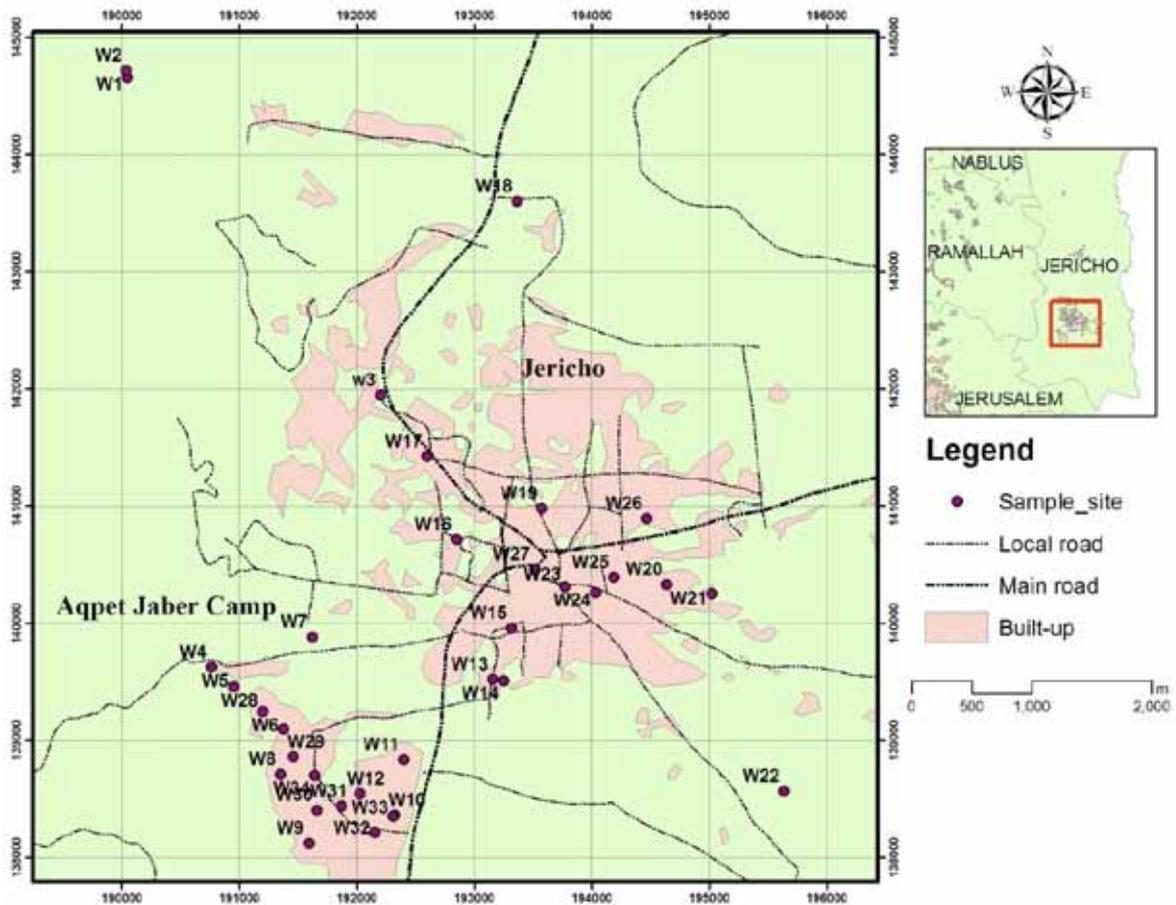


Figure 4: sampling sites in Jericho city and Aqbat Jaber Refugee camp

Data in table 3, and 4 show that, free chlorine concentration in water samples collected from both networks are below the recommended value of the WHO, which is 0.5 mg/L, which means that the chlorination dose in both water sources is not sufficient. The low concentration of free chlorine could be refer to the low chlorine does added during the primary disinfection, which is less than the long term demand, therefore the concentration of chlorine in insufficient.

### Formation of THMs- Trihalomethens in Drinking water

THMs measurement campaigns were carried for the two water networks during October 2009 and January 2010. Results are presented in Table figure 4-7. Bromoform ( $\text{CHBr}_3$ ) was the most dominants components within THMs-group. THMs concentrations in Jericho network water range between 2.5 and 6.0  $\mu\text{g/L}$  in October 2009, and between 6.8 and 36.4  $\mu\text{g/L}$  during January 2010. The high value in January is due to the high TOC concentrations in groundwater. In general, the low TTHMs-values in water networks are related, more or less, to the low chlorine does in water (Figure 5, 6).

In Aqbat Jaber water network, Bromoform is also the dominant THMs-components in the water network. It is clear that October samples contain high THMs than January samples; this is related to the higher temperature during October which facilitates the reaction between organic matter

and halogens. Only sample W5 during January shows high concentration of bromoform and also chloroforms. In all water networks the TTHMs concentrations were less than the maximum contamination level of 100 $\mu\text{g/L}$  that recommended by USEPA and by the WHO to be the upper acceptable limit, but these values exceeded the USEPA maximum contamination level for Bromoform (Figure 7, 8). This distinctive concentration in Bromoform is simply due to the presence of excess amount of bromide in groundwater which reach its high concentration by the end of the season as shown above. The reaction between bromine and precursor organics in water was reported to be much rapid than similar reactions between chlorine and organics as reported by Stevens et al. 1976.

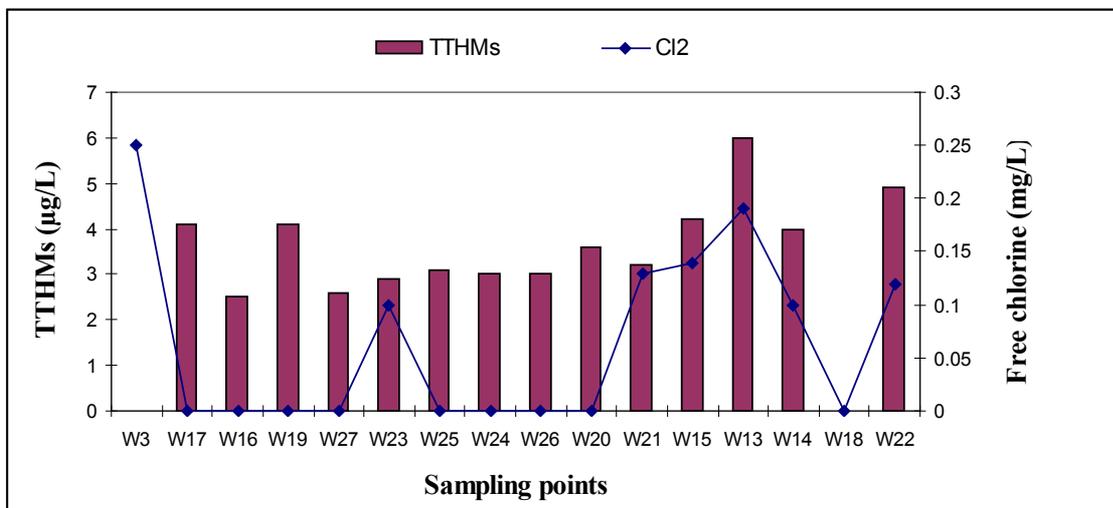


Figure 5: free Chlorine, TTHMs in Jericho distribution system, October 2009

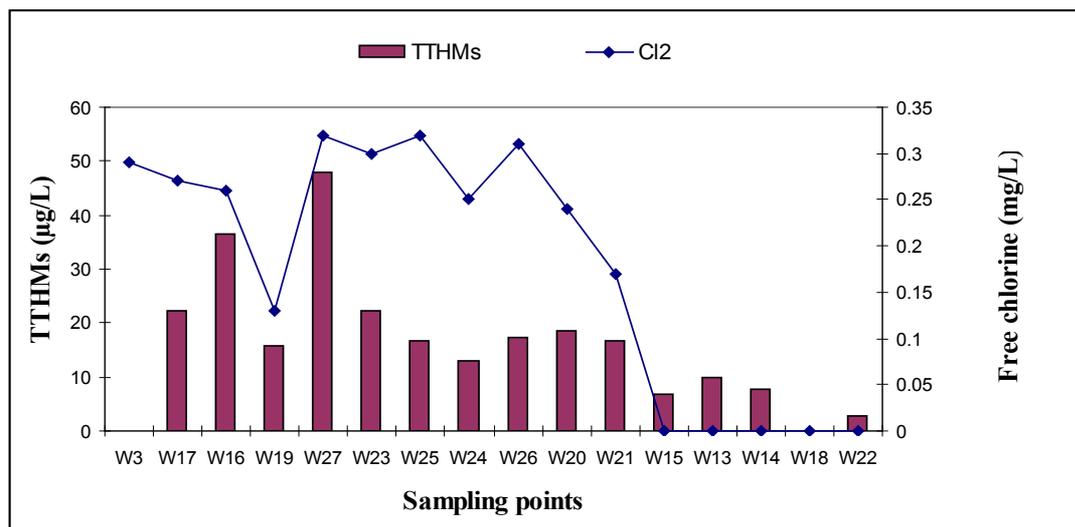


Figure 6: Free Chlorine and TTHMs in Jericho distribution system, January 2010

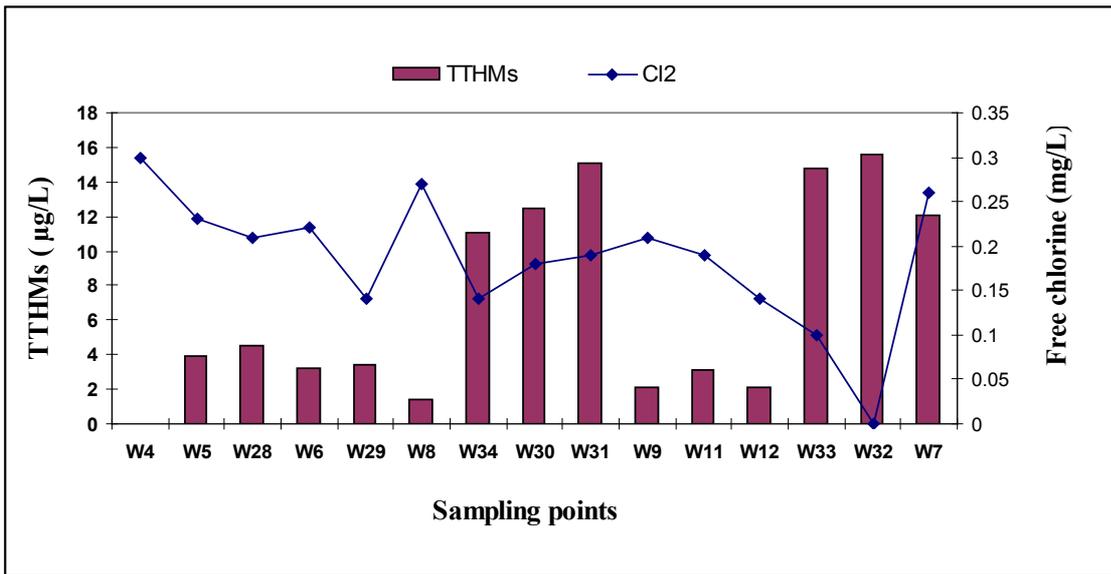


Figure 7: free chlorine, THMs in Aqbat Jaber distribution system, October 2009

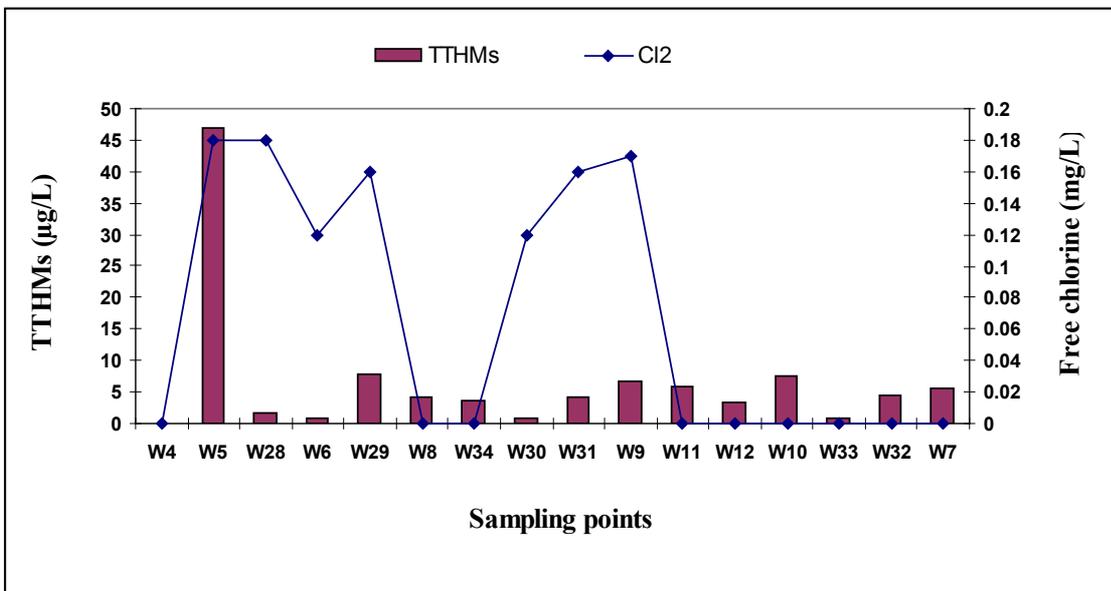


Figure 8: free chlorine and TTHMs in Aqbat Jaber distribution system, January 2010

## Conclusion & Recommendations

The Domestic water sources in Jericho city and Aqbat Jaber were investigated for its Na, Cl, Br, TOC, TN, Free Chlorine and THMs concentrations. Sampling campaigns were carried out 2 times during October and January 2010 to see the seasonal variation effect. The results show that high anthropogenic pollutant such as, TOC, TN-values were measured in Ein Sultan and Ein Dyuk spring water during January 2010. These were flushed out by the first heavy rain event. The next rain event come later also act as solutes washer but the resulted solutes were mainly related

to the sediments residues rather than other pollutant; this was clearly indicated by the bromide shock in April. The sources of TOC, TN refer to the wastewater in the recharge area. The chlorine concentration in water network is less than the WHO recommended values; this is due to the low chlorine doses in both water networks. Bromoform is the dominant THMs in both water sources, the value exceeded the USEPA limit, this could be due to the presence of bromide in water which were significant by the last rain event in April, in the other hand the TTHMs in all water samples were less than 100µg/L, this value considered the upper limit for drinking water, but this value will increase as soon as the chlorine dose is optimized, and then, it is to expect that the THMs concentration will increase. In order to avoid future formation of THMs in drinking water, a pre-treatment of Jericho and Quilt spring groups is recommended. The second recommendation is to transfer the wastewater through pipeline from the upper part of Wadi Quilt to Jericho area, where the need for irrigation is high.

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# **Evaluation of Focus Groups Attitudes and Perspectives Towards Palestinian Environmental Higher Education Programs**

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## ABSTRACT

This paper synthesizes the outcome of three workshops conducted at three selective Palestinian universities for alumni and enrolled students, teachers, and stakeholder. The workshops aimed at evaluation of focus groups attitudes and perspectives towards Palestinian environmental higher education programs offered at the three universities. A stratified sample of 164 focus groups members participated in the workshops. The focus groups found to be aware of the problems and deficiencies facing the Palestinian environmental higher education programs and very enthusiastic towards reforming and upgrading them to meet present and future Palestinian developmental needs. The paper tackled separately the key problems identified by each of the focus groups. These key problems include among others the need for improving teaching skills and tools, the demand to add extracurricular activities to the programs, and the necessity to improve communication and coordination between the various focus groupings.

**Keywords:** Qualitative Approach, Environmental higher education, reform, lessons learned, Palestine

## Introduction

The education and higher education system in the Palestinian Territory at one point was and is affected by the Israeli military occupation of the Palestinian land and resources and on the other hand it is affected by general factors facing third world countries such as poor socio-economic conditions, lack and/or poor institutional arrangements, and poor technical and human capacities. It was reported that more than 1,300 Palestinians schools have been disrupted by curfews, and closures (SFG 2007).

Data showed that the population of the Palestinian Territory is young; the percentage of individuals in the age group (0-14) was 41.9% of the total population in the Palestinian Territory mid year 2009, The elderly population aged (65 years and over ) was 3.0% of the total population in Palestinian Territory in mid year 2009 (PCBS 2010-a).

Although statistics showed that 4.2 percent of the general population in Palestine are enrolled in higher education institutions (PCBS 2010-a), many graduate programs are with very low enrolment and suffering from closure or freeze. Accordingly, higher education institutions in Palestine have much to fear about the future of such programs if no change in the educational environment will take place. In this regard Rowley and Sherman (2001) indicated that “it’s not going to be education as usual.” and have clearly spelled out in their book “From Strategy to Change” that this is true and everyone associated with colleges and universities must learn if their institution is going to survive and prosper. They identified two central themes of concern (1) the playing field is changing and (2) effective implementation of strategy is going to be the critical success factor.

Also, expectations on the political side lead to the conclusion that an independent Palestinian State will prevail in the Palestinian Territory in the near future (in less than 10 years). The newly formed Palestinian State will face among others enormous needs and challenges in both the education and higher education and the development arena.

However, the Palestinian National Authority has already a very large amount of formal employment undertaken by the government since its initiation in 1995. PCBS labor force survey results showed that employment in the public sector constitutes about one fourth (23.5%) of the total employed persons, distributed as 15.7% in the West Bank and 46.9% in Gaza Strip (PCBS 2010-b). This will not allow for much new labor absorbance in this sector.

Worth mentioning and pinpointing that the university system in Palestine which was mostly geared towards producing graduates for governmental jobs. This will be shifted in the near future and most jobs will be created in the private sector. And accordingly, changes in the higher education system need to take place to accommodate for the private sector needs. Taking this matter into account and by simple calculation, the Palestinian Authority needs to generate something like 1.68 million new jobs over the next 10 to 15 years. This is a real problem to consider.

There are three institutions that offer master degrees in environmental science and/or engineering in the West Bank, namely An-Najah National, Birzeit, and Al-Quds University. The main aim of establishing these programs was to serve and support the society. However, the three institutes did start their academic programs with low academic technical and/or human capacities and without any coordination and/or integration between each other. This practice has resulted in lower efficiency and effectiveness of the aforementioned programs and in some cases duplication.

Because of the relatively long time lapsed since the start of these programs and the major socio-economic and political changes taking place in the Palestinian territory, it is of importance and interest to reform and/or upgrade these programs. To do so, it is of more importance to evaluate the attitude and viewpoints of various related groups including auminis, enrolled students, teaching astaff and various stackeholders.

This paper main aim was to evaluate the attitudes and perspectives of environmental higher education focus groups, in order to reform and/or upgrade those programs and for better addressing current and future Palestinian environmental developmental needs, problems, and challenges.

## **Higher education system in Palestine**

The university education consists of 4 years of a college education to obtain a bachelor's degree and additional 2 years for a master's degree. Some colleges provide 2 years of education for a diploma (MOEHE 2006 and 2008, World Bank, 1999 and Wikipedia 2010).

A total of forty nine registered higher education institutions exist currently in Palestine (MOEHE, 2010-a, See Table 1). There are 15 universities in Palestine of which thirteen using traditional education system and two using open education system (see Table 2). The term "traditional education system" is used to denote the main full-time approach to educational provision that has been evident in higher education. By location there are nine universities in the West Bank and six in the Gaza Strip (see Table 1). In addition, there are 15 university colleges and 20 community colleges in Palestine (see Tables 2 and 3). While most universities are public, university colleges and community colleges are either governmental or private.

The languages of instruction adopted by Palestinian universities are Arabic and English. Three university and community colleges were established and operated by UNRWA(6.1% of total). The majority of higher education institutions in Palestine are (1) either public (40.8% of total) or governmental (24.5% of total) non-profit institutions, and (2) mostly they fundraise for infrastructures and equipment support and receive governmental funding as well (see Tables 2, 3, and 4).

The number of students enrolled for bachelor degree in the Palestinian traditional universities in 2009/2010, was 107925 students of which 61139 or 56.6% are females. The number of students enrolled in graduate studies was 6234 of which 2668 or 42.8% are females. Gross male enrollment ratio for higher education was 44.5% (MOEHE 2010-a).

More higher education students are enrolled in humanity's academic programs such as social science, education, humanities, and arts and fewer shares of those are in science and engineering.

Demand for higher education has increased significantly in the past decades with students enrolled in higher education institutions more than tripling between 1995 and 2006 and increased about 50% from 2006 until present (MOEHE 2006, 2008 and 2010-a).

It was indicated that Palestinian higher education system needs not only to satisfy the increasing demand from the growing population of secondary education graduates, but also to maintain quality and relevance to meet the changing demands of the global economy. In addition, public financing for higher education is weak, given current financial circumstances. The system heavily depends on student fees, which is 60 percent of Palestinian universities' operating costs (Heyneman, 1997, World Bank,1999, Jaramillo and Hiromichi, 2009, and Wikipedia 2010).

Since early eighties, several international institutions including AMIDEAST did support Palestinian Faculty Development Program (PFDP) which seeks to increase capacity within the higher education sector in the West Bank and Gaza. PFDP intended to address long-term issues of reform in teaching and learning practices, thereby setting in motion a process that will address the quality of higher education well beyond the project's life span. These faculty development programs have intensified with the establishment of Palestinian National Authority and MOEHE (MOEHE 2006, 2008 and 2010-a).

The MOEHE has developed new student loan schemes for higher education (Heyneman, 1997, Jaramillo, Hiromichi, 2009, and MOEHE 2010-b). The objectives of these loan schemes are:

- 1) to create a sustainable financial resource that will assist students into the future,
- 2) to ensure that students understand their responsibility to share the cost of their education,
- 3) to provide a strong, streamlined repayment system that is easy and fair, and
- 4) to provide a collection mechanism that will ensure sustainability-a revolving fund

Inter-university co-operation programs are underway in the Palestinian territory, such as TOKTEN, PEACE and MEDCAMPUS. They are supported by partners such as the European Union, UNESCO and the UNDP. The PEACE program (Palestinian-European Academic Co-operation in Education) 1991-until present involves 66 Palestinian and European universities –March 2011 (PEACE 2011). It has been particularly noteworthy in these programs for having allowed students and teachers from the West Bank to be sent to European faculties at a time when the university establishments of Gaza and the West Bank were closed. In a second phase of the Peace project, it is to provide for the dispatch of missions of volunteer academics, on sabbatical, from Europe, North America and the rest of the world to the West Bank and Gaza (Nicolai, 2007 and PEACE 2011).

## **Environmental higher education system in Palestine**

In Palestine, and particularly in the West Bank, there are three higher education universities that offer master programmes in fields of water and environmental engineering as well as water and environmental sciences. These are Birzeit University through Institute of Environmental and Water Studies, Al-Quds University through the department of Applied Earth and Environmental Sciences and An-Najah National University through Water and Environmental Studies Institute. All of these institutes have been dealing with environmental and water issues in Palestine since they were established (see Tables 5, 6, and 7).

The three institutes have other activities rather than teaching. All of the three organizations are offering training courses, carrying out researches and serving the local society in Palestine. Unfortunately, all of these activities have been carried out without any coordination. Therefore, this lack of coordination that leads to the waste of efforts in terms of financial and human resources.

Several hundred students successfully obtained their master degree from those universities in the decade. All of these Alumni have master degree in Water and Environmental engineering or water and environmental sciences. Most of those graduates are working at Palestinian ministries, governmental associations and other firms, which are involved in the water and environmental issues, related to Palestine.

In comparing the five programs offered by the three institutes (see Tables 5, 6, and 7), the following points were observed:

- The three institutes use the American credit hour education system with total of thirty six hours of which 30 credit hours course work and six credit hours were reserved for the thesis. The system at the three institutes allows students to follow either the thesis or none-thesis track.
- The three institutes require that the applicants to the five program to have a B.Sc degree (in the major under consideration) with a minimum of good GPA (according to the grading system of the candidate's original university).
- The requirements in compulsory and elective courses for the various programs differ in number and content

- The core courses for some programs do not reflect the title of the program. For example, the core courses for the MS in water and environmental engineering offered by Birzeit are mostly environmental in nature and water engineering is not considered or covered.
- It is difficult to link the compulsory and elective courses of each program of the five programs in one ILO grid.

## **Methodology**

### **Instruments and procedures**

Considering that new trends in research methods and approaches in the field today are combining quantitative and qualitative data analysis to investigate activities of interest and to provide additional layers of triangulation to validate findings (Bernard, 2006 and Wolcott, 2009). Accordingly, the qualitative method of instruments and procedures was chosen and used in this research in which open discussion workshops with relevant stakeholders were organized and implemented.

### **Study sample**

A stratified sample was selected for the qualitative methods and comprised of the following four groupings:

1. Students enrolled in the master program on Environmental Studies.
2. Teaching Staff,
3. Stakeholders,
4. Alumni's of the Master Program of Environmental Studies

The four focus groupings were invited at each of the campuses of the three universities to a workshop coordinated by a panel representing leading experts in the field.

### **Workshop procedure and approach**

In assessment of present higher environmental education situation in Palestine, three main workshops were held in the three campuses: one workshop at An-Najah National University, one workshop at Al-Quds University, and one workshop at Birzeit University. All workshops were conducted, transcribed, and analyzed as the focus groupings during May and June 2010. Workshop program consisted of the following steps:

- 1 - Call of graduates and currently enrolled students of the environmental higher education programs at the three universities from previously prepared lists by all available means (newspapers, radio, personal contacts, e-mails, phone , mobiles , classmates, etc.)
- 2 - Inviting lecturers from the university and other universities through formal letters and e-mail,

3 - Inviting relevant institutions and NGOs.

4 - Inviting all project partners.

5 - Inviting the last year engineering students as observers,

6 - Communication with Public Relations for media coverage and photography

A workshop panel of each university was selected to act during the workshop as focus groupings moderators. After an opening session where participants were introduced by program coordinator or institute director to the workshop objectives and goals, the four focus groups were set and separated in four rooms. A moderator for each targeted group was assigned. Each target group was asked face to face to talk freely about the master programs including program content, teachers, teaching tools, teaching environment, and others.

## **Results and discussion**

This section included the main results obtained in this study. Results are listed in three parts: general data of study population, identification of key problems, themes, and issues, and key problems, themes, and issues expressed by each focus group.

### **Study population**

The population of this study consisted of four targeted group related to the master program on environmental studies: students enrolled in program in the year 2010 (59.8% of total), teaching staff (12.2% of total), stakeholders (4.9% of total), and alumni's of the master program since 1994 (23.2% of total). In total, about half of the sample (47%) was from Birzeit University. About half of the total sample was from Birzeit due to the large participation number of enrolled students. Stakeholders were small in number indicating the hesitance to involve in such discussions. Enrolled students and alumni represented 83% of the total sample indicating high willingness to help in reform and upgrade of the programs. Table 8 gives the distribution of the study population by university and target group.

### **Identification of key problems, themes, and issues**

All discussions from the three workshops at the three universities were recorded. The records were separate for each focus grouping. Surprisingly, the outcome of workshops was very similar between the three universities and from the various focus groups and homogeneous outcome was found. This means that the problems faced are the same and the learning-teaching environment is very similar in substance. Accordingly, five main themes, factors, or groups of program deficiencies were identified including:

## 1. The Quality of the MSc. Program Content and its Application.

- Students in the program are coming from different disciplines (math, agriculture, chemistry, physics, biology, public health, pharmaceutical sciences, and engineering) so they do not have the same level of knowledge.
- Instructors are forced to go back to deal with principles and to spend time to assimilate this knowledge. Students with strong backgrounds are disappointed from the level of knowledge that they receive. This kind of conflict between instructor and students needs a solution. Few instructors follow old traditional methods of teaching, which depends on reading the material.
- There is a need to introduce new topics with the aim to strengthen student's background knowledge such as a course on Geology or Hydrology of Palestine.
- There is poor training infrastructure in terms of the possibility of training students in and outside the campus (directly in the field),
- There is a weakness in the academic and knowledge uptake because of fact that students are mostly not regular (part-time),
- There are diversity of knowledge and lack of homogeneity and by the fact that students have different scientific backgrounds, which means that there is variation in the fields of knowledge and this leads on the one hand to the weak attainment and the difficulty of educational of some of them and repeating of teaching materials for some specialists, and here the teacher to balance between diverse scientific backgrounds of the students.
- There is strong opposition to teaching method of education for some teachers, the fact that their style of dictation is not appropriate to teach a graduate level.
- There is lack of appropriate place for students for field visits with a lack of the possibility of applying some of the experiences they want to do in the field,
- There is a call for the introduction during the period of the program of more environmental sites visits, the illustration of the problems facing those sites, and alternative solutions to them,
- There is a request for post more than one professor specialized in different disciplines to accompany the students during site visits
- There is a need that courses provided during the program to be needed for thesis preparation as well as real life job.
- There is a need to introduce an environmental education course to the program, since many of the alumni's work in schools or in civil institutions with a relationship to awareness or teaching environmental awareness. The inability of alumni's to employ the information gained in the study period in the process of environmental awareness.

## 2. Availability of Extracurricular Activities.

- Responses show high agreement on the lack of various extracurricular activities offered in the program such as sport activities, social activities, touristic trips, and others.

### 3. Availability of Training and Support Environment (in class and in the field)

- There is a weakness in practical training and lab experiments and demonstrations. This puts pressure on students specially when they start working after graduation in different sites and fields, as they can not employ the information and skills they have acquired in practical terms, and there is a feeling that much of the information gained is not applicable because of the difference between practice and applied programs. The practical part of the program needs to improve, this can be reached by increasing and/or enhancing:

Field visit and site investigations

Laboratory work and analysis technique

Specialized conferences, seminars, and workshops.

### 4. Un-availability of communication and technical writing skills

- There is a weakness in scientific research skills, in terms of report writing or instrumentation. The problem of using these instruments which related to other departments. From the program perspective students are part time students and they come to the university two days maximum, due to this, it is not possible for them to earn these skills.
- There is a weakness in communications skills. How to approach the practical world after graduation and go through the work stages from writing resume/curriculum vitae to interviews to dealing with bosses and employees of different levels .
- Graduates have difficulties in getting along with work environment

### 5. Un-availability of coordination and linkage means

- There is lack in information flow between the Alumni and the department. This problem can be solved through students club, with portal.
- There is also a lack in coordination between governmental, public, civil institutions and alumni.
- There is absence of a body or unit at the university which follow-up alumni's and direct them to conferences or to pursue their higher studies or even the knowledge upgrade.
- There is weak linkages between students from different universities and the lack of relationship between universities and government and civil institutions, which led to a lack of knowledge of the nature of the work of these institutions in addition to weak links with them.
- The role of the environmental club is for communication between graduates in different universities and among the graduates themselves.
- There is weak or no career preparation steps for students or with stakeholders at the three universities and in relation to the offered five programs.

### **Key Problems, themes, and issues by focus grouping**

In more specific terms, the key problems, themes and issues related to the existing environmental higher education programs and identified by the four focus groupings are:

- Enrolled students and alumni were very critical of the existing lack of extracurricular activities, lack of practical and field training, the weak teaching skills and tools, and the lack of coordination/communication steps with the institutes offering the programs after graduation.
- Teachers were critical of the current diversity of student's background, the lack of integration between departments within the university, the integration, cooperation, and coordination between universities and programs, and of the demand for extra courses to the program.
- Stakeholders were critical of that graduates have difficulties in getting along with work environment, have difficulties in presenting themselves, and the lack of coordination between various stakeholders and the universities.

### **Conclusions**

Based on the results obtained in this study, it was concluded that:

- The four focus groups agree that the three universities offering environmental higher education programs in Palestine face similar problems, themes and issues (as listed in previous section) and that the learning-teaching environment is very similar in substance,
- Enrolled students as well as alumni at the three universities highly demanded that the academic programs to include extracurricular activities, and practical training either in the field and/or in the laboratories,
- Enrolled students as well as alumni at the three universities requested that the academic programs to include internships in coordination with the private sector and/or various stakeholders to help them to adapt to real working environment after graduation,
- There is a high necessity to improve teaching skills and tools used by teachers and use clear and continuous quality assurance measurements of teaching outcomes to ensure high quality teaching and learning,
- There is a urgent request to improve coordination/communication between alumni, universities and stakeholders during program offering and after graduation.
- There is a pressing recommendation to enhance integration and consolidation between the three universities in such a way one complete the efforts of the other and all serve the developmental needs of the country.

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**Table 1: Distribution of Palestinian Higher Education Institutions by Location and Type**

Type of Institution	Location		
	West Bank	Gaza	Total
Open Education	(16)*	(7)*	1
Traditional Universities	8	5	13
University Colleges	10	5	15
Community Colleges	14	6	20
<b>Total</b>	<b>32</b>	<b>16</b>	<b>49</b>

\* Education centers belonging to al-Quds Open University

Data Source: Ministry of Education and Higher Education, MOEHE (2010).

**Table 2: List of Palestinian Universities**

<b>Universities</b>			
<b>In the West Bank</b>		<b>In the Gaza Strip</b>	
<b>Name</b>	<b>Status</b>	<b>Name</b>	<b>Status</b>
1. Al-Quds University	Public	1. Al-Azhar University - Gaza	Public
2. Palestine Technical University (Khadoury)	Governmental	2. Islamic University of Gaza	Public
3. Birzeit University	Public	3. University of Gaza - Women	Private
4. An-Najah National University	Public	4. University of Palestine	Private
5. Hebron University	Public	5. Al Aqsa University	Governmental
6. Bethlehem University	Public		
7. Arab American University - Jenin	Private		
8. Palestine Polytechnic University			
Al Quds Open University*	Public	Al Quds Open University*	Public

\* = Open Education System

# = Traditional Education System

Data Source: Ministry of Education and Higher Education, MoEHE (2010).

**Table 3: List of Palestinian University Colleges**

University Colleges			
In the West Bank		In the Gaza Strip	
Name	Status	Name	Status
1. Palestine Technical College-AI-Aroub	Governmental	1. University College of Applied Sciences - Gaza	Governmental
2. Palestinian Academy for Security Sciences – Jericho	Governmental	2. Deir Al Balah Science & Technology	Governmental
3. Palestine College of Technology - for Girls, Ramallah	Governmental	3. Palestine College of Nursing - Khan Younis	Governmental
4. Palestine Community College - Bethlehem	Private	4. College of Islamic Call (Daawa), Gaza	Private
5. College of Educational Sciences, Men	UNRWA	5. Faculty of Science and Technology - Khan Younis	
6. College of Educational Sciences, Women	UNRWA		
7. Ibn Sina Health Sciences College - Nablus	Governmental		
8. Bethlehem College of the Bible - Bethlehem	Private		
9. Nihad Abu Gharbieh Technology Institute	Private		
10. College of Islamic Call (Daawa) / Qalqilya	Governmental		

Data Source: Ministry of Education and Higher Education, MoEHE (2010).

**Table 4: List of Palestinian Community Colleges**

Community Colleges			
In the West Bank		In the Gaza Strip	
Name	Status	Name	Status
1. Al-Ommah, Jerusalem	Governmental	1. Faculty of Intermediate Studies - Al-Azhar, Gaza	Public
2. Al-Ibrahimiyyah, Jerusalem	Private	2. Applied Sciences & Tech.- Al-Islamiyyah, Gaza	Private
3. Modern Community, Ramallah	Private	3. Arab Community College. Rafah	UNRWA
4. Al-Rawdah College for Professional Science, Nablus	Private	4. Gaza Community College, UNRWA, Gaza	Private
5. Dar Alkalemah, Bethlehem	Private	5. College for Tourist Studies, Gaza	Public
6. Hishm Hijjawi Tech. College, Nablus	Public	6. Al-Aqsa college, Gaza	
7. Coolege of Applied Professions, Hebron	Public		
8. Community Health, Ramallah	Public		
9. College of Nursing-Hebron, Hebron	Private		
10. Andaleeb El-Amad Nursing, Nablus	Public		
11. Nursing Coll. -Inash El-Usra, Ramallah	Public		
12. Nursing Coll. - Karitas H. Public, Beitlehem	Public		
13. Nursing Coll.- Almaqasid H. Public, Jerusalem	Public		
14. Taleetha Kommee, Beit Jala	Private		

Data Source: Ministry of Education and Higher Education, MoEHE (2010).

**Table 5: Description of Environmental Higher Education Programs  
at An-Najah National University**

University	Department	Program Title	Date Stated	Core Courses		Electives (Cr. Hrs)		Track	
				Load (Cr. Hrs)	Title	Load (Cr. Hrs)	Title	Thesis	None Thesis
An-Najah National	Water and Environmental Studies Institute	Master of Science in Water and Environmental Engineering	1994	18	1.Probability and Statistics for Engineers 2.Hydrological Processes and Systems 3.Ground Water 4.Aquatic Chemistry 5.Water Treatment Processes and Systems 6.Sanitation and Public health 7.Water Quality Lab	12	<u>Elective courses in Water Engineering</u> 1.Computer Application in Civil Engineering 2.Advanced Hydraulic Engineering 3.Hydraulic Structures Design 4.Water – Plant – Soil System 5.Sediment Transport 6.Water Resources Management 7.Irrigation and Drainage Systems 8.Special Topics in Water Engineering  <u>Elective courses in Environmental Engineering</u> 1.Computer Application in Civil Engineering 2.Wastewater Treatment Processes and Systems 3.Solid Waste Management 4.Water Quality Modeling 5.Sludge Treatment and Disposal 6.Instrumentation and Pollution Control 7.Environment Impact Assessment 8.Special Topics in Environmental Engineering	x	x
	Water and Environmental Studies Institute	Master in Environmental Sciences	1994	18	1.Environmental Science 2.Natural Resources Management 3.Environmental Law 4.Public Health and Sanitation 5.Environment Social Impact Assessment 6.Applied Statistics	12	1.Environmental Microbiology 2.Wildlife Protection and Management 3.Coastal Protection and Management 4.Fisheries Management and Aquaculture 5.Soil, Water and Plant Relationship 6.Land Reclamation 7.Environmental Pollution and Pesticides 8.Waste Management 9.Environmental Chemistry 10.Instrumental Analysis 11.Environment Corrosion 12.Petroleum and Petrochemical Pollution 13.Pesticide Chemistry 14.Biochemistry of Toxics and Pollution 15.Mathematical Ecology 16.Special Topics	x	x

Table 6: Description of Environmental Higher Education Programs at Birzeit University

University	Department	Program Title	Date Stated	Core Courses		Electives (Cr. Hrs)		Track	
				Load (Cr. Hrs)	Title	Load (Cr. Hrs)	Title	Thesis	None Thesis
Birzeit	Environmental and Water Studies Institute	Master Program in Water and Environmental Engineering	2001	21	<ol style="list-style-type: none"> <li>1.Urban Drainage and Sewerage Systems</li> <li>2.Wastewater Treatments and Wastewater Reuse</li> <li>3.Solid Waste</li> <li>4.Environmental Impact Assessment</li> <li>5.Bioremediation</li> <li>6.Water and Environment Pollution</li> <li>7.Integrated Land and Water Management</li> </ol>	9	<ol style="list-style-type: none"> <li>1.Political Economy for Environmental Planners</li> <li>2.Water Distribution</li> <li>3.Environmental Processes</li> <li>4.Hydrology</li> <li>5.Environmental information Technology</li> <li>6.Scientific Research Methods</li> <li>7.Statistical Methods in Water and Environmental Sciences.</li> <li>8.Advanced Water and Wastewater Treatment</li> <li>9.Urban Planning and Environmental Management</li> <li>10.Special Topics</li> </ol>	x	x
	Environmental and Water Studies Institute	Master Program in Water and Environmental Sciences	2001	18	<ol style="list-style-type: none"> <li>1. Environmental Processes</li> <li>2. Wastewater Treatment and Wastewater Reuse</li> <li>3. Bioremediation</li> <li>4. Soil- Plant -Water Relation</li> <li>5. Water and Environment Pollution</li> <li>6. Instrumental Analysis</li> </ol>	12	<ol style="list-style-type: none"> <li>1. Political Economics for Environment Planners</li> <li>2. Water Quality</li> <li>3. Solid Waste</li> <li>4. Environmental Information Technology</li> <li>5. Environmental Impact Assessment</li> <li>6. Research Methods</li> <li>7. Statistical Methods in Water and Environmental Sciences</li> <li>8. Integrated Land and Water Management</li> <li>9. Geographic Information Systems (from the Master's Program in Urban Planning and Design)</li> <li>10.Environmental Monitoring</li> <li>11. Special Topics</li> </ol>	x	x

Table 7: Description of Environmental Higher Education Programs at Al-Quds University

University	Department	Program Title	Date Stated	Core Courses		Electives (Cr. Hrs)		Track	
				Load (Cr. Hrs)	Title	Load (Cr. Hrs)	Title	Thesis	None Thesis
Al-Quds	Department of Applied Earth and Environmental Sciences	MASTER OF SCIENCE IN ENVIRONMENTAL STUDIES	1999	27	1.Statistics 2.Project Management 3.Environmental pollution 4.Radiation 5.Natural water chemistry 6.Water Pollution 7.Environmental Impact Assessment 8.Biodiversity	9	1.Water Resources Management 2.Wastewater, Sewage treatment 3.Radioactivity of the Environment 4.Nuclear methods in Environmental studies 5.Groundwater Modeling 6.Toxicology 7.Human Demography 8.Metreology and climatology 9.Organics in the Environment 10.Waste Management and solid waste deposal 11.Soil Microbiology 12.Environmental Biotechnology 13.Isotope hydrology 14.Sustainable water resources development in Palestine 15.Environmental Modeling 16.Atmospheric Pollution 17.Agriculture and environment 18.Business and the Environment 19.Marine Pollution 20.Biotechnology	x	x

Table 8: Sample Distribution by University and Target Group

University	Alumni	Enrolled Students	Stakeholders	Teachers	Total	
					No.	%
Birzeit University	17	53	1	6	77	47.0
Al-Quds University	9	18	3	8	38	23.2
An-Najah National University	12	27	4	6	49	29.9
Grand Total, No. %	38	98	8	20	164	100.1
	23.2	59.8	4.9	12.2	100.1	



# **Temporal Rainfall Distribution and its Impact on the Amount of Generated Recharge on Karst aquifer systems**

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## ABSTRACT

Quantifying groundwater recharge is essential for water resources management. Estimating recharge in groundwater is very complicated especially in karst aquifers as the case of the Western Aquifer Basin (WAB), Palestine. In the WAB, recharge is usually estimated using an empirical equation which relates the annual recharge with the annual rainfall. The high variation of the rainfall distribution as well as the high contrast of the aquifer properties indicate that the recharge of the WAB is not only function of rainfall, therefore, an alternative approach for estimating recharge for the WAB is still needed. This paper presents an alternative technique for estimating annual groundwater recharge based on the Water Level Fluctuation (WLF) technique. The rainfall over the replenishment area of the WAB most often starts in October and ends in April with an average annual precipitation of around 560 mm. The annual recharge estimated for the analyzed period (1970/71 to 2006/07) ranges between 93 mm during the driest year 1998/99 and 520 mm during the wettest rainy year 1991/92 with an average annual recharge 200 mm/yr (i.e. 385 Mm<sup>3</sup>)

**Key Words:** groundwater, recharge, water level, storage coefficient, rainfall distribution.

## Introduction

The Western Aquifer Basin (WAB) stretches northward from the area south of the Egypt border all the way up to the foothills of Mountain Carmel and from West Bank mountains in the east heading westward towards the Coastal Plain of the Mediterranean Sea, Figure 1. The WAB is naturally replenished by rainfall on exposures covering an area of 1932 km<sup>2</sup>. The natural outlets of this aquifer are Ras Al Ain and Timsah springs. The mean annual volume of the undisturbed flow from these springs is estimated at 350 Mm<sup>3</sup>/yr (Weinberger *et al.*, 1994).

Generally, groundwater recharge is dominated by the seasonal rainfall, evapotranspiration, outcropping geological formations, infiltration, soil and land use types. The annual recharge for the WAB has been studied by different researchers. Up to date, the most accepted technique for estimating annual recharge is the empirical equation which correlates the annual recharge with the annual rainfall (Weiss *et al.*, 2007). This equation does not account for the high variation of the rainfall temporal distribution. This paper will present an alternative approach for estimating the annual recharge based on the water level fluctuations. Then, the result will be used to develop a new empirical equation that takes into account the monthly rainfall variation in addition to the rainfall amounts.

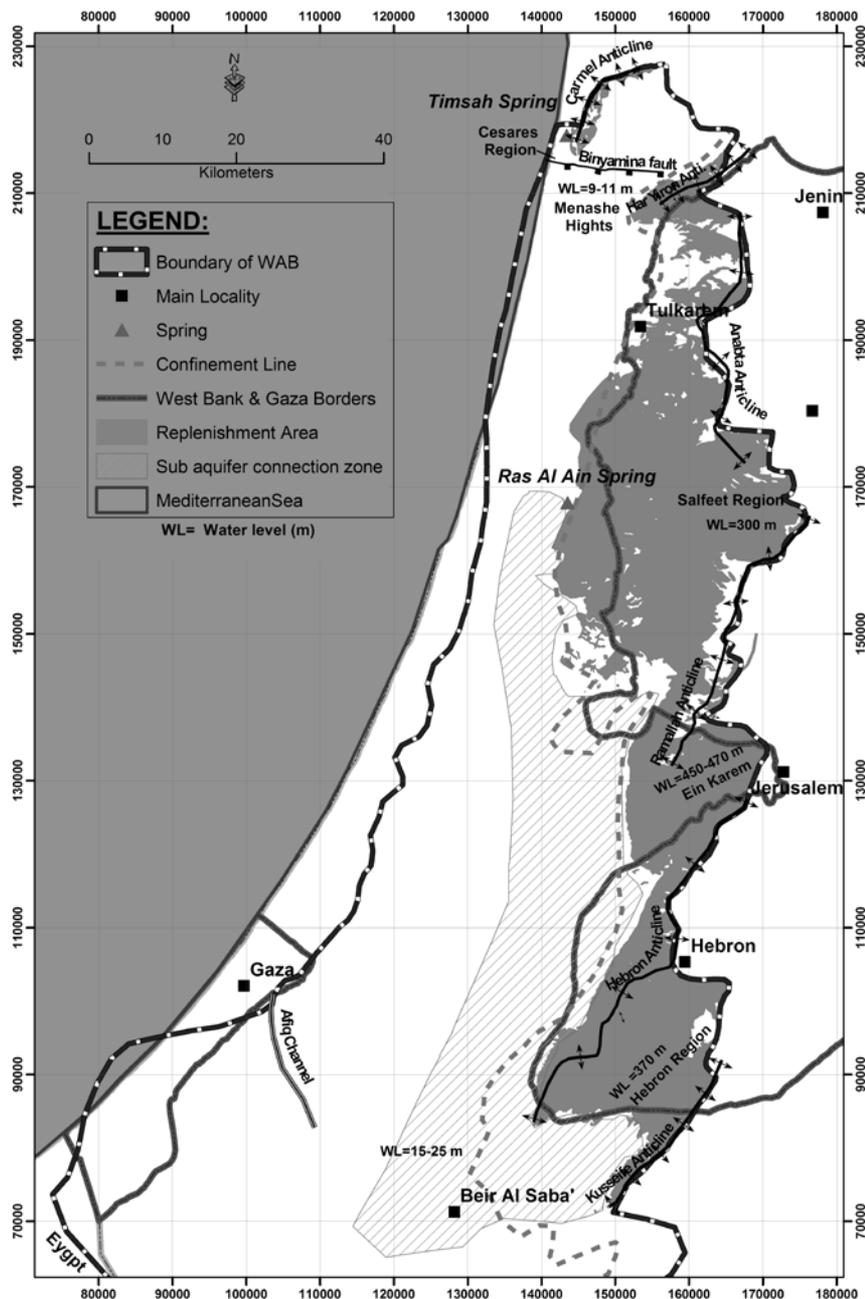


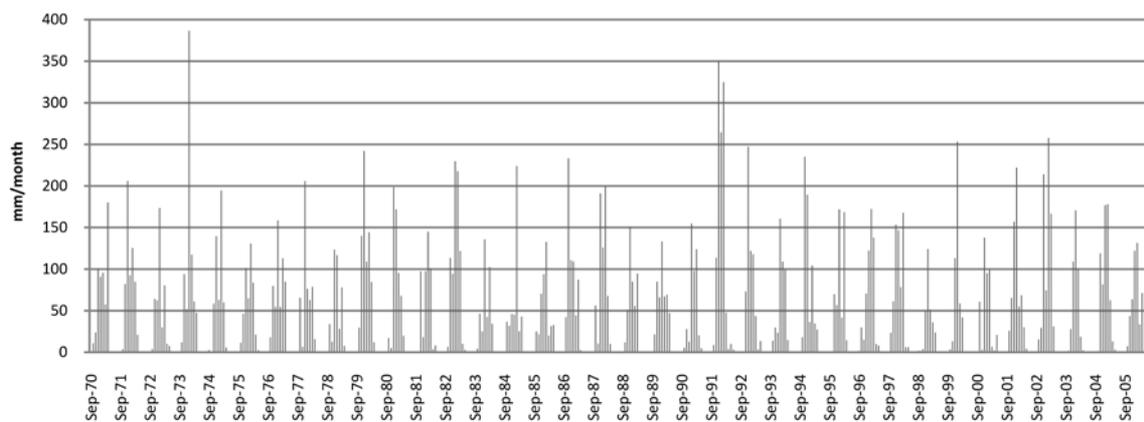
Figure 1: Map of the study area

The WAB is classified as a karstic aquifer; with a general thickness ranging between 600 and 1000 meters. The aquifer is predominantly composed of permeable limestones and dolomitic limestones inter-bedded with argillaceous rock (Mercado *et al.*, 1980; Guttman *et al.*, 1988; Weinberger *et al.*, 1994). The water table of the WAB demonstrates a large variation across the basin. In replenishment areas (i.e. the unconfined part of the aquifer), groundwater elevations are within the 450-470 m range in Ein Karem area, 370 m in the mountains of Hebron and 300 m in the Salfeet area, (Guttman *et al.*, 1988). In the confined part of the WAB, the water level is very low ranging between 9-11 m in Menashe Heights in the north to 15-25m near Beir Al Saba' area in the south.

The basin is located in a Mediterranean climate zone, characterized with moderate temperatures and intermediate precipitation that mostly falls during the coldest half of the year (October-April). Generally, the mean annual precipitation over replenishment areas of the aquifer is estimated at around 560 mm.

## Rainfall in the WAB

The monthly rainfall records were calculated from all stations covering replenishment areas of the WAB, Figure 2. The distribution shows a high variability of annual rainfall with mean annual rainfall 559 mm/yr. The average monthly rainfall and its characteristics over the period of 1970 to 2006 are summarized as follows, Table 1:



**Figure 2: Monthly rainfall records over the recharge areas of the WAB**

- January shows the highest average amount of rainfall (138.2 mm) representing 24.7% from the annual average. Additionally, in January, the highest monthly rainfall rates were found on January 1974 reaching a total of 387mm.
- Most of the annual rainfall occurs during December, January and February with an average of 65% from the mean annual rainfall.
- The rainfall during September and May presented the lowest values during the year standing for less than 1% of the annual average.
- Rainfall in April is generally very low (4.4% of the annual average), with few exceptions of high intensity storms such that of 1971, which generated approximately 180mm.
- November and March have moderate average rainfall depths (11.1% and 13.9% from the annual average rainfall respectively).

**Table 1: Monthly rainfall characteristics over recharge areas of the WAB**

Param.	Unit	Monthly Rainfall Characteristics									
		Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Total
Mean	mm	0.2	17	62	119	138	116	78	25	4	559
Annual Average	%	0.0	3.1	11.1	21.3	24.7	20.8	13.9	4.4	0.6	100
Standard Deviation	mm	1	17	56	77	69	69	42	33	7	155
Maximum		3	66	235	350	387	325	168	180	33	1126
Minimum		0	0	3	12	36	28	7	0	0	293

- Records show that rainfall during summer months is almost nonexistent (June, July and August).
- The mean monthly rainfall amounts form a normal distribution shape of the mean annual rainfall.

### Recharge estimation

The annual precipitation over the replenishment areas is the dominant natural source of recharge for the WAB (Guttman *et al.*, 1988; Rosenthal *et al.*, 1992). Generally the accepted approach for estimating the annual recharge is the *empirical equation* (Guttman’s equation) which correlates the annual recharge with annual rainfall, Eq.1. This equation was developed by using an inverse calibration technique, whereby recharge is estimated by following the calibration of heads and groundwater flow rates (Weiss *et al.*, 2007).

$$R_c = \left\{ \begin{array}{ll} 0.45(R_f - 180) & \text{when } R_f < 600\text{mm} \\ 0.88(R_f - 410) & \text{when } 600 < R_f < 1000\text{mm} \\ 0.97(R_f - 463) & \text{when } R_f > 1000\text{mm} \end{array} \right\} \dots\dots\dots \text{Eq.1}$$

where :

*R<sub>c</sub>* : annual recharge (mm)

*R<sub>f</sub>* : annual rainfall (mm)

This equation neglects the high variation of the temporal distribution of the rainfall meaning that the estimated annual recharge is either over or under estimated. Therefore an alternative approach for estimating recharge is still needed.

The water level fluctuation (WLF) technique is considered as one of the classical approaches for estimating groundwater recharge (Gieske, 1992). Accordingly, recharge can be determined

by examining water level fluctuations shown in well hydrographs, where it is assumed that if no recharge occurred, then the hydrograph recession would continue until a base level is reached. By extending the hydrograph recessions, the difference between the extrapolated recession curve and the actual groundwater level, multiplied by the specific yield, corresponds to the amount of recharge for that time period, taking into account any abstractions or infiltrations/injections and the net balance of inflows and outflows (Kruseman, 1997).

However, the WLF technique is commonly used in unconfined aquifers; it can be also used for the WAB as a special case; the aquifer behaves as one entity system where aquifer layers are well connected in both vertical and horizontal dimensions. As a result, the water levels in the confined part were distributed systematically from north to south, Figure 3. This distribution of water levels proved that water levels in the entire aquifer will be systematically affected as a result of any inflow or outflow. Accordingly, the WLF technique could be applied where the average drop/rise of the water level in the confined part of the aquifer could be used as an indicator for the amount of inflow or outflow and could be mathematically described as the following equation, Eq. 2:

$$R = \alpha \times \Delta h + Q_o - Q_{\text{Other inflows}} \dots\dots\dots \text{Eq.2}$$

Where :

*R* : recharge ( $m^3$ ) during period *T*

$\Delta h$  : average change in water table elevation (m) during period *T*

$\alpha$  : storage coefficient ( $m^3 / m$ )

$Q_{\text{Other inflows}}$  : sea water intrusion, artificial recharge, lateral flow ( $m^3$ ) during period *T*

$Q_o$  : outflow ( $m^3$ ) during period *T*

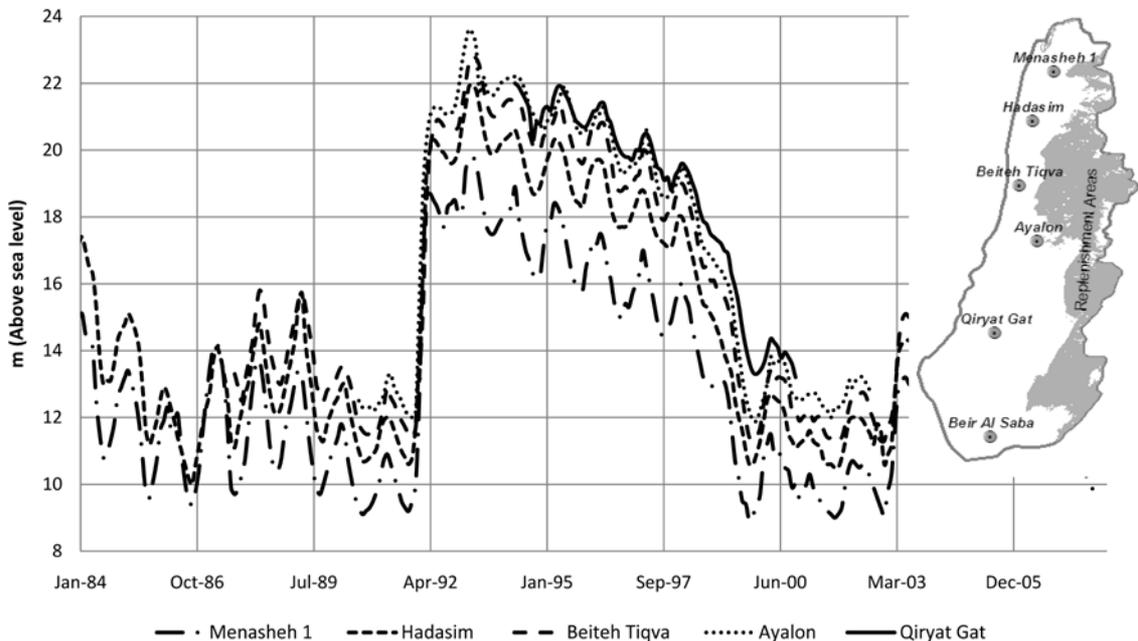


Figure 3: Water level time series for different observed well within the confined part

Since  $\alpha$  is not defined yet, Eq. 2 has two unknowns. As a result, quantifying recharge for any time interval is still not possible. This problem can be solved by looking for a period within the historical records of the average water level where the start and the end of the selected period have the same water level (complete cycle), Figures 3 and 4. The figure shows a full cycle between 1989/90 and 2001/02. During this period, the net storage of the aquifer should be equal to zero. Accordingly, the term  $(\alpha \times \Delta h)$  becomes zero, R will then equal the net outflow during the same period.

### Calculating the storage coefficient of the WAB

The storage coefficient of the WAB ( $\alpha$ ) is defined as the total water that could be abstracted from or injected into the WAB per one meter drop/rise in the confined part of the WAB. Based on this definition and taking the water level during year 1989/1990 as a reference, the amount of water stored in the aquifer at time (t) is calculated through the following equation Eq. 3:

$$S(t) = \alpha \times h(t) \dots \dots \dots \text{Eq.3}$$

Where:

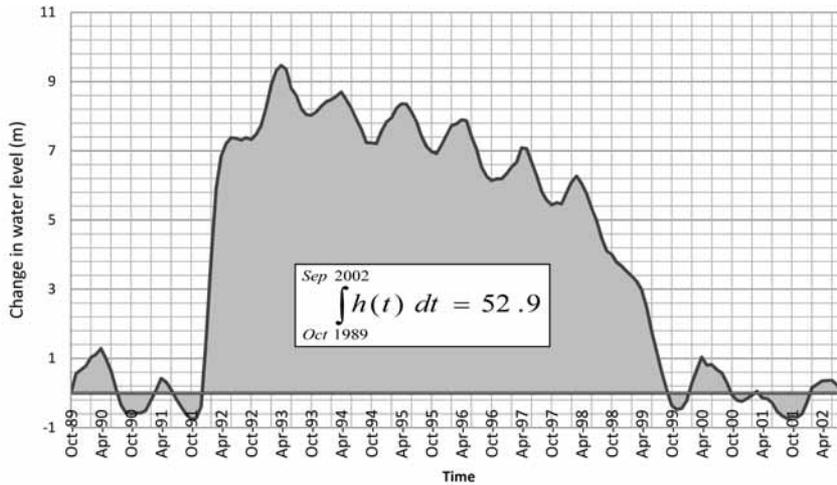
- $S(t)$ : storage after exceeding the reference water level ( $m^3$ )
- $h(t)$ : average water level in the confined zone (m) at time t (reference year : 1989 / 90 )
- $\alpha$ : storage Coefficient of the WAB ( $m^3 / m$ )

During the period 1989/90 and 2001/02, the sum of inflows was equal to the sum of outflows (i.e. the net storage is equal to zero). Therefore, the integral of S(t) over the same period is equal to the sum of either outflow or inflow and also equal to storage coefficient ( $\alpha$ ) multiplied by the integral of water level (h) over the same time period. For an accurate calculation of storage coefficient; monthly records of water level were used, Figure 4. As a result, the storage coefficient of the WAB could be calculated by Eq. 4:

$$\alpha = \frac{Q}{\int_{Oct89}^{Sep02} h(t) dt} = \frac{5395.5}{52.9} = 102 \text{ Mm}^3 / m \dots \dots \dots \text{Eq.4}$$

- $Q$ : sum of outflow over the considered period ( $m^3$ )
- $h(t)$ : average water level (m)
- $\alpha$ : storage coefficient of the WAB

Once this equation was applied, it was concluded that for every meter drop or rise in the confined area within the WAB, the aquifer storage will lose or gain  $102 \text{ Mm}^3$ . This quantity appears to almost match the result obtained from (Guttman *et al.*, 1988) where he concludes that between 1977 and 1987 the cumulative groundwater deficit was in the order of  $300 \text{ Mm}^3$ , a volume equivalent to a 3 m drop in water level for the confined part of the WAB.



**Figure 4: Average monthly water level in the confined part during the selected period**

This step was followed by the calculation of the annual recharge by incorporating the storage capacity coefficient, the annual change in water level in the confined part and the net outflow according equation, Eq. 5.

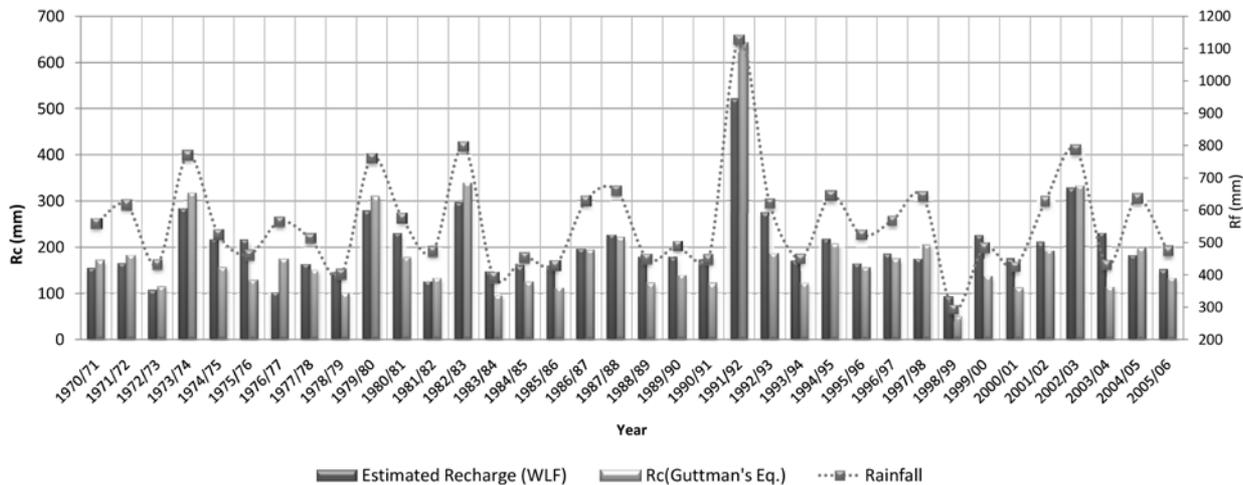
$$R_i = Q_o^i + \alpha \times \Delta h_i \dots\dots\dots Eq.5$$

*R* : recharge in year *i*

*Q<sub>o</sub><sup>i</sup>* : net outflow in year *i*

*α* : storage capacity of the WAB = 102 Mm<sup>3</sup>/m

Figure 5 illustrates the recharge values estimated by the two different methods (Water level fluctuation and Guttman’s equation) drawn out in the same graph with the annual rainfall over the period 1970-2007. The estimated recharge obtained from the WLF technique has similar trends to the Guttman method, due to the fact that the generated recharge is directly proportional to rainfall amounts. However, it was obvious that in many years the generated recharge was more influenced by the temporal distribution of rainfall. For example, the year 2003/04 had a much higher recharge rate than was estimated by Guttman equation. Similarly, the year 1976/77 had a much lower rate than other estimate owing to the factors mentioned above. The average recharge during this period yielded 385 Mm<sup>3</sup>/yr which is a value higher than the values obtained by Guttman’s equation (i.e. 329.6 Mm<sup>3</sup>/yr).



**Figure 5: Annual recharge estimates with rainfall distribution for the analyzed period.**

## Recharge equation

To consider the temporal distribution of rainfall, the monthly rainfall amounts from 1970/71 to 2005/2006 were used to simulate the annual recharge quantities which were estimated previously. The data set was divided into two parts; the first (1970/71- 1996/97) was used to develop an empirical equation which relates the annual recharge with monthly rainfall. The second part of data was used to validate the developed equation. A correlation test between monthly rainfall and the annual estimated recharge has been carried out. The rainy year 1991/1992 was removed from the correlation test since it is an exceptional year where rainfall is twice the mean annual rainfall. Table 2 shows the results of the correlation test as well as the significance levels of the correlated parameters. The result proved that the rainfall during December, January and February are highly correlated with high significance to annual recharge; November is also correlated but with less significance. All other rainy months were totally not correlated. Accordingly, the annual recharge is considered as a function of four rainy months within the year; November to February.

**Table 2: Correlation test between monthly rainfall and annual recharge (1970/71-1996/97)**

		Monthly Rainfall								
		Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Recharge	Pearson Correlation	0.072	0.002	0.25	0.7	0.38	0.68	-0.164	-0.243	-0.089
	Sig. (2-tailed)	0.363	0.495	0.082	0.006	0.046	0.007	0.211	0.115	0.332

Based on the correlation results, the empirical equation of annual recharge and monthly rainfall was developed using a multi-regression technique. The result of multi-regression provided the equation coefficients with high significant level (less than 5%). The recharge equation has been noted below (Eq.6), through which 39.6 mm/yr has been assumed the value representing all recharge reaching the WAB during the months of March to October as well as from other minor sources of recharge (i.e. leakage from agricultural and domestic networks and return flow from irrigation). This value represents around 19.8% of the average recharge reaching the WAB.

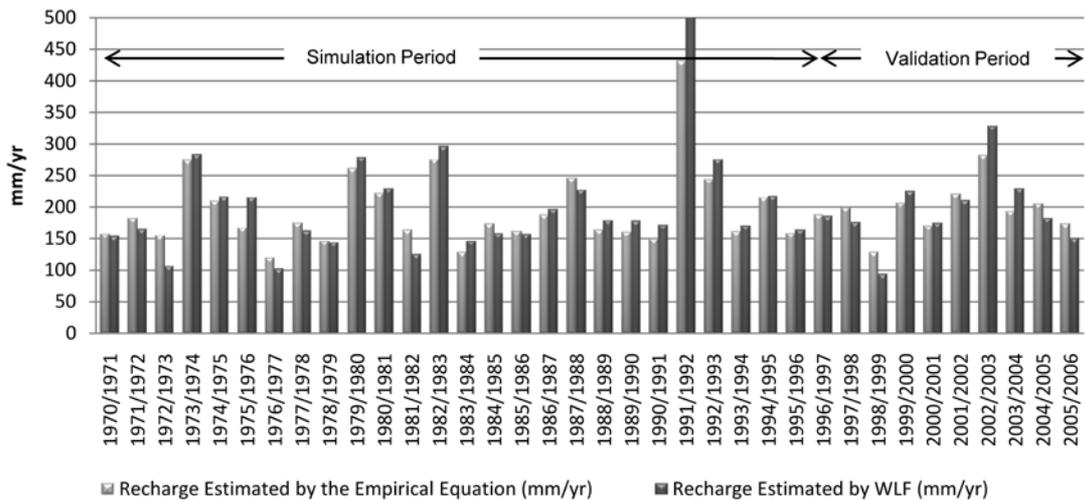
$$R_c = 0.197 \times R_{Nov} + 0.382 \times R_{Dec} + 0.381 \times R_{Jan} + 0.413 \times R_{Feb} + 39.7 \dots \dots \dots Eq.6$$

where:

$R_c$ : annual recharge (mm)

$R$ : monthly rainfall (mm)

The equation above was used to generate annual recharge estimates for the complete data set (1970/71-2006/07). The result, Figure 6, shows an excellent match for both simulation and validation periods. As a result, this equation is applicable to be used for estimating the annual recharge for any synthetic rainfall scenario taking into consideration the monthly rainfall variations.



**Figure 6: Recharge versus rainfall relations obtained by WLF and multi regression techniques**

## Discussion and conclusion

The annual recharge of the WAB was estimated by using the historical aquifer records of inflows, outflows and water level. As a prerequisite condition for applying this technique, finding a water level cycle within the records is required. Within this water level cycle, the net aquifer storage will equal to zero. This period also formed the basis for the estimation of the storage coefficient of the WAB ( $\alpha$ ), i.e. the amount of water that could be abstracted from or recharged into the aquifer per one meter drop/rise. This factor provides a good tool to estimate the annual recharge by using the annual change in water level and the net outflow of the aquifer.

The estimated annual recharge of the WAB proves that the amount of annual recharge is controlled by both annual amount and distribution of the rainfall. Therefore, estimating annual recharge from total annual rainfall amounts is an inaccurate approach and will probably lead to either over or under estimating the annual recharge amounts. The annual recharge was estimated by the WLF technique for the last 36 years (1971-2007) and then the time series of annual recharge and monthly rainfall were used to develop an empirical equation relating annual recharge with monthly rainfall. This

developed of recharge equation will improve the future estimate of annual recharge by taking into account the monthly distribution of rainfall. The equation shows that recharge is highly dependent on rainfall amounts during four main rainy months: November, December, January and February. Also, the equation concludes that the monthly rainfall in the months May to September is not effective for generating recharge; where the generated recharge from rainfall during these months and other minor recharge components were estimated by the a value of 39.6 mm/yr during the analyzed period (1970/1971-2006/2007). The rainfall/recharge relation in the two WAB recharge estimation techniques can be summarized as follows:

Recharge estimates by Guttman's equation: recharge estimates are strictly proportional to the annual amount of rainfall, yet estimates intensify with higher rainfall amounts due to the polynomial nature of the graph that was generated via a second-order polynomial equation. Furthermore, this technique does not take into account the temporal monthly distribution, (Figure 7.a).

Recharge Estimation by Water Level Fluctuation Technique (WLF): In this technique, the estimated annual recharge values show less correlation with the annual amount of rainfall (Figure 7.b). The examination of historical records proves that the relation between annual recharge and rainfall is not that well developed, thus the monthly distribution was considered as supporting factor. This factor constitutes the underpinning elements of the WLF technique and was thus deployed in the development of the consequent computational equation.

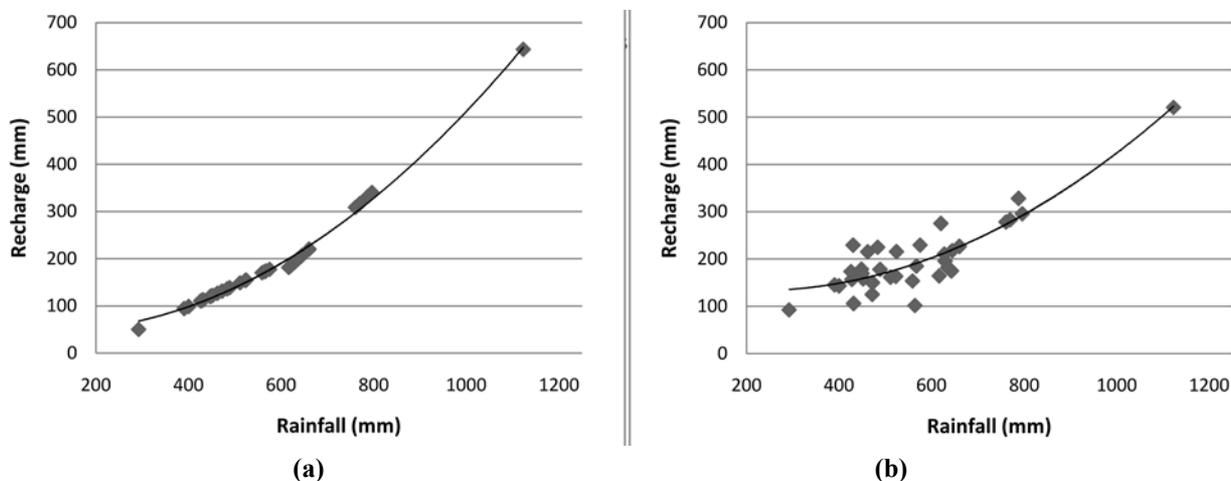


Figure 7: Recharge versus rainfall relation (a) By Guttman's Eq (b) by WLF technique

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## **Effect of Vehicles on Environment**

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## ABSTRACT

Motor vehicles offer reliable and convenient mobility on demand to an ever-growing number of populations all over the world. But with there all positives, motor vehicles carry with them some negatives, they affect both air and water, which have the direct effect on all aspects of organisms. Carbon monoxide is the main product of combusting fossil fuels. Harm products such as CO, HC, and particulate matter (PM) are produced due to incomplete combustion, the higher combustion temperatures produces  $\text{NO}_x$  which is also harmful to the environment. Tyres contain rubber, zinc, copper, lead, magnesium, and cadmium, these materials are washed by rain into lakes and streams. Other vehicle components which affect the environment are brakes, motor oil, batteries, painting, and body. All the above mentioned material amounts were estimated, and the effect of a single motor vehicle on environment was studied as well as the total effect of all registered vehicles in the West Bank of Palestine. It was found that during manufacturing about 500 million cubic meters of air are polluted, 148 tons of water are used and of course polluted, and about 28 tons of waste is disposed. While during driving, the car produces about 100 million cubic meters of polluted air, 11 kilograms of heavy metals, and more than 5 tons of  $\text{CO}_2$  are produced. Disposing the car produces about 100 million cubic meters of polluted air.

**Key words:** Vehicles, air pollution, water pollution

## Introduction

Cars are often seen as the symbol of freedom and prosperity. They are a social custom that designates coming of age. They are also one of the greatest threats to the environment and human health. Experts estimate the number of cars to be between 600 million and 1 billion all over the world. The number of cars per thousand residents varies among nations. 950 cars in the united states, 584 cars in Europe, 122 in Brazil, 8 in China (The Ecologist, 2005) and 85 cars for each thousand residents in the West Bank.

Motor vehicles are considered the biggest source of atmospheric pollution, contributing an estimated 14% of the world's carbon dioxide emission from fossil fuel burning, a proportion that is steadily rising. Carbon Dioxide ( $\text{CO}_2$ ) is a product of perfect combustion. As a pollution concern, it doesn't directly impair human health, but it is a "greenhouse gas" that traps the earth's heat and contributes to the potential for global warming. Carbon Monoxide (CO) is a product of incomplete combustion of hydrocarbon-based fuels, it enters the bloodstream through the lungs and forms carboxyhemoglobin which affects healthy and ill people. CO is most likely to occur at low air-to-fuel ratios in the engine. These conditions are common during engine starting when air supply is restricted, when engines are not tuned properly, and at altitudes, where "thin" air effectively reduces the amount of oxygen available for combustion.

Hydrocarbons ( $\text{C}_x\text{H}_y$ ) are emitted from engines, hydrocarbon pollution results when unburned or partially burned fuel is emitted from the engine as exhaust, and also when fuel evaporates directly into the atmosphere.  $\text{C}_x\text{H}_y$  include many toxic compounds that cause cancer and other adverse health effects.  $\text{C}_x\text{H}_y$  also react with Nitrogen Oxides ( $\text{NO}_x$ ) in the presence of sunlight to form

Ozone. A very significant fraction comes from cars in urban areas. The  $\text{NO}_x$  are highly reactive gases, they are colorless and odorless; they can often be seen combined with particles in the air as a reddish-brown layer over many urban areas, and the formation of  $\text{NO}_x$  is favored by high temperatures and excess oxygen. Motor vehicles are the primary source of  $\text{NO}_x$ .

Nitrogen dioxide ( $\text{NO}_2$ ) is one of a group of highly reactive gasses known as “oxides of nitrogen,” or “nitrogen oxides ( $\text{NO}_x$ ).” Other nitrogen oxides include nitrous acid and nitric acid;  $\text{NO}_2$  is the component of greatest interest and the indicator for the larger group of nitrogen oxides.  $\text{NO}_2$  forms quickly from emissions from fossil fuel combustion with air at high temperatures. In addition to contributing to the formation of ground-level ozone and fine particle pollution,  $\text{NO}_2$  is linked with a number of adverse effects on the respiratory system. It is one of the main ingredients involved in the formation of ground-level ozone, which can trigger serious respiratory problems. It reacts to form nitrate particles, acid aerosols, as well as  $\text{NO}_2$ , which also cause respiratory problems. It contributes to the formation of acid rain, contributes to nutrient overload that deteriorates water quality, and it also contributes to atmospheric particles, that cause visibility impairment most noticeable in national parks. Further, it reacts to form toxic chemicals, and contributes to global warming (Karaeen, 2005).

Soot is a solid substance consisting of roughly eight parts carbon and one part hydrogen. Newly formed particulate have the highest hydrogen content with a C/H ratio as low as one, but as soot matures the hydrogen fraction decreases. The density of soot is reported to be  $1.84 \pm 0.1 \text{ g/cm}^3$  (Choi *et al.* 1994). Soot is formed from unburned fuel, which nucleated from the vapor phase to a solid phase in fuel-rich regions at elevated temperatures. Hydrocarbons or other available molecules may condense on, or be absorbed by soot, depending on the surrounding conditions. Particulates are the combination of soot and other liquid-or solid- phase materials that are collected when product (exhaust) gases passes through a filter. Particulate is often separated into a soluble and an insoluble or dry fraction. The fraction of particulate, which is soot, is often estimated by finding the insoluble portion of the particulate. The fraction of soot in particulate from diesel exhaust varies. But it is typically higher than 50%. Other particulate matter constituents include: un or partially burned fuel or lubricant oil, bound water, wear metals and fuel-derived sulfates (Ulman, 1989).

Combustion-related particulate matter is associated with a host of severe impacts such as heart attacks, stroke, cardiovascular death and lung cancer in adults. In children, fine particles are associated with upper and lower respiratory impacts as well as retardation of lung growth and crib death. Carbon soot particles from diesel engines adsorb onto their surfaces other metals and toxic substances produced by diesel engines such as cancer-causing aldehydes (like formaldehyde) and PAH (polycyclic aromatic hydrocarbons.) Occupational health studies link cancers, particularly lung cancer to diesel exhaust exposure (Lee *et al.* 1998).

Vehicles tyres carry the vehicle, passengers, and other loads, offer traction, steering, and absorb variations in the road surface to improve ride quality. Tyres are a mix of several materials, mostly synthetic and natural rubbers, and also including carbon black, sulfur, steel, and chemicals added as antioxidantants, strengtheners, and fillers. Zinc, cadmium, nickel, chromium, and copper are also added to the tyres.

Tyres contain highly combustible and pollutant materials and generate large quantities of wastes at the end of their life cycle. Toxic substances such as sulfur, cadmium and zinc, which demand special treatment so as to avoid environmental contamination, are present in their composition. The main pollutant elements consist in vehicle tyres are zinc which consist as zinc oxide and lead as lead oxide. As vehicles move, and especially corner and brake, tyres continually abrade against the road surface, and to some extent wear away just due to flexing as they roll along. This tyre wear takes the form of rubber left on the road, heavy particles that quickly settle on the road and shoulder, and lighter particles that become airborne. Originally deposited on the pavement, it gets washed by rain into lakes and streams. Chemicals leaching out of tyre dust can kill water organisms such as algae, plants, minnows, and snails (Erik and Vincent, 1979).

Land filing is seldom a sound disposal option since constituents in buried wastes can and do escape into the surrounding environment, primarily through leaching into ground water and then volatilizing into the air, causing danger to human health and to the environment. The disposal of waste tyres in landfills and their contact with other solid wastes can cause chemical interactions neither foreseen nor controlled that will generate the liberation of toxic elements such as sulfur, mercury, chromium and nickel, among others with the consequent land, and water contamination<sup>[7]</sup>. Even when tyres are shredded previously to their burial in landfills, there remains a considerable risk of damage to the environment.

Dumping or burning of tyres in the environment obviously causes extremely serious environmental harms. When tyres are burned their hazardous constituents create new and frequently more toxic compounds such as dioxins, furans, PCBs and PAHs (polyaromatic hydrocarbons), which are released into the air<sup>[7]</sup>. Toxic chemicals released by burning tyres will become part of the food chain, entering water, soil, plants, livestock, dairy products and wildlife. Studies have found that indirect exposure to toxins through the food chain poses serious health risks to humans; they increase cancer deaths, diabetes and cardiovascular diseases (Brazilian Federal Constitution, 2007).

Brake materials generally fall into the category of organics or semi-metallic. The different formulations have varying wear rates, braking properties, and noise levels. Semi-metallic brake pads are visibly different from organics. Semi-metallic pads are a darker color with visible metallic fibers and have a rough texture. Organic pads are a lighter shade of gray and have a smoother texture. Organic formulations often contain polymers such as Kevlar, resins. Organic brake pads may also contain copper, zinc, lead, and nickel (Engberg, 1995).

Motor oil keeps our cars, lawnmowers, and many other machines running smoothly. However, once oil is used, it must be discarded properly, to keep it from contaminating the environment. Used oil is exactly what its name implies; any petroleum-based or synthetic that has been used. During normal use, impurities such as dirt, metal scrapings, water or chemicals, can be mixed in with the oil, so that in time. The oil no longer performs well. Eventually, this used oil must be replaced with virgin or re-refined oil to do the job correctly. Recycling used oil is becoming the preferred way of handling used oil to protect the environment and conserve natural resources (ATSDR, 1997).

Mechanics and other autoworkers that are exposed to use mineral –based crankcase oil from a large number of cars have experienced skin rashes, blood effects (anemia), and headaches and tremors, However, these workers are also exposed to other chemicals, which may have caused these health effects. When used oil enters the environment it enters the air through the exhaust system during engine use. It enters water or soil when disposed of improperly. The hydrocarbon components of the oil generally stick to the soil surface. Some metals in used mineral based crankcase oil dissolve in water, move through the soil easily, and may be found in surface water and groundwater (Auckland Council, 2006).

Motor oil can partially dissolve in water introducing toxic substances into the environment. These include heavy metals such as lead, chromium and hydrocarbon compounds that are a by – product of vehicle operation.

If discharged, these substances can cause harm to environment by:

- Allowing oil to seep into the land and underlying groundwater.
- Poisoning animals and plants.
- Forming an oily layer or film on surface water and preventing oxygen and sunlight from entering the water, making it difficult for animals to breathe and find food and for plants to get energy.
- Some chemicals can build up in the bodies of plants and animals potentially causing long-term health effects.

Vehicle battery is basically made of lead, polypropylene plastic, and electrolyte (a sulfuric acid and water mixture). Water is one of our most important resources in life. The water can be polluted by lead comes from battery vehicles, polluting the water that people drink. Small amounts of lead can harm people or even kill. This is an important health issue.

Vehicle paint is one of the environmental problems that factories face, dealing with this takes up a major proportion of environmental expenditure. Volatile organic compounds (VOC) emissions are the main concern in this issue, due to their potential to cause respiratory problems, the average levels of VOC produced by a single car paint is about 5 kg (Howard and Miemczyk, 2000).

## **Discussion and result analysis**

In this research, the methodology that has been followed is estimating the single pollutant for each vehicle by taking the average of privet car and taxies; with the small commercial vehicles, since these types cover more than 95% of all types of vehicles. According the statistics of the number of vehicles in the West Bank in the year 2010, these types cover about 97% of the total number.

According to the Palestinian ministry of transportation annual report, for the year 2010, the total number of registered vehicles reached 194,702. For the purpose of this research it was assumed that the total number of vehicles in the west bank is 200,000 (Palestinian Ministry of Transportation, 2011). Since there are some unregistered vehicles are still working, as well as many Jerusalem registered cars (which is difficult to assess), are found all the time on the West Bank roads.

## Vehicle emissions

Vehicle working on conventional fuels (gasoline and diesel) emit hundreds of combustion products. Complete combustion produces water and carbon monoxide, while incomplete combustion emits these hundreds of emissions, most of them are hydrocarbons with small traces, the most important and countable emissions are: carbon monoxide, hydrocarbon, nitrogen oxides, and soot. Table 1 shows the average amounts of pollutants for a car uses about 2200 liters of fuel each year.

## Vehicle tyres

The actual rate of tyre wear rate depends on a large number of factors, including driving style, tyre position, vehicle traction configuration, bulk surface material properties, tyre and road condition, tyre age, road surface age, and the weather. The total amount of material lost during a tyre's lifetime is different for each individual vehicle, and may range from a few hundreds of grams for two wheelers to 1-1.5 kg for passenger cars and up to 10 kg for a trucks or bus (Paul and Jenifer, 2002).

About a million of tyres are generated every year in planet and if these tyres were chunked or shredded it still have the potential for remaining metal, and these metals are known to be toxic for environment and human. Number of replacement of tyre for each vehicle per year, where it has the highest value for public diesel, is nearly two times each year. Table 2 represents the amounts of heavy metals released by one vehicle and the total amount released to Palestinian land.

Calculations show that the amount of zinc released from vehicle tyres is the highest element and the amount of Cadmium is the lowest, these results depend on the metal availability per tyre mass, tyre weight, traveled distance, and replacement needed.

**Table 1: Emission estimation for each car for one year, and the total emissions in the West Bank**

Emission	Emissions from one car (kg/year)(Easy Breathers, 2011)	Emissions for Palestine (ton/year)
HC	35	7000
CO	261	52200
NO <sub>x</sub>	17.4	3400
Soot	24	4800
CO <sub>2</sub>	5200	1040000

**Table 2: Heavy metal amounts per year for a car and the total amount in the West Bank**

Heavy metal	Cu	Zn	Pb	Mg	Cd
Avg (gm/car/year) <sup>[14]</sup>	0.35	671	0.25	3.2	0.1
Avg (kg/year, West Bank)	70	135000	50	640	20

## Vehicle brakes

In order to calculate heavy metals from vehicles brakes, it is necessary to know the metal contents of brake pads. Content analysis of copper, zinc, nickel, cadmium and lead are shown in table 3, analysis of metal availability per brakes mass is also presented in table 3; it shows that copper has the highest concentration than any other pollutant elements.

**Table 3: Composition per brake pad and average rate of metal released from vehicle brakes**

Metal	Cu	Zn	Pb	Ni	Cd
Concentration (mg/kg)(Vergina, 2007)	142,000	21,800	3,900	850	29.9
Metal Amount for 1 car (g/year)	120	18	3.5	1	25
Metal Amount In the West Bank (kg/year)	24000	3600	700	200	5

Calculations show that the amount of copper released from vehicle brakes are the highest element and the amount of cadmium are the lowest, , these results depend on the metal availability per brakes mass (mg/kg), brakes weight, traveled distance, and replacement needed.

## Motor oil

Waste crankcase oil (WCO) is defined as used lubricating oils removed from the crankcase of internal combustion engines. Before they are used, crankcase oils consist of a base lubricating oil (a complex mixture of Hydrocarbons, 80 to 90% by volume) and performance enhancing additives (10 to 20% by volume).

Crankcase oils are altered during use because of the breakdown of additives, contamination with the products of combustion, and the addition of metals from the wear and tear of the engine. Therefore, the composition of waste oil is difficult to generalize in exact chemical terms. It is recognized that the major components consist of aliphatic and aromatic hydrocarbons (such as

phenol, naphthalene, Benz anthracene, benzo, pyrene, and fluoranthene) (Irwin, 1997). Used motor oil is generally similar to new motor oil except for the addition of additional metals including zinc, magnesium, barium, lead, aluminum, chromium, copper, iron, manganese, nickel, silicon, and tin [16].

Studies estimate the average amount of disposal oil for each car to be 55 liters per year for both private and commercial vehicles, taking the number of registered vehicles in the West Bank into consideration, the total amount will be 11,000 tons of used oil each year. Table 4 represents the metal percentages in oil and the amount of these metals disposed to the environment each year

**Table 4: Lubricant oil analysis and amount of released heavy metals**

Element	Weight (%)	Heavy metals per car (g/year) (Irwin, 1997)	Total amount disposal each year (kg/year)
S	0.26	115	23000
Cd	0.25	110	22000
Ni	0.016	7	1400
Zn	0.068	30	5984
Pb	0.061	27	5368
Mg	0.001	0.5	88

This number indicates that there is a many used oil splitted on the roads. Huge number, about 11 millions litter/year means more health problems and more negative impact to the environment (soil pollution, air and water pollution) also it could cause cancer and many other diseases. There are no regulations to limit this number or just decrease this amount. There are small recirculation been done for limited types of oil, but this is still not enough. We should immediately start thinking more about this issue to decrease oil effects on the environment and save public health.

## Vehicle battery

In order to calculate the amount of pollutants from vehicle battery, it is necessary to know its metal contents, it contains lead, electrolyte, plastic, and residual materials, their amounts are shown in table 5.

**Table 5: Materials that exist in vehicle battery (Cnjonline, 2007)**

Weight of lead (kg)	Weight of electrolyte (kg)	Weight of Plastic (kg)	Weight of residual materials (kg)
9	1.8	0.6	0.6

Assuming that each battery life is about one year, then each car leaves 9 kg of lead each year from its battery, and the total amount of lead released from all vehicles in the West Bank is about (1800 tons) per year.

## The environmental cost of one car

Table 6 represents the amounts of produced pollutants for each car during its entire life, from its beginning of manufacturing till its disposal.

**Table 6: The car from its Cradle to its Grave (1993)**

Action	Waste	Polluted Air (m <sup>3</sup> )
Extracting Raw Materials	26.5 tons of waste	922
Transporting Raw Materials	12 liters of crude oil in the ocean	425 million
Producing the Car	1.5 tons of waste 148,000 liters of water are used	74 million
Driving the Car	18.4 kilos of abrasive waste	1,016 million
Disposing of the Car	-	102 million
Total	28 tons of waste	1608 million

This shows that a car causes more pollution before it's ever driven than in its entire lifetime of driving (Cradle to Grace, 1993).

## Summary of amounts of pollutants

Table 7 summarizes the amounts of all gaseous and heavy metal pollutants during a year:

**Table 7: summary of Pollutant gases and heavy metal for one car each year**

Pollutant	Amount per 1 year
CO <sub>2</sub>	5200 kg
CO	261 kg
NO <sub>x</sub>	17.4 kg
HC	35 kg
Pm	24 kg
Pb	9 kg
Zn	719 g
Cu	121 g
Mg	29 g
Cd	110 g
Ni	7 g
S	115 g
Polluted air	100 million m <sup>3</sup>
Abrasive waste	18.4 kg
Disposal oil	55 liter

## Conclusion

This general overview on the car shows the huge impact of it on the environment, during its manufacturing, driving, and disposal.

During manufacturing about 500 million cubic meters of air are polluted, 148 tons of water are used and of course polluted, about 28 tons of waste are disposed.

Driving the car will cause about 100 million cubic meters of polluted air each year, 11 kilograms of heavy metal, more than 5 tons of CO<sub>2</sub>. Disposing the car produces about 100 million cubic meters of polluted air.

Finally, the whole world should reconsider that problem and see if we do need that number of produced cars. Do some of us need to change his car every year, 2, 5, or even 10 years as long as it is working properly?

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## **Assessment of a Roughing Filter as a Pre-treatment System for Slow Sand Filter at Aqbat Jaber Refugee Camp**

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## ABSTRACT

Slow Sand Filtration is used to treat surface water from Al-Qilt and Al-Fawwar springs to supply Aqbat Jaber with drinking water. However, the sand filters are frequently clogged due to increase of turbidity above 20 NTU during winter time due to flooding, and so pretreatment is required. Direct roughing filtration is a promising pre treatment method for slow sand filtration. Several jar tests were conducted in order to assess the optimum operating conditions for roughing filter to find the optimum coagulant dose needed to simulate coagulation and flocculation processes, upflow roughing filters in layers (4 layers) was used in this study, different flow rates (1 and 1.5 m/hr) and coagulant doses in the range of 10 to 50 mg FeCl<sub>3</sub>/L influent were applied to achieve turbidity of less than 20 NTU for raw water influent turbidity of less than 1000 NTU. The roughing filters effluent quality met the influent requirement of SSF of less than 20 NTU under the investigated process conditions 1.5 m/hr and 0.5 m/hr filtration rates without adding any coagulant with turbidity range 20 to 100 NTU. It was observed that coagulation in roughing filtration could be effectiveness with more than 100 NTU canal turbidity.

**Keywords:** Surface water; Turbidity; Slow Sand Filter; Roughing Filter

## Introduction

Aqbat Jaber Refugee Camp is located at Wadi Al Qilt area 3km southwest of Jericho city. There are more than 6804 inhabitants living in the camp. The socio-economic conditions in the camp are extremely harsh and the people are living in primary conditions and simple houses. Limited water supply is a significant problem for the refugee camp. The UNRWA is responsible for the camp including the water supply, so it has to take actions in case of any disruption in water supply. The estimated average daily demand of the camp is rated at 817 m<sup>3</sup>/day assuming water consumption of 120 l/c/d and 20% unaccounted for water (WHO, 1996).

The water supply system to the camp consists mainly of springs, conveying open canal, treatment plant, and distribution network. In case water supply system fails to provide good water quality, an alternative, but more expensive source, is available from Mekorot (Israeli Water Supply Company). The main springs feeding the water supply system are Al Fawwar and Al Qilt springs. Water reaches the treatment plant very polluted with high turbidity during the rainy season over the period November to March. It is worth to mention that the slow sand filter of the treatment plant was rehabilitated during the year 2006; the underlying layers and mechanical system were changed. An automatic on line turbidity meter has been installed to drain the polluted water (reading turbidity over 20 NTU) to the irrigation canal during the rainy season. Under such conditions, the water supply to the camp is interrupted for several days.

The main problem is the intermittent water supply to the camp as the water treatment plant (WTP) is taken out of operation when the source of water has poor quality (turbidity more than 20 NTU). This requires pretreatment stage to eliminate the turbidity, increase the efficiency of the WTP and then to ensure continuous operation of the plant and then permanent water supply to the camp. For slow sand filtration, pretreatment is essential if the raw water has a turbidity of

more than 20 NTU (Wegelin *et al.*, 1987). The selection of the most suitable type of pretreatment for a particular design should be made on the basis of field investigations, in which samples are taken to determine variations in raw water characteristics. The technology must satisfy the economical status of people and should not require a high personnel skill for operation. Here a particular experience should be carried out in WTP, which is an interesting example to apply adequate technology for each particular situation and also as an example of transfer of knowledge from a university to the community. Several treatment processes are used for solid removal like sedimentation, coagulation flocculation, up flow roughing filters. Sedimentation will remove the settleable and part of the suspended solids, but not smaller particles will hardly be separated. In such situation, sedimentation is enhanced by addition of chemicals. Pre-treatment using roughing filters are simple and more efficient low tech/cost solutions (Wegelin, 1996a, b). The roughing filters height, number of steps, type and size of media, number of layers need and filtration rate are the determinant operation process conditions of the filters.

Accordingly, pilot roughing filtration plants studies are essential to elucidate the potential of the filter as a pre-treatment step under the local and environmental conditions, prior to full scale application.

## Materials and methods

The experiments were conducted in two stages, starting by Jar tests, and afterwards operating the pilot roughing plant set up.

### Jar test analysis

These tests were conducted in order to find the optimum conditions to coagulate and flocculate the raw turbid water using ferric chloride ( $\text{FeCl}_3$ ) coagulant. Raw water was taken from the open canal at Aqbat Jabber treatment plant during rainy season with high turbidity ranges from 20 to more than 1000 NTU. Jar test experiments were done at Birzeit laboratory and Aqbat Jabber water treatment plant. Different coagulant dose were added to the beakers at the same time while stirring at 100 rpm speed for 1 min. The stirring speed were reduced to 35 rpm and continue mixing for 15 min. The mixers were turned off and the beakers allowed settling for 30 min. The final turbidity and pH were measured in each beaker.

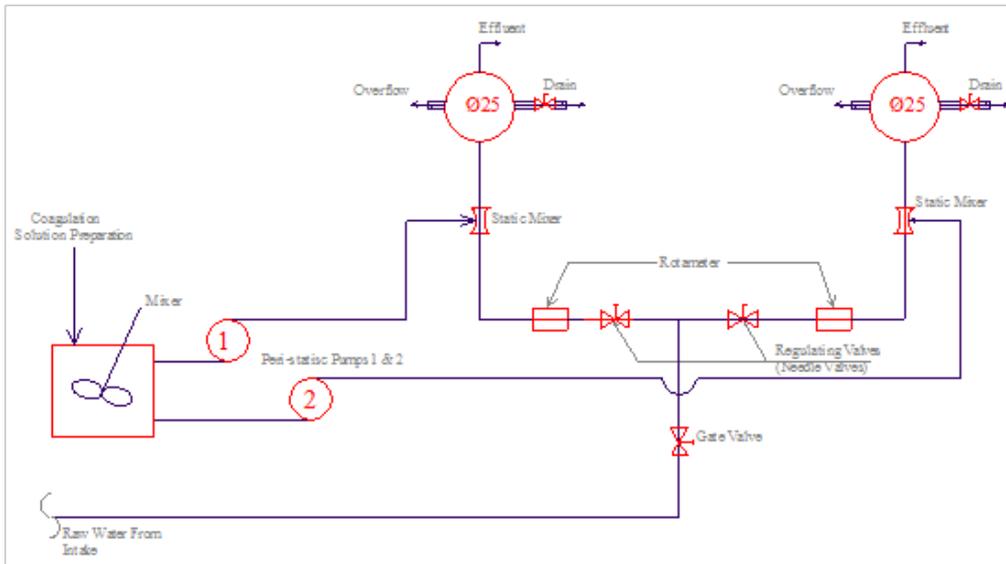
### Roughing pilot plant setup and operation

Roughing filtration runs were carried out at Aqbat Jaber WTP. Turbid raw water was used to feed the two roughing filters A and B directly from the open canal. The turbidity in the canal was not constant. The experiments were carried out with varying process conditions as given in table 1. Turbidity was measured continuously to check the course of filters performance at the end of each filter layer. The experimental filter run was ended when the effluent turbidity had started to deteriorate.

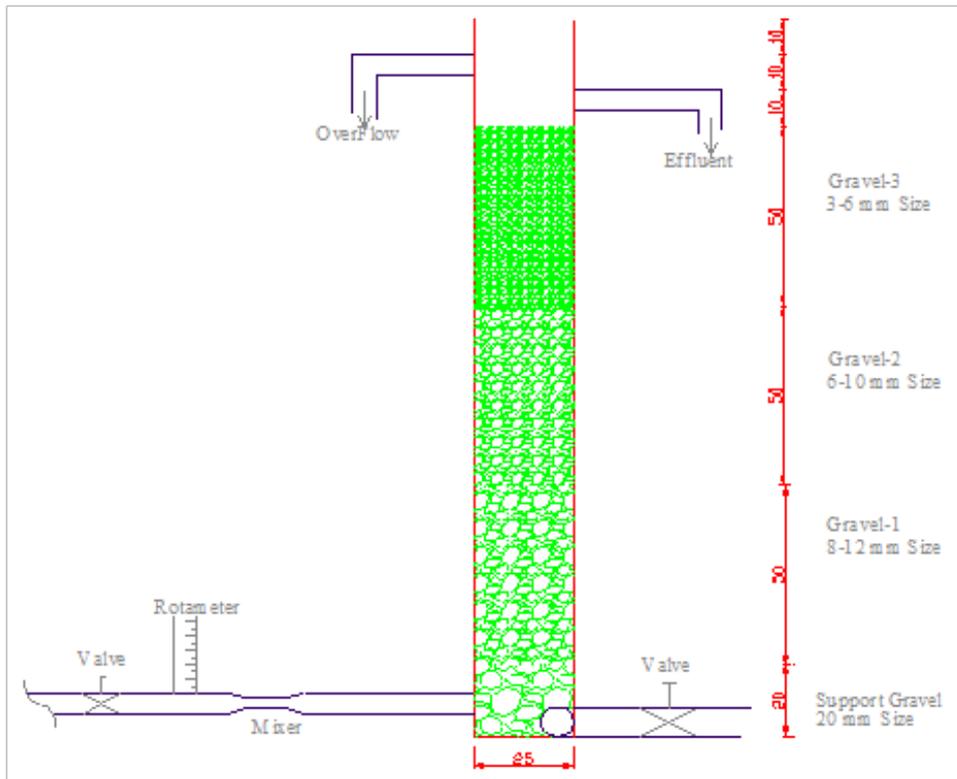
A schematic diagram of the experimental set up used in this research is given in figures 1 and 2. The pilot plant consists of:

- 1- Raw water intake feeding system with two stages:
  - a- Raw water with natural high turbidity from open canal directly at rainy season.
  - b- Synthetic turbidity produced after turbidity lost in canal stored in large tank.
- 2- Up flow gravel filter

- 3- Coagulation system
- 4- Static mixers
- 5- Peri-staltic Pumps.
- 6- Rotameter for flow measurement.



**Figure 1: Layout of the Water Treatment Pilot plant**



**Figure 2: Cross section of the Roughing Filter Pilot plant.**

**Table 1: Pilot experimental process conditions**

Run no	Filtration rate m/h	Coagulant dose mg/l Ferric chloride	pH	Temp. (°C)
1A	0.5	0	8.3	10.8
2A	0.5	0	8.4	16.1
2B	0.5	0	8.4	16.1
3A	1.5	0	8.1	10.2
3B	0.5	0	8.1	10.2
4A	1.5	0	8.4	26
4B	0.5	0	8.4	26
5A	0.5	40	8.1	25
5B	0.5	0	8.1	25
6A	0.5	30	8.2	23
6B	0.5	0	8.2	23

Note A = Roughing filter no. 1

B = Roughing filter no. 2

## Raw water intake

The raw water used for feeding the roughing filters was coming from the open canal that transports water from Wadi Al Qilt springs to the Water Treatment Plant of Aqbat Jaber.

## Upflow roughing filters

Two units of gravel up flow filters were used. They were made from PVC tubes with 0.25 m diameter and 2 m high. Four layers of gravels media were filled in each roughing filter starting with 20 mm size at the bottom to reach 6 mm at the top. Four sampling taps including piezometers were installed at the end of each layer. The two roughing filters were operated in parallel at different conditions with investigated filtration rates of 0.5 and 1.5 m/hr.

## Coagulation system

Ferric Chloride ( $\text{FeCl}_3$ ) was used as a coagulant, because it's cheap and available. A stock coagulant solution was prepared in 10 liter's plastic tank by dissolving 100 g of ferric chloride in 10 L demineralised water. A peristaltic pump was used to feed the required coagulant dosage to the up flow roughing filter after passing through a static mixer where mixed with raw water was achieved.

## Static mixer

The used static mixer type is Komax tube mixer manufactured in the USA. The mixer is of 17.5 cm length and 1 cm diameter. The overall system design incorporates a method for delivering two streams of liquids into the static mixer (raw water and coagulant stock solution). As the streams

move through the mixer, the non-moving elements continuously blend the materials.

## Analytical methods

Turbidity in raw water and the effluent of each filters' layers were measured by turbidity meter type (HI 93703). pH measurements of raw canal water were carried out at Aqbat Jaber WTP using pH meter at the beginning of each filter run (HACK). Total Fe measurement was conducted at Aqbat Jaber WTP using DR/890 HACH colorimeter from filter effluent and water canal influent. Samples were taken each 4 hours during a filter run. Raw water from open canal influent were analyzed for total coliform (TC) and fecal coliform (FC) were carried out at the Center Public Health laboratories of the Ministry of Health.

## Results and Discussion

### Jar test results

Seventeen jar test experiments were carried out to achieve the objectives of this research. The optimum coagulant doses, defined as those just adequate to reduce turbidity to 20 NTU are presented in Table 2.

**Table 2: Optimum FeCl<sub>3</sub> coagulant dose to reduce canal turbidity to less than 20 NTU obtained by Jar test at Agbet Jaber Refugee Camp/ Palestine**

Turbidity canal	Optimum dose
	mg/l FeCl <sub>3</sub>
30	0
35	0
37	<10
40	0
50	<10
65	<10
80	<10
140	0
235	<10
240	10-20
300	<10
530	10-20
800	10-20
1000	20-30
More than 1000	≥30

## Roughing filters results

Several process conditions were investigated by operating the filters at various conditions as described in the following sub-sections.

### Run #1: System workability

A one roughing filter was operated at a filtration rate of 0.5 m/hr to check the potential and workability of the system. The filter effluent turbidity ranged from 0 to 3.8 NTU with more than 95% removal efficiency with raw water turbidity as high as 75 NTU (Figure 3). The effluent quality met the influent requirement of SSF of less than 20 NTU, implying that under the given process conditions of a filtration rate of 0.5 m/hr is adequate.

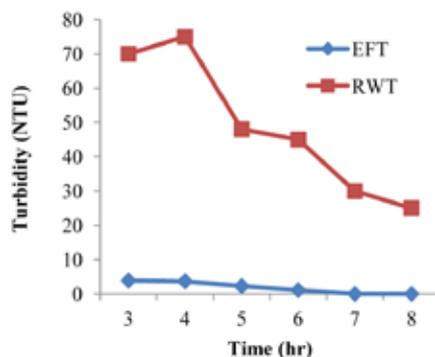


Figure 3: Effluent water Turbidity from a pilot roughing filter pre-treating raw water canal run at 0.5 m/h filtration rate without using coagulant.

### Run #2: Similarity of the two pilot roughing filters

The two roughing filters were operated in parallel at identical filtration rate of 0.5 m/hr. The influent raw canal water turbidity varied in the range of 35 to 75 NTU, which is the dominant turbidity range over the rainy season (Figure 4). The turbidity in the both filter effluent was remarkably low of almost zero, without adding any coagulant.

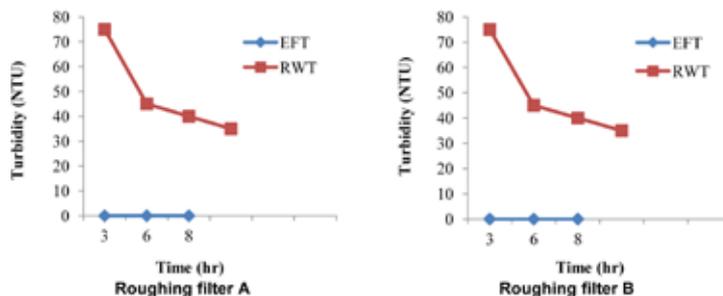


Figure 4: Effluent water Turbidity from pilot roughing filters pre-treating raw water canal run at 0.5 m/h filtration rate without using coagulant.

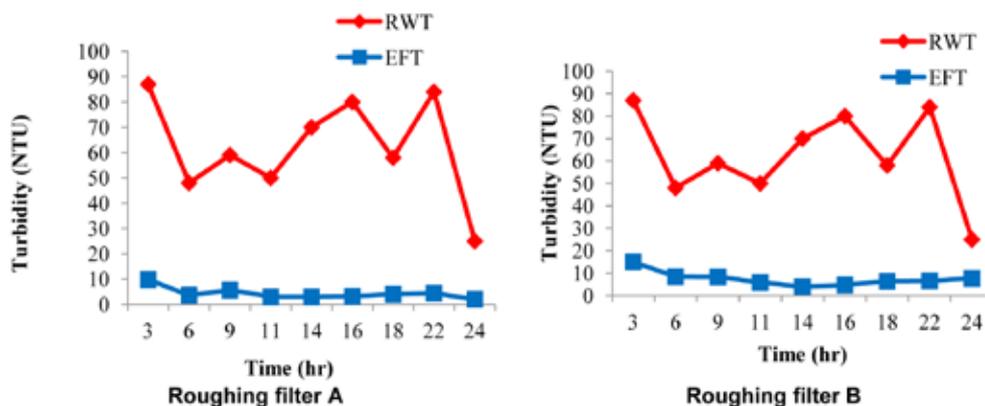
### Run #3: Filtration rate

The two roughing filters were operated in parallel, with one at 0.5 m/hr and the other at 1.5 m/hr. The raw water turbidity was in the range of 25 to 87 NTU (Figure 5). The achieved effluent turbidity in the filter operated at 1.5 m/hr ranged from 2.4 to 15 with 82% removal efficiency at the highest raw water turbidity of 87 NTU.

**Table 3: Course performance in terms of turbidity (NTU) of a roughing filter operated at 1.5 m/hr at various filter's layers**

Sample #: layer gravel size	Sampling time													
	7:30 PM	8:30 PM	10:00 PM	11:00 PM	12:00 AM	1:00 AM	2:00 AM	3:00 AM	6:00 AM	7:00 AM	8:00 AM	10:00 AM	2:00 PM	4:30 PM
A: 20 mm	23	17.4	14.5	12	13.4	13.54	11.4	9.65	5.47	8.30	8.22	8.50	9.65	8.40
B: 8-12 mm	22	13.6	12	10.7	13	12	10	7.60	6.9	8.10	7.70	7.20	8.00	8.00
C: 6-10 mm	18.6	10.6	9.6	9.46	10.8	9.65	9.3	7.20	5.50	6.40	6.10	7.00	7.30	6.30
D: 3-6 mm	16.6	9.13	8.78	8.16	9.26	8.58	7.5	5.90	3.89	2.70	5.40	6.50	7.00	7.60
Effluent	15	8.76	8.40	8.10	9.20	8.30	7.3	5.85	4	2.40	4.70	6.40	6.60	7.60

The results presented in Table 3 and Figure 6 reveal that the major turbidity removal was attained in the first layer of 20 mm gravel size. The turbidity removal further improved in the subsequent filter layers. The results presented in Table 3 also reveal a stable performance over a whole day of continuous operation, which proves the system reliability and robustness. The influent requirement of SSF of at least 20 NTU was attained in the both filters operated at filtration rates of 0.5 and 1.5 m/hr.



**Figure 5: Effluent water turbidity from two pilot roughing filters pre-treating raw water canal run at filtration rates of 0.5 m/h for roughing filter B and 1.5 m/h for roughing filter A without using coagulant.**

### Run #4: Effect of long term filtration

The raw water turbidity was rather low with 4 NTU maximum. The effluent turbidity over the whole long operation period was stable and close to zero in the both filters operated at 0.5 and 1.5 m/hr (Figure 6). Although the influent turbidity was far below 20 NTU, the solids removal in the roughing filter will eventually increase the operation period of the sand filter without any interruption. Worth mentioning that roughing filters effluent turbidity was stable without any solids eruption indicating the high capacity of the filters to hold on solids.

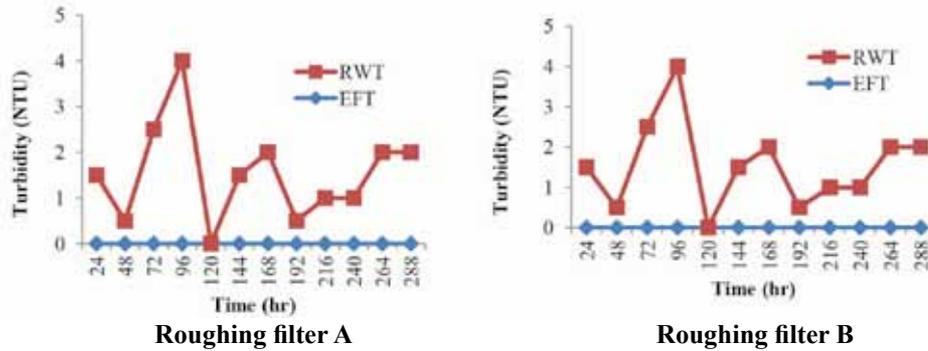


Figure 6: Effluent water turbidity from pilot roughing filter pre-treating raw water canal run at 0.5 m/h filtration rate for roughing filter B and 1.5 m/h for roughing filter A without using coagulant.

### Run #5: High water influent turbidity

During this experimental run, the two filters were operated at 0.5 m/hr, and fed with very turbid influent water in the range of 800-1000 NTU (Figure 7). The first filter, namely filter A, was fed with raw water mixed with 30mg /L FeCl<sub>3</sub> coagulant, while the second filter, namely B, was fed with raw water without adding coagulant.

The effluent turbidity of the filter fed with mixed water with coagulant was 0.63 NTU and 26 NTU after 5 and 8 hours of operation respectively, but deteriorated after 14 hours reaching 112 NTU with noticeable flow water resistance that mean the end of this run .

The turbidity in the effluent of filter B after 5, 8 and 14 hrs were respectively 182, 169 and 159 NTU, respectively, with more than 82% removal efficiency. The effluent quality in this run did not meet the influent requirement of SSF of at least 20 NTU, implying that under the given process conditions a filtration rate of 0.5 m/hr without coagulant produces unsatisfactory. Nonetheless, the high turbidity removal efficiencies of more than 80%, despite of the extremely high influent turbidity indicate the robustness of the roughing filter.

The results of Fe measurements for water canal shows that Fe is zero, but the effluent water from the roughing filter show increases to reach more than 1.17 mg/l, 1.19 mg/l and 1.15 mg/l. The samples were taken every 2 hour during filter run, the coagulant dose was 40 mg/l FeCl<sub>3</sub> with turbidity more than 1000 NTU. The total and faecal coliforms were not removed in the roughing filters under all operated conditions.

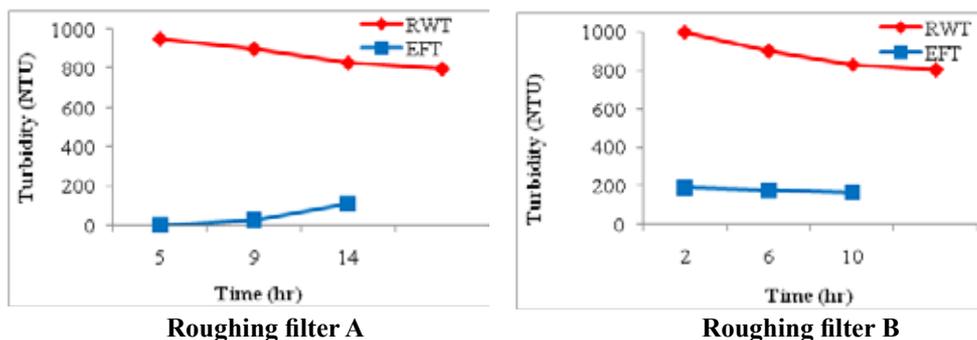


Figure 7: Effluent water turbidity from two pilot roughing filters pre-treating raw water canal run at 0.5 m/hr filtration rate with 40 mg/l FeCl<sub>3</sub> coagulant for roughing filter A, and without any coagulant for roughing filter B

## Conclusions

1. The roughing filters effluent quality met the influent requirement of SSF of less than 20 NTU, under the investigated filtration rates of 1.5 m/hr and 0.5 m/hr without adding any chemical coagulant, when the turbidity of the raw water was in the range of 20 to 100 NTU, which is the dominant turbidity range of influent raw water during the rainy season.
2. When turbidity is higher than 100 NTU, a coagulant is needed.
3. The roughing filter is robust as it is capable to accommodate solids with eruption over the rainy event of as long as a one day.

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