



INTERNATIONAL CONFERENCE

SUSTAINABLE DEVELOPMENT AND MANAGEMENT OF WATER IN PALESTINE



ABSTRACTS

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Preface

Millennium Development Goals approved by 189 countries in September 2000, and the Johannesburg Plan of Implementation adopted in 2002 by the World Summit for Sustainable Development, emphasize the need to reduce inequalities, to change unsuitable consumption, to protect and sustainably manage natural resources for economic and social development and to safeguard health. These goals are in the heart of sustainable development of the Palestinian water sector. The historic balance between water demand and supply in Palestine has been artificially constrained by non-market forces and suffered from inequality problems. Thus, it is necessary to plan for and develop more equitable, yet sustainable, future water consumption rates and supply capabilities for needed social and economic development. The pollution question and environmental issues in Palestine are a major concern to the sustainable development of Palestinian water resources.

This conference will focus on the challenges facing the Palestinian water sector and demonstrate how solutions can be found through applied, innovative research and programmes of sustainable development and management, as well as capacity building.

The conference aims to contribute to the long-term conservation, development and management of the water resources in Palestine through holistic approaches.

This conference, "Sustainable Development and Management of Water in Palestine" is an activity of the "Capacity Building and Training on Environmental Planning and Management" Project, 1998-2007 funded by the UNESCO-FLANDERS FUST, Flemish Government-Kingdom of Belgium who provided both financial and technical support, and implemented by the Water Research Center at Al-Azhar University in coordination with Palestinian institutes working in the field of water and environment.



This conference will disseminate the results of some 20 research studies conducted and completed through the activities of the UNESCO-FLANDERS FUST Project. Furthermore, researchers from the Arab region and the international community will participate in the conference by presenting papers about the results of their research and all will be published in a special proceeding of the conference. This booklet contains the abstracts of the papers accepted for publications in the conference proceedings.

We would like to thank all participants, organisers, donor agencies and all committees of the conference.

Ramallah, 26 August 2007

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UNESCO-Cairo office, Egypt.

Dr. Amjad Aliewi
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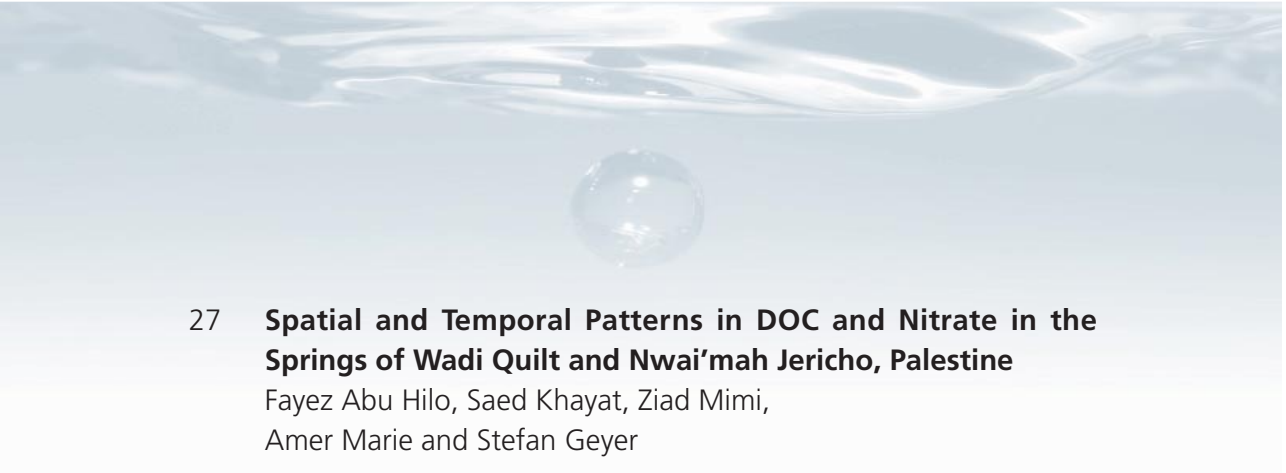
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Developing a Spatial Modeling Approach to Integrate Water Sustainability Map for the West Bank Aquifers

Walid Sabbah¹ and Woodruff Miller²


Abstract

The goal of this paper is to present a Spatial Modeling Approach (SMA) developed to integrate a Water Sustainability Map (WSM) for the West Bank aquifers. This SMA is based on interpolating physical and hydro-meteorological data from point stations into GIS raster grids and then using the various GIS geo-processing tools to create feature spatial maps with tables of attributes representing the various estimated parameters within the boundary of the study area. Because groundwater is the only accessible water in the West Bank, the WSM is defined as the total annual renewable recharge classified by various groundwater basins and related aquifers and so it is equivalent to the West Bank Aquifer Sustainable Yield (ASY).

The SMA used a 25-meter topographic contour map to construct a digital elevation model that was then used to delineate the surface water drainage and 72 watersheds for the West Bank boundary. The 72 created watersheds represent the spatial boundary of the model. Of these, 14 watersheds have their stream outlets draining their surface water out of the West Bank boundary.

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The SMA used a 10-year (from 1990/91 to 1999/00) average annual temperatures, radiation, relative humidity, and wind speed to estimate the evapo-transpiration using the Penman-Montieth method which was then multiplied by the crop coefficient to get the crop evapo-transpiration. The estimated evapo-transpiration and the measured precipitation and runoff data were interpolated from point stations into the GIS grid. The recharge grid was then estimated by subtracting the evapo-transpiration and runoff grids from the precipitation grid. Finally, the SMA converted the recharge grid into a GIS contour map with an embedded table of attributes that shows the recharge estimate.

The 10-year annual average estimated volumes for precipitation, evapo-transpiration, runoff, and recharge were 2508, 1607, 78, and 679 MCM/Yr, respectively, and the resulting estimated yield of the WSM was 679 MCM/Yr.

Key words: sustainability map, groundwater modeling, West Bank Aquifers.



GIS-Based SCS-CN Method for the Far'ah Catchment

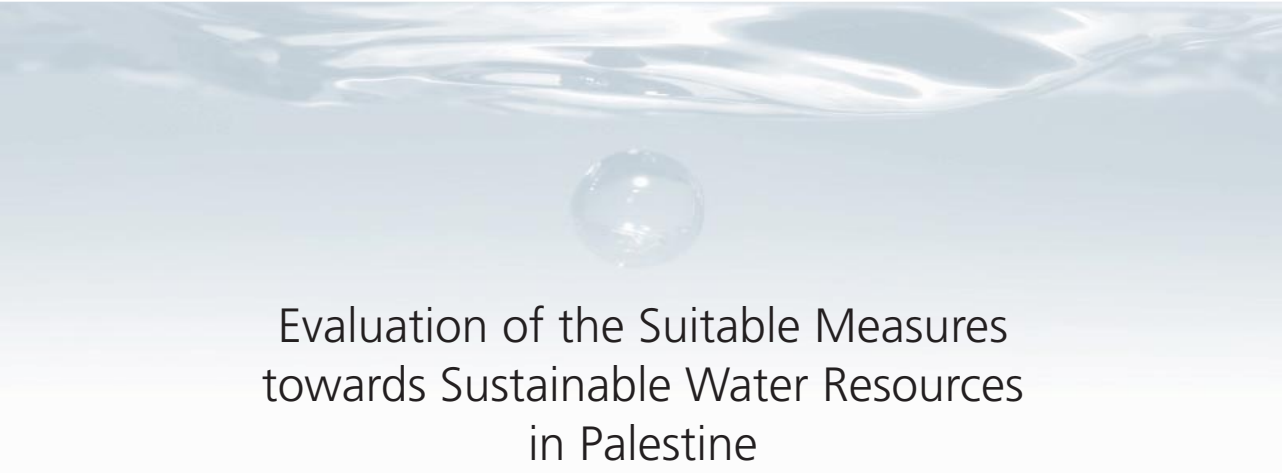
Sameer Shadeed¹ and Hafez Shaheen¹

Abstract

Among the most basic challenges of hydrology are the prediction and quantification of the catchment surface runoff. Runoff Curve Number (CN) is a key factor for determining the runoff in the SCS (Soil Conservation Service) based hydrological modeling method. The traditional SCS-CN method to calculate the composite CN is very tedious and consumes a major portion of the hydrologic modeling time. Therefore, the use of the Geographical Information System (GIS) combined with the SCS-CN method has evolved. This paper models the flow in the Far'ah catchment using the GIS-based SCS-CN method. Far'ah catchment, located in the northeast of the West Bank, Palestine, is characterized as semiarid with annual rainfall depths ranging on an average between 150 and 640 mm at both ends of the catchment. The results showed that the estimated composite CN of the Far'ah catchment is about 60. Co-axial curves to predict runoff volumes due to rainfall events are developed. The paper clearly demonstrates that the integration of GIS with the SCS-CN method provides a powerful tool for estimating runoff volumes in the Far'ah catchment representing semiarid catchments of Palestine.

Key words: GIS; SCS-CN method; surface runoff; Far'ah catchment; semiarid regions.

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Evaluation of the Suitable Measures towards Sustainable Water Resources in Palestine

Subha Ghannam¹, Mu'ath Abu Sadah² and Amjad Aliewi³

Abstract


As the supply/demand gap continues to expand, the careful management and planning of Palestinian water resources becomes more essential. In order to achieve sustainability of the sources and to fill the deficit, effective management techniques must be introduced. This paper discusses an Integrated Water Resources Management (IWRM) planning tool used to evaluate the overall socio-economic and environmental situation of a specific region that could be at a national, regional or local scale and for specific period of time called the management period. In general this tool is an interactive computer-based system intended to help decision makers utilize data and models to identify and solve problems and make decisions. The general objectives of the tool are to build a rational environment and socio-economic database for a specific area, to evaluate the baseline situation in terms of social, economical and environmental aspects as well as the future situations, and to facilitate the opportunity to build future plans in the social, industrial and agricultural sectors.

Key words: integrated water resources management; planning tools, social, environmental, and economic, indicators.

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Public-Private Partnership for Wastewater Reuse in Irrigated Agriculture: A Vision for the Palestinian Case


Reda M. Abd El-Hady Rady¹

Abstract

The Middle East is one of the world's most water-stressed regions. In this region, water security, like food security, is a matter of survival. In Palestine, as in most of the region's countries, the stress on water resources is continuously increasing and managing these resources is a challenging task. Owing to water scarcity, urbanization, and violation of the right to equitable and fair utilization of the shared water resources, wastewater reuse in irrigated agriculture is a must. The Palestinian community is faced with the need to spend millions of dollars to rehabilitate, repair, expand, and run water and wastewater infrastructure systems. The local governments will need to consider solutions that ensure a sustainable water supply. In this context, Public- Private Partnership (PPP) can offer the much needed answers.

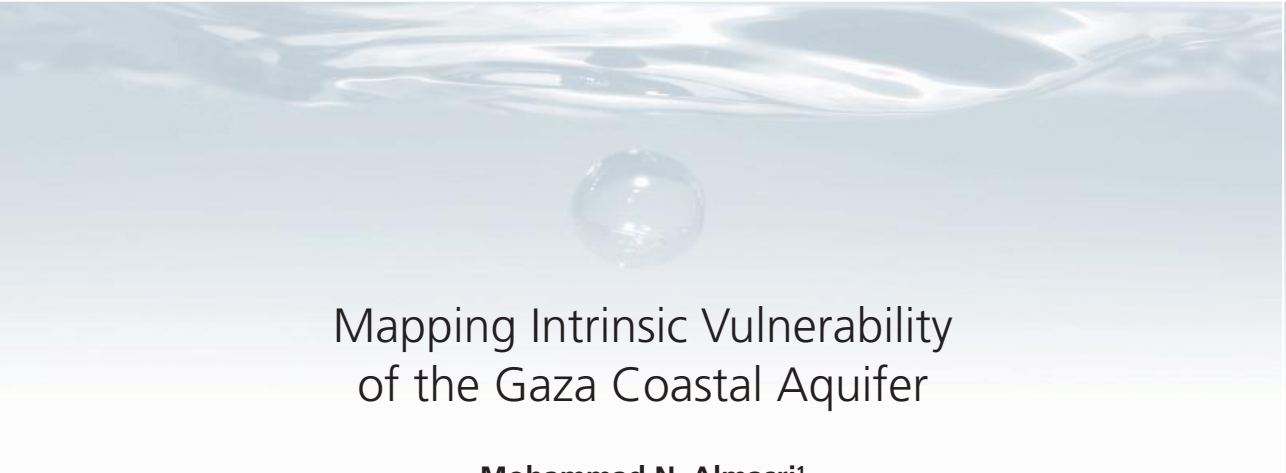
This paper presents the role that PPP can play in promoting the use of wastewater in irrigated agriculture. It delineates the range of services that PPP can provide, including treatment plants, distribution systems, and billing and collections. Furthermore, the paper exemplifies the benefits of applying the PPP concept in wastewater reuse from both the socio-economic and environmental sides. The paper also elucidates the key points for a successful PPP as well as the appropriate implementation environment, including the required qualifications of the private partner. Finally, the paper concludes

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with a proposal for the Palestinian case that involves the implementation of a triangular PPP. The proposed PPP consists of a public entity (water authority local government municipality) in cooperation with Water Users Associations (WUA); a private partner (company/enterprise); and a foreigner donor (regional or international organization).

Key words: public-private, partnership, wastewater reuse, PPP, socio-economic aspects.



Mapping Intrinsic Vulnerability of the Gaza Coastal Aquifer

Mohammad N. Almasri¹

Abstract

The Gaza Coastal Aquifer (GCA) is the major source of fresh water for the 1.4 million residents of Gaza Strip, Palestine. The aquifer is under deteriorating quality conditions mainly due to the excessive application of fertilizers. The vulnerability of the GCA to contamination was assessed using the well-known DRASTIC method. The DRASTIC method was developed by the US EPA to be a standardized system for evaluating groundwater vulnerability to pollution. The primary purpose of DRASTIC is to provide assistance in resource allocation and prioritization of many types of groundwater-related activities and to provide a practical educational tool. Detailed analysis of the vulnerability map of GCA was carried out and did consider different relationships between the vulnerability indices and the on-ground nitrogen loadings and land use classes. In addition, correlation between vulnerability values and the nitrate concentrations in GCA was studied. Based on the vulnerability analysis, it was found that 10% and 13% of the Gaza Strip area is under low and high vulnerability to groundwater contamination, respectively; while more than 77% of the area of the Gaza Strip can be designated as an area of moderate vulnerability to groundwater contamination. It was found that the density of groundwater monitoring wells for nitrate concentration is high for the moderate and high vulnerability zones. The highest first quartile, median, mean, and third quartile of nitrate concentrations are reported in the high vulnerability zones. Results of sensitivity analysis show a high sensitivity of the high vulnerability index to the depth to water table.

Key words: groundwater, vulnerability, agriculture, fertilizers, management, coastal aquifers, contamination.

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Integration of Environmental Concerns into Water Resources Planning and Management in Gaza Strip


Said Jalala¹

Abstract

In this research, a new conceptual water integrated model has been developed based on a cause-effect relationship tackling the life cycle of water resources management. The Driver-Pressure-State-Impact-Response (DPSIR) was selected as a well established framework to develop the possible variables under five categories which are socio-economic, pollution pressures, water quality, impacts and management responses. The effective variables have been characterized and prioritized using multi criteria analysis with artificial neural networks (ANN), risk assessment techniques and expert opinion and judgment. The selected variables have been classified and organized using multivariate techniques which are cluster analysis, factor analysis and principal component and classification analysis.

It was concluded that no single measure will be able to solve the water problems in the GS, but a combination of these measures is needed to ensure water availability, suitability, sustainability and security. Therefore, any future integrated strategy plan in the GS should include: (1) policy and legal instruments for water pollution control (2) regulatory tools for controlling and auditing the use of water including metering, billing and revenue collection (3) monitoring networks and information management systems (4) actions that are purely technical including reuse of treated wastewater, storm water harvesting in urban and rural areas, seawater

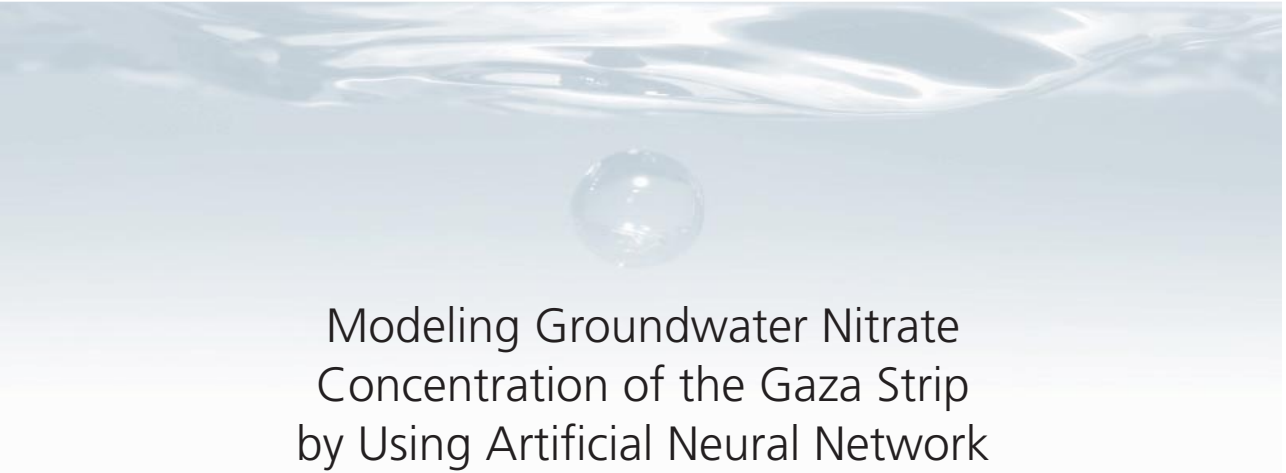
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desalination, brackish water desalination, rehabilitation of water networks, regional water conveyance, water chemical treatment, clean-up and remediation of water hotspots and (5) socio-economic aspects including pricing, access to water services, awareness on rational use of water; and empowerment of the role of women in the water sector management. Within the integrated process for water resources management, it is recommended to adopt two significant approaches. The first is the preventive approach which is to move from restorative to protective management, while maintaining support for remediation of existing water hotspots, as the costs of preventing water pollution are rather small compared to remediation. The second is the ecosystem approach which aims to meet the human water requirements whilst maintaining the hydrological and ecological processes. Besides the existing project-focused Environmental Impact Assessment (EIA), the Strategic Environmental Assessment (SEA) procedure is recommended as an effective

decision-making tool to strengthen the integrated approach and to mainstream the environmental sustainability considerations into water sector developmental policies, plans and programs. SEA ensures that the cumulative and large scale effects of certain water sector policies, plans and programs are identified and addressed at an early stage and before their adoption.

Key words: ANN; integrated water management model; management and policy responses; pollution pressures; public health and ecological impacts; socio-economic driving forces; state of water quality.



Modeling Groundwater Nitrate Concentration of the Gaza Strip by Using Artificial Neural Network


Khamis Al-Mahallawi¹, J. Mania²

Abstract

This study examines the relation between nitrate concentration of urban groundwater and hydrological and land use factors in the Gaza Strip coastal aquifer using artificial neural networks (ANNs). Nine explanatory variables were used as input data for ANNs models. The variables used were total well depth, depth to initial water level, depth to the screen level, well screen length, rainfall intensity, well discharge, well distance from the seashore, population density within 250m buffer zone, and population density within 500m buffer zone. Water samples were collected and analyzed from 87 groundwater wells. The Multilayer Perceptrons, Radial Basis Function, Generalized Regression Neural Network, and Linear Networks were applied. The standard bivariate statistical test also was used to analyze the correlation between groundwater nitrate concentration and the explanatory variables. The results show that the MLP model is the best network for simulating nitrate concentration. The model had a good performance with a correlation coefficient of 0.9773. The bivariate statistical test shows considerable unexplained variation. Based on the ANN model, groundwater quality with respect to nitrate depends on a combination of the hydrological and land use factors. Because coastal aquifer areas are typically stressed

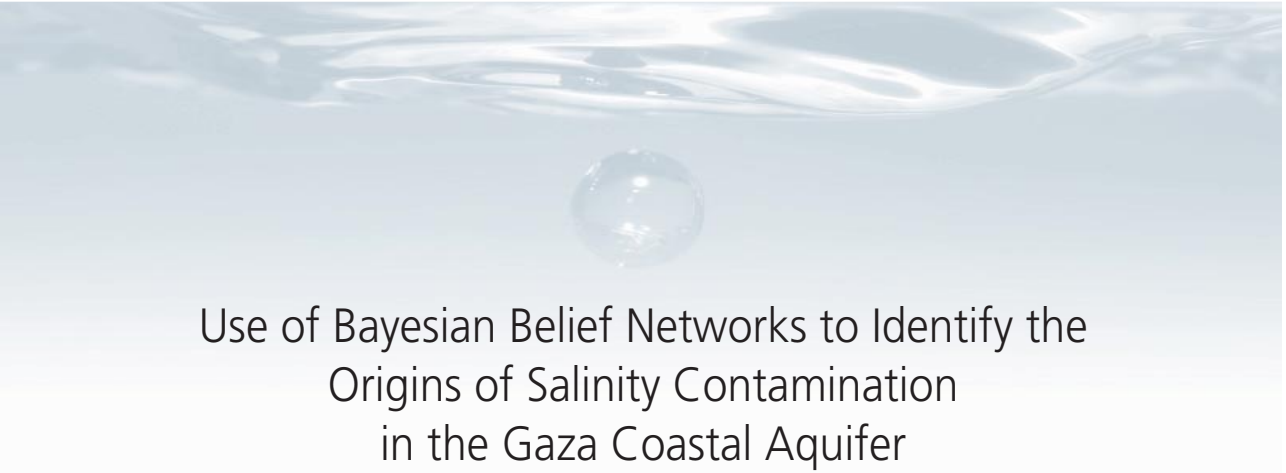
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throughout the world, this approach for nitrate modeling of groundwater can be applied to other aquifers on a regional scale.

Key words: coastal aquifer; bivariate statistical test; artificial neural network; nitrate; groundwater.



Use of Bayesian Belief Networks to Identify the Origins of Salinity Contamination in the Gaza Coastal Aquifer


Said Ghabayen¹ and Mac McKee²

Abstract

Groundwater is the only source of fresh water in the Gaza Strip. However, it is severely polluted and requires immediate effort to improve its quality and increase its usable quantity. Intensive exploitation of groundwater in the Gaza Strip over the past 40 years has disturbed the natural equilibrium between fresh and saline water, and has resulted in increased salinity in most areas. Salinization in the coastal aquifer may be caused by a single process or a combination of different processes, including seawater intrusion, upcoming of brines from the deeper parts of the aquifer, flow of saline water from the adjacent Eocene aquifer, return flow from irrigation water, and leakage of wastewater. Each of these sources is characterized by a distinguishable chemistry and well known isotopic ratios. In this paper, Na/Cl, SO₄/Cl, Br/Cl, Ca/(HCO₃⁻ + SO₄²⁻), and Mg/Ca ionic ratios, along with water isotopic composition such as 11B and 87Sr/86Sr, are used to distinguish different salinization sources. The task of monitoring and the associated decision making process are characterized by a high degree of uncertainty with respect to input data and accuracy of models. For this reason, probabilistic expert systems, and more specifically, Bayesian belief networks (BBNs) are used to identify salinization origins. The BBN model incorporates the theoretical background of salinity sources, area-specific monitoring data that are characteristically incomplete in their coverage, expert judgment, and common sense reasoning to produce a geographic


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distribution for the most probably sources of salinization in the Gaza coastal aquifer. The model also identifies areas where additional data on chemical and isotopic parameters are needed in order to identify pollution sources with an acceptable level of certainty.

Key words: Bayesian Belief Networks, groundwater, salinity, Gaza coastal aquifer.



Optimal Management of Groundwater Resources: Rafah, Gaza Strip


M.S. Albanna¹ and Z. Abu Heen²

Abstract

Fresh groundwater resources (Cl < 600 mg/l, NO₃ < 90 mg/l, and Palestinian standards for drinking water) that are available to the Palestinians in the southern area of Gaza Strip are very limited. Therefore, the continuous increase in the water demand has resulted in over pumping the aquifer. This in consequence resulted in the depletion and deterioration of these groundwater resources. In this study, a transient linear optimization management model has been developed to recover the groundwater resources by determining new operational pumping policies for the aquifer in the mentioned area over a planning period of 15 years. The management model is based on the response matrix approach. The management model has been developed after linking a groundwater flow simulation model for the study area to a linear programming management algorithm. The groundwater flow model has been developed using the USGS simulation code MODFLOW. The objective function of the management model was to maximize pumping from the study area while meeting some hydraulic and water demand constraints. Two management scenarios have been tested. In the first management scenario only limits on drawdown at some control nodes in the study area have been set. In the second management scenario, both drawdown limits and upper limits for water demands have been imposed. The idea beyond the drawdown limits at the control nodes in the model domain was to recover the groundwater levels above the mean sea level and then utilize a fraction of the groundwater saturated

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horizon. The developed management model has been solved using the optimizer LINGO

In the first management scenario, the optimizer tends to locate pumping at the eastern parts of the aquifer where naturally more drawdown is available. Moreover and since no water demand limits were imposed in the first scenario of the management model, the optimizer tended to locate the pumping rates in the last year of the planning period. However when limits on water demand were imposed in the second scenario, the optimizer tended to distribute the pumping rates over the planning period. It is interesting to note that the total optimal abstraction quantities from the study area are less than or equal to the aquifer recharge.

Key words: optimization management model, groundwater flow simulation model, linking code, planning period.



Spatial and Temporal Patterns in DOC and Nitrate in the Springs of Wadi Qilt and Nwai'mah Jericho – Palestine

**Fayez Abu Hilo¹, Saed Khayat², Ziad Mimi¹, Amer Marie³
and Stefan Geyer²**

Abstract


The interpretation of monitoring for the anthropogenic nitrate and dissolved organic carbon in four springs, and precipitation in the Jerusalem Ramallah sub-basin during the hydrological year 2006 has been carried out. The rainwater samples show a high nitrate values after the first rain event and directly after dry period between storms. These values tend to get lower as the winter season proceeds under the washout effect for the atmospheric pollutants. The response of the karstic systems to the precipitations and the nitrate content are quite heterogeneous and depend on the hydrological state of the system as well as the time and the intensity of the storm events. The effluent of different anthropogenic pollutants from the sewage water of the settlements, Bedouins and animals surrounding the wadi was varied also depending on the storm intensity and the length of the dry period between each rain event. The spring waters show a shock in the NO₃ and DOC values several weeks after a significant storm event. The values of DOC in the groundwater reach over 12 mg/L in the Qilt and Dyuk springs which might constitute a potential health risk if the water was chlorinated for drinking purposes.

Key words: exceptional storm, karstic system, anthropogenic pollutants, spring response.

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Integrated Land Use and Water Resources Management (ILWRM)

Adla Khalaf¹ and Taghreed Hithnawi²

Abstract

This paper aims to highlight the relation between land use and water resources and to address the future management approaches and the need for consistent policies towards achieving a “viable” Palestinian state. The environmental pressure related to the political situation and conditions is causing intervention on land and water resources relations and is setting-off economical problems related to land and agriculture in the West Bank. Such pressure is caused by the Israeli constraints on water use, closures and annexation of the Palestinian lands. Various negative outcomes on the Palestinian vision of a future “viable” state have resulted through experiencing:

- Decrease of water supply (per capita use)
- Re-distribution of farming land
- Reduction in cultivated land
- Decrease of agricultural production leading to food shortage
- Decrease in arable land in the Jordan Valley, the “food basket” for Palestinians

A ten-year (1994-2004) trend in growth patterns and activities on land use has been considered a significant indicator for water quality and quantity supplied to Palestinians during this period of time.

The study is conducted through a comprehensive data examination, utilizing computer aided analyses and visual interpretation of satellite images.

Key words: water resources, land use, integration, management, satellite images.

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Delineation of Groundwater Aquifer and Salt front in Coastal Areas

(Case Study Delta El-Arish Sinai, Egypt)

Hatem M. Mekhemer¹ and M.A. Abd Alla²

Abstract


The Sinai area attracted the Egyptian government to set a national plan for its sustainable development, since the major problem facing the construction of new communities in the Sinai generally and particularly in El Arish is the source of water. This work represents a part of an extensive field program for groundwater evaluation that was planned and executed by WRRRI since 2006. The objective of this work is how to develop the area to become attractive for population and reclamation.

This study includes forty-eight Vertical Electrical Soundings (VES) using the Schlumberger arrangement which were measured in the north part of El Arish, in order to investigate the Quaternary groundwater aquifer systems. Special care was directed towards groundwater investigations to be used later for domestic and irrigation purposes. The present work is selected to show the drawbacks of the effect of saltwater intrusion on the groundwater potentiality.

These (VES) measurements have been interpreted both qualitatively and quantitatively to make isoresistivity and geoelectrical cross-sections. Correlation of the deduced geoelectric parameters with the available geological information helped in establishing the specific resistivity of the formations. The results revealed that there are three main geoelectrical


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units. The second geoelectric layer represented the water bearing formation but it is not connected under all VES. The third geoelectrical units are the ones affected by salt-water intrusion.

Key words: coastal aquifers, saltwater intrusion, groundwater evaluation, Schlumberger, VES.



Towards Sustainable Management of Wadi Far'ah, Palestine

Walid Saleh¹, Ahmed Abu-Thaher² and Anan Jayyousi³

Abstract

With limited resources and rapidly increasing demands, sustainability is becoming an increasingly important, yet difficult goal to achieve in wadis (Salih and Ghanem, 2003). Sustainability of wadi systems is more complicated due to the conflicts and interactions among the different resource utilizations. It is a fact that sustainability of any natural entity can only be achieved through an integrated approach for its management.


In this paper, an attempt is made to summarize the challenges facing sustainable development of Wadi Fara'a and to propose some solutions towards achieving that goal. The challenges considered in this paper include technical, socio-economic, environmental, institutional, political and legal aspects. Wadi Fara'a located in the North Eastern part of the West Bank is taken as an example due to its characteristics as a natural environmental set-up that must be managed in a comprehensive, sustainable manner.

The proposed solutions are based on the outcome of the Al-Fara'a and Jerash integrated watershed management project. The overall aim of the project is to create sustainable development conditions for the study area through which water resources, natural resources and human resources are protected and conserved. The project is conducted by the Palestinian

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Environment Quality Authority (EQA) and United Nations University (UNU-INWUH) which received financial support from the European Union (EU); Short and Medium term Environmental Action Program (SMAP) and the Dutch Ministry of Environment (VROM).

Key words: sustainability, wadis, hydrology, Palestine, Wadi Far'ah.



Integrated Water Utility Management to Improve Water Availability

David Rosenberg¹ and Jay Lund²

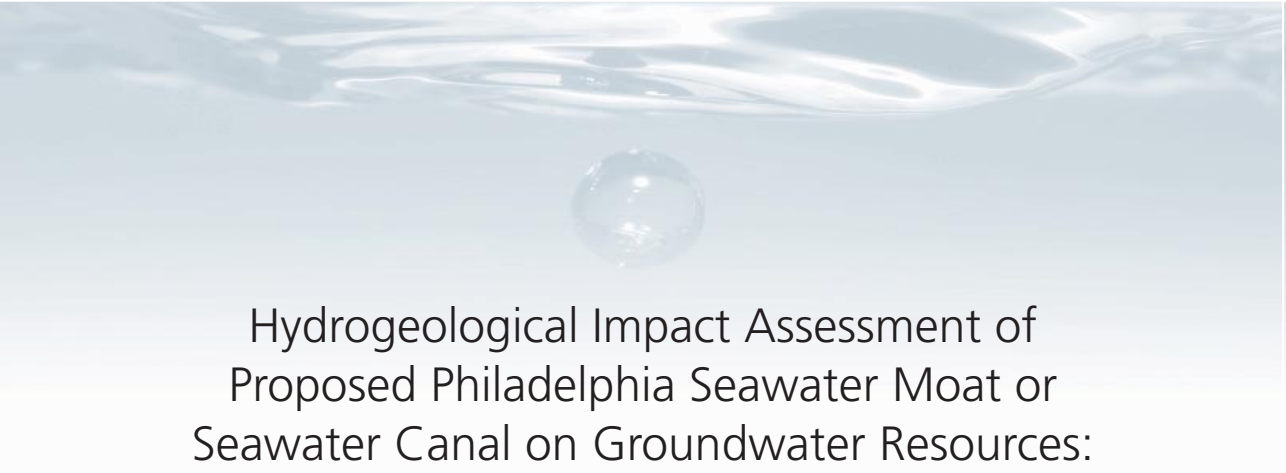
Abstract

We use stochastic mixed-integer optimization to identify a mix of long- and short-term new supply and conservation actions a water utility can implement to cost-effectively improve water availability to customers. A detailed example for Amman, Jordan considers 23 potential actions such as encouraging residential customers to install water-efficient appliances and water conserving landscaping, restructuring the distribution system to reduce physical leakage, curtailing apparent water losses, restricting certain outdoor uses, expanding waste-water reuse, developing new surface and groundwater supplies, desalination, delivering water by tanker trucks, short-term transfers, rationing service, and others. Alternative robust, grey-number, and best/worst case formulations systematically explore implications of uncertainties in action costs, life spans, water volumes gained or saved, availability levels, and probabilities. Results show: (i) Conserving water—reducing physical leakage and targeting select customers to install water efficient appliances—play important and growing roles over time. (ii) A delayed need for mega supply projects like pumping the Disi aquifer. (iii) No role for seawater desalination (Red-Dead Canal) before 2040. (iv) Desalinating brackish Zara-Ma’een water is the low-cost option to increase water availability to customers, but increases will still require substantial capital investments. And (v) Remarkable consistency across the different modeling approaches.

Key words: Two-stage programming; Amman; Jordan; Water supply; demand management; socio-economic aspects of water resources.

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Hydrogeological Impact Assessment of Proposed Philadelphia Seawater Moat or Seawater Canal on Groundwater Resources: Rafah, Palestine

Ahmed Al Yaqoubi¹ and Mazen Al Banna²


Abstract

After the Israeli withdrawal from the Gaza Strip in September 2005, the Israeli Ministry of Defense thought about constructing a seawater moat or seawater canal at the Philadelphia corridor to prevent digging sub-surface tunnels that were used for weapons smuggling, as it was declared. The dimensions of the seawater canal or seawater moat as published in the media 50-100 meters wide, 10-15 meters deep and 4000 meters in length. A three dimensional numerical flow and transport model was constructed and calibrated. The model then was applied to test the hydrogeological impacts of such a new boundary condition on the local groundwater resources in terms of quantity and quality. Using the numerical model two scenarios have been investigated and tested. The first scenario represents the construction of a seawater moat with 100 m width, 15 m depth and 4000 meters in length. The second scenario represents the construction of a seawater canal starting from the Mediterranean with total length of 4000 meters. The seawater canal has a width of 100 meters and is 5 meters deep.

To simulate the first scenario the numerical model was assigned a constant recharge rate of 0.2 m/d with chloride concentration as seawater (20000 mg/l). The advection and dispersion transport model simulation results indicated that hundreds of production wells on both sides of the borders

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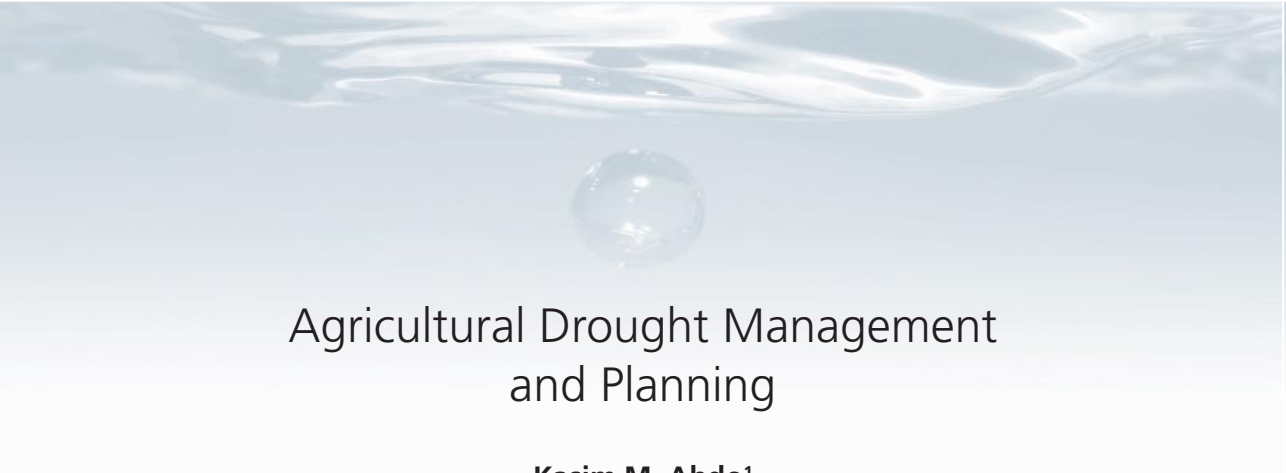
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will be under threat of the contaminant plume. The second scenario was simulated by assigning a constant head boundary with constant chloride concentration as seawater. Also in this scenario, the model results indicated that hundreds of production wells on both sides of the borders will be under threat of the contaminant plume. The only difference between the two scenarios is the progress rate of the contaminant plume. In the first scenario, the progress rate was 200 m/year, while in the second scenario it was 100 m/year based on the groundwater flow regime.

The numerical modeling study shows that in case such a project is implemented, the groundwater resources on both sides of the borders will be under threat. As a consequence, the environment and the socio-economic life of the Palestinians and Egyptians will be severely affected. Therefore diplomatic and political efforts from both the Palestinian and Egyptian governments should stress to prevent the implementation of such a project.

Key words: seawater moat, seawater canal, groundwater flow model, groundwater transport model.

A photograph of a water surface with a single, clear bubble rising from the bottom center. The water is light blue and has gentle ripples. The bubble is in sharp focus, showing its spherical shape and the light reflecting off its surface.

Agricultural Drought Management and Planning

Kasim M. Abdo¹

Abstract

Scarcity of water resources and limited accessibility to land are the main constraints for the sustainable management and development process in Palestine. Currently, available resources do not allow the satisfaction of existing water demand and competition among economic sectors; this has been enforced the planners to modify their perspective in managing the resources. For water resources, postponing the resolution of water issues to the final negotiation stage and the freezing of peace process are making water one of the most important limiting factors in developing all economic sectors and in establishing the viable future state in Palestine.

Vulnerability of natural resources due to mismanagement and limited opportunities to narrowing the imbalanced ratio of supply and demand can be worsened by the drought occurrence. The impacts of such event with increasing population will be harmful for food security, equity of resources, environment, and socio-economy. The importance of adopting new approaches and updating policies to face the regional and global climate changes are important issues to be considered in future planning.

Key words: agricultural, drought, management and planning.

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Analyzing Future Palestinian Water Issues with the WAS Model

**Franklin Fisher¹, Annette Huber-Lee, Karen Assaf,
Ammar Jarrar and Anan Jayyousi**

Abstract


The WAS (“Water Allocation System”) model* provides a method for system-wide analysis of water infrastructure and policy decisions, as well as a mechanism for cooperative international trade in water. Recently, that model has been extended to greatly facilitate multi-year analysis (MYWAS for “Multi-year Water Allocation System). This enables systematic consideration of the timing, order, and capacity of potential infrastructure projects.

The present paper illustrates the use of these models as applied to Palestinian water issues. We examine the benefits of additional water allotments on the West Bank as opposed to the construction of additional infrastructure. We find that, except in drought years, with current water allotments, desalination at Gaza will be required primarily to supply the southern West Bank through piping desalinated water uphill to the Hebron area. Were water allotments in the West Bank substantially increased, such obviously economically inefficient conveyance would be unnecessary.

Such conveyance would also be unnecessary were there to be a WAS-guided cooperative arrangement with Israel. But that would require a peaceful, cooperative environment, which can be hoped for but not

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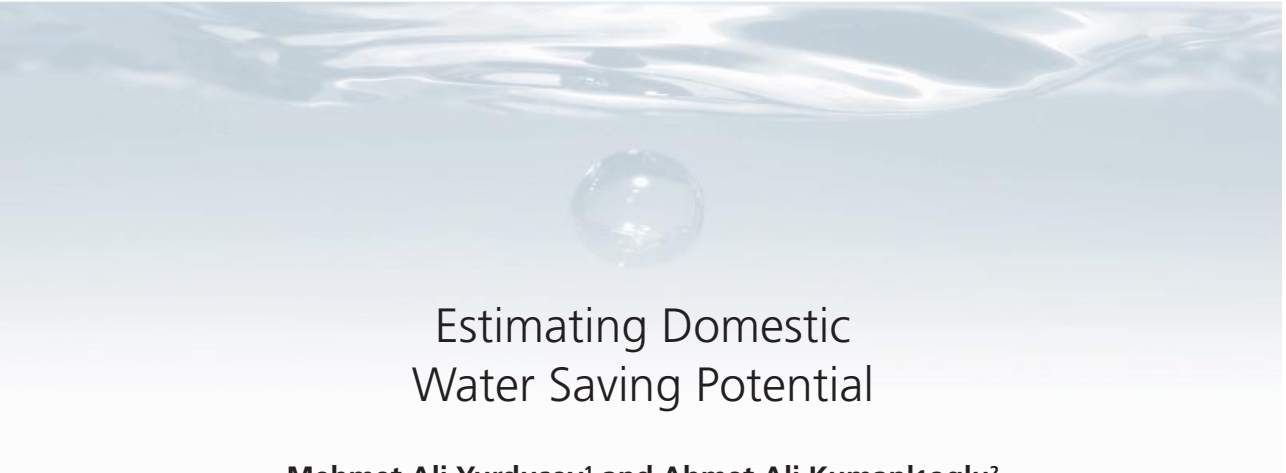
* The model is extensively described in F.M. Fisher, A. Huber-Lee, I. Amir, S. Arlosoroff, Z. Eckstein, M.J. Haddadin, A.M. Jarrar, A.F. Jayyousi, U. Shamir, and H. Wesseling, *Liquid Assets: An Economic Approach for Water Management and Conflict Resolution in the Middle East and Beyond* (Washington: Resources for the Future), 2005.



assumed. Hence we consider what infrastructure should be built in the absence of such an arrangement and what steps should be taken if such an arrangement seems fragile.

Because the results obtained are based on old data and forecasts, they should be considered illustrative of what can be achieved through the use of WAS and MYWAS. Actual application of such methods to truly guide policy will require a renewed effort to extend and rebuild the existing Palestinian model.

Key words: WAS Model, policy decisions, trade in water, water allocation, and water future scenarios.



Estimating Domestic Water Saving Potential


Mehmet Ali Yurdusev¹ and Ahmet Ali Kumanlıoğlu²

Abstract

Water supply for water demanders have come to a critical edge. Therefore, there is an obvious need to question water use practices. There is, in this regard, so-called demand management phenomenon. Demand management can be described to yield some quantity of water from the water in service through some demand management measures such as metering, pricing, using water saving devices, introducing water-wise water bylaws, water restriction, controlling water leaks in distribution systems and in homes and, above all, education. Despite the world-wide high-level popularity of demand management, it was unfortunately discovered that the importance of water conservation is not recognized in the normal people level. They either have not heard about water conservation or do not take it seriously. This is because people have not yet faced the severity of water shortage in developed countries. In developing countries, however, normal people neglect it among their many other problems even if they have been experiencing water scarcity. To this end, this paper discusses the demand management concept and the related measures to achieve a targeted level of water saving, which is inevitable to safeguard our precious resource, without which life is not imaginable. Having discussed demand management conceptually, this paper investigates domestic water saving potential in the case of Manisa, Turkey. For this purpose, firstly, domestic water use forms are analyzed in an attempt to estimate how much water

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is used by each particular use within total domestic use. Then, the water conservation measures for each water practice are examined and some easy-to-apply measures proposed. Finally, an experimental study was conducted to determine if the domestic water conservation measures proposed were applicable for the city considered. For this purpose, a questionnaire was developed and 200 respondents were asked to fill it in. The respondents were chosen from different people based on education level, financial status and size of the family to represent the society living in the city. Based on the results of the study, it is shown that the measures proposed are quite applicable and around 27 % saving is manageable if the proposed measures are publicized adequately and applied effectively.

Key words: domestic water, water saving devices, water demand management, Turkey.



Regulating Training Coordination as a Tool towards an Integrated Human Resources Development

Rebhy El Sheikh¹ and Sawsan Al Masry²

Abstract


The Palestinian Water Law No. 3/2002 delegates to the Palestinian Water Authority the planning and monitoring implementation of the training and capacity building programs in the field of water resources development and service providing. It has been realized that training efforts, mostly project-related training financed by different donors, have not been fully effective. Hence the need for a HRD plan based on a training policy and strategy and creating a relevant data base became a pre-requisite for a sustainable performance in the water sector. Through that, it is anticipated that all water sector professionals will be adequately trained and have access to continuing training and knowledge that maintains the integrity of the sector.

Through GTZ technical support, the Palestinian Water Authority on behalf of the water industry has placed the corner stone for such pre-requisites. The approach has been based on involving Palestinian sector professionals and training providers directly from the start so as to encourage ownership and sustainability.

A Training Co-ordination Unit (TCU) with professionals plus support staff has been set up in the PWA. The PWA with the TCU prepared a statement of water sector training policy and strategy.

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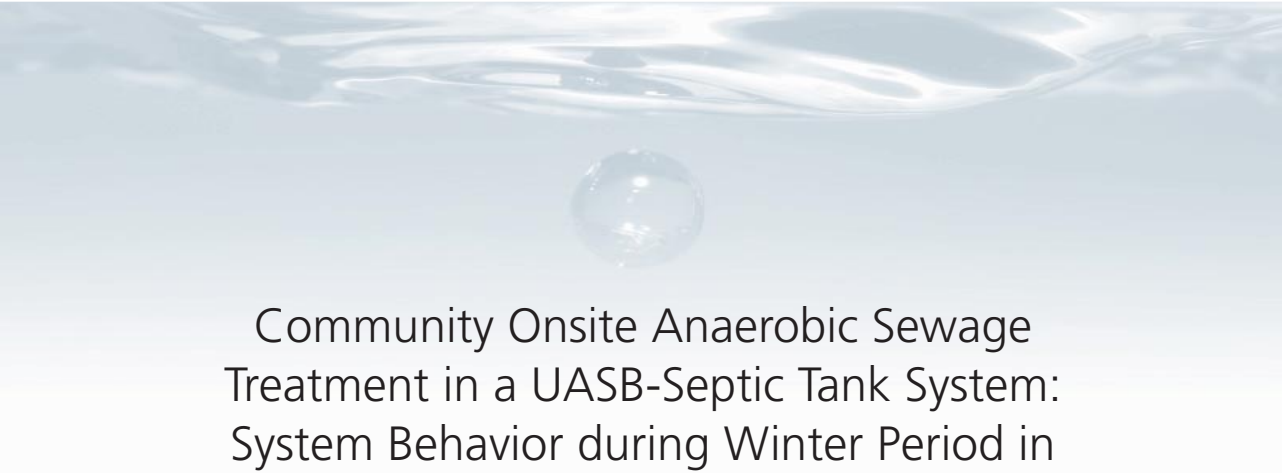
² Palestinian Water Authority, Palestine



Four Working Groups have been designated to follow up training themes on Technician Training - Water Supply, Technician Training – Wastewater, Graduate and Professional Training, Management and Finance Training. Each Working Group has prepared a short-term pilot plan setting out priority training activities. A number of pilot training activities have been practiced to test the system. The TCU has been focusing on building the structure and securing support, carrying out studies and designing the co-ordination system.

This paper exposes what has been performed in terms of the preparations and mechanisms applied and the challenges faced in addition to the corrective measures that shall be taken in consideration to reach the target.

Key Words: coordination, planning, training policy, training strategy.




Community Onsite Anaerobic Sewage Treatment in a UASB-Septic Tank System: System Behavior during Winter Period in Palestine

Wafa Al-Jamal and Nidal Mahmoud¹

Abstract


Two pilot scale community onsite UASB-septic tanks (capacity: 0.8 m³, height: 2.5 m) were operated in parallel over a six months period at the sewage treatment plant of Al-Bireh City, Palestine. The main objective of the research was to formulate design criteria for designing the UASB-septic tank for pre-sewage treatment under Palestinian/Middle East conditions, particularly during the cold period of the year. The effect of HRT on the performance of the system while treating domestic wastewater was assessed. The reactors were operated under two different HRT (2 days for R1 and 4 days for R2) at ambient temperature fluctuating between 2 to 27 °C with 14.7 °C average value, and average sewage temperature of 17.3 °C with 12 and 25 °C extreme values. The treated domestic wastewater over the whole research period was of medium strength with average COD_{tot} concentration of 905 mg/l and (COD/BOD₅) of 1.97. The COD_{ss} in the raw sewage represented a high fraction of the total COD, viz. about 43.7% from the COD_{tot}. R1 achieved mean removal efficiencies for COD_{tot}, COD_{sus}, COD_{col}, COD_{dis}, of 51%, 83%, 20% and 24% respectively and BOD₅ and TSS average removal efficiencies of 45% and 74% respectively. R2 achieved mean removal efficiencies for COD_{tot},

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COD_{sus}, COD_{col}, COD_{dis}, of 54%, 87 %, 10% and 28%, respectively with BOD₅ and TSS average removal efficiency of 49% and 78% respectively. The sludge production from both reactors was very low with VS/TS ratios of 67.9 and 67.02 of the sludges in R1 and R2, respectively. Based on the removal efficiencies and sludge productions it can be concluded that the researched UASB-Septic tank system is a potential compact and effective community onsite pre-treatment unit for domestic wastewater in Palestine. The reactor can be designed at either 2 or 4 days HRT, but slight preference might be given to 4 days HRT when sludge production is of concern.

Key words: Anaerobic sewage treatment, UASB-septic tank, sewage treatment.



Reuse of Reclaimed Wastewater for Irrigation of Agricultural Crops in the Palestinian Highlands

Nesreen Mansour¹, Ziad Mimi² and Jamil Harb³

Abstract


Farmers in Palestine suffer from a continuous shortage of water due to its scarcity/ It is important to note that both brackish water and reclaimed wastewater represent major sources, although both resources are problematic, as they impose stress to growing plants. Consequently, alleviation of these stresses is required, particularly salt stress, imposed by the use of brackish water or reclaimed water. The aim of this study is to search for the means to alleviate stress through irrigation with reclaimed wastewater mixed with brackish water. Jasmonic acid (JA), a plant growth regulator, proved to be efficient in alleviating various types of stresses, such as chill and drought stress. JA was tested in this study to determine whether or not it would alleviate salt stress imposed through irrigation of broad bean (*Vicia faba*) plants by /reclaimed water mixed with brackish water (EC= 7ds/m) 'Mix'. Broad bean plants are considered sensitive to salinity. Results showed that treating plants with JA lessened, although only slightly, the negative impact of the Mix. Moreover, cultivating plants in pots prevented the contamination of fruits with the pathogens present in reclaimed wastewater. Treating plants with JA enhanced the plant's tolerance to stress conditions imposed through irrigation of plants with alternative water resources.

Key words: wastewater reuse, irrigation, brackish water, crops tolerance.

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Statistical Analysis of Long-Term Rainfall Data for a Mediterranean Semi-Arid Region: a Case Study from Palestine

Sameer Shadeed¹ and Mohammad Almasri¹

Abstract

West Bank, Palestine, is one of the Mediterranean semi-arid areas. The available water resources in the West Bank are limited and insufficient to meet the agricultural and domestic water demand. Rainfall is the main replenishment of surface and groundwater resources in the West Bank. Characterization of rainfall magnitudes and patterns is of great importance in the management and development of scarce water resources in the main cities in the West Bank. This has compelled the motivation for carrying out a statistical analysis of long-term rainfall data for the meteorological station of Nablus City. This city is situated in an intensive agriculture-dominated area overlaying an important groundwater aquifer. This paper employs the fundamental statistical parameters and concepts to analyze the long-term rainfall data of Nablus Meteorological Station (NMS) in order to evaluate the temporal variation of rainfall in the area. Assessment of daily, monthly, seasonal and annual rainfall was carried out. Results showed that the rainfall for NMS is of high variability where the annual rainfall approximately varies between 280 and 1,400 mm with an average of 658 mm. Drought was observed in 7 years out of the last 30 years. The winter season has the highest amount of rainfall whereas rare rainfall events occurred in summer. The estimated return periods for daily rainfall events of over 70 and 100 mm exceed 3 and 12 years, respectively.

Key words: rainfall; statistical analysis; semi-arid regions; management; variability; drought.

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Is Our Existing Groundwater Quality Monitoring Network Efficient?

Khalil Ammar¹ and Mac McKee²

Abstract

This study presents a new methodology for developing an efficient design for a groundwater quality monitoring network by identifying and removing redundant sampling sites from an already existing monitoring network. The methodology is based on a Sparse Bayesian Learning approach known as a relevance vector machine (RVM). A reliable and parsimonious network configuration that is pertinent to the physics of the case study is sought through application of the RVM. The methodology has been employed to reduce the redundancy in the network for monitoring nitrate (as NO_3^-) in the West Bank aquifers in Palestine. It is also used to explore possible tradeoffs between different monitoring objectives, e.g., monitoring cost versus uncertainty in groundwater quality estimates. This application illustrates the strength of the relevance vector machine to understand the information content of the available data, and the potential for use of RVMs in optimal groundwater monitoring. Proof of correctness and accuracy using rigorous statistical tests are presented.

Keywords: groundwater monitoring, relevance vector machines, uncertainty, reliability.

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Erosion Classification of Natural Streams in south Sinai: Case Study-Wadi Watier

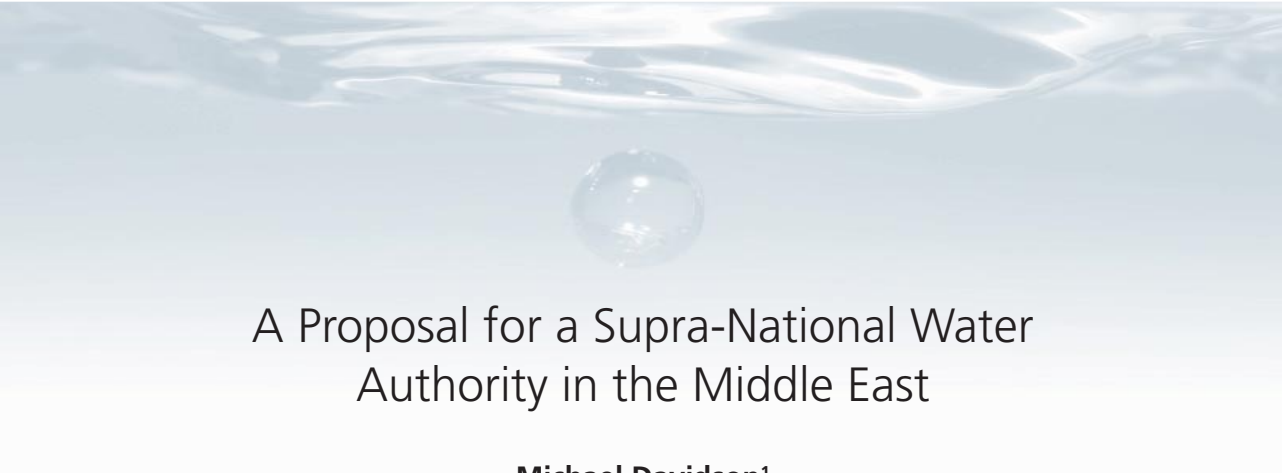
Gamal Kotb¹

Abstract

Arid region areas have limited surface water resources but sometimes they are exposed to extensive rain storms that produce flash floods. These kind of floods may have a great erosion power on the bed and banks of the stream. This may result in instability of the stream itself and the constructed hydraulic structures. On the other hand, for allocating hydraulic structures, some main topographic, morphologic, and geologic features are taken into consideration. However, after construction, these structures may face some problems related to erosion or deposition owing to the fact that the hydraulic structure may be allocated in a reach of the stream characterized by erosion or deposition. A number of typical natural streams in South Sinai (Wadi Watier and its tributaries) were selected for analysis with the aim of classifying these streams according to their erosion propensity. These streams have many different physical characteristics; therefore, each stream has its erosion capability and local regime, in which the character of flow, the slope, the resistance of bed and banks to erosion, and other factors result in a specific erosion situation corresponding to the local conditions of the stream. In this paper, the mean stream power concept is used to give a measure about the energy expenditure and the erosion tendency of each stream under different flow depth conditions. A dimensionless mean stream power approach is proposed in order to establish a factual basis for analysis and to enhance the comparison of the erosion power of the different streams.

Key words: flash flood, hydraulic structures, erosion, means stream power, a dimensionless mean stream power.

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A Proposal for a Supra-National Water Authority in the Middle East


Michael Davidson¹

Abstract

The challenges of establishing institutional structures for sustainable and equitable water management in the Middle East are formidable. Severe institutional asymmetry between Israel and Palestine in every socio-economic sphere is evident. Nonetheless, NGO's, local, disparate communities and academicians have found common ground and are engaging in local, trans-boundary riverine and catchment basin joint management. However, management of large-scale, groundwater resources requires national recognition and consensus of "Upper Politics". Abstraction rates of groundwater have reached their limit; new water sources, in particular, desalination, will be developed and major public works, such as the Red Sea-Dead Sea canal will be executed. Clearly, a centralized form of management will be necessary. This paper will examine the shared benefits of a supra-national water authority that is structured to balance the geo-hydrological reality of the region with cultural, economic and political proclivities of the parties. This proposal will take into account temporal and spatial aspects of the region as well.


This policy proposal is predicated on the 'desecuritization' of water by both Israel and Palestine. The foundation of a supra-national water authority is not to supplant the sovereignty of each nation, but to form a policy and publicly-owned agency that meets the economic, environmental, and physical security needs and rights of each party in an equitable and

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sustainable manner. Heretofore, the concept of such a water authority has been dismissed by the “Upper Politics” and I suggest that, unwittingly, a myopic decision-theoretic model of policy diffusion has been utilized whereby governments only learn from their own experience. This paper will show that a game-theoretic version of learning-based diffusion will permit new and creative ways of thinking, allowing for the establishment of a jointly managed water authority of the trans-boundary water resources of Palestine and Israel.

Key words: policy diffusion, joint management of trans-boundary water resources, high performance water utilities.



The Need for Proper Irrigation Water Users Institutions as an Effective Means to Resolve Irrigation Problems


Mohammed Sbeih¹

Abstract

Water is always considered as an essential factor of life and development in arid and semi-arid countries. In Palestine the total per capita water consumption is 139 m³ while in the neighboring countries such as Israel it is 411 m³. Irrigation consumes about 75% from all of the water utilized in Palestine, so water should be managed properly in order to utilize the water efficiently, economically and insure the sustainability of these projects. An example of the bad management of irrigation water is the existing practice in the Jordan Valley where the application efficiency as well as the conveyance efficiency is less than 65%. However; the percentage of the irrigated area in West Bank is not more than 6%, and it didn't exceed 12% in all of Palestine. In order to fill full these as well as to improve the performance of the irrigation water sector, proper institutions such as water users associations should be formed that will be able to manage the distribution of water properly.

The role of these institutions will be not only managing the water distribution but also will provide extension to the farmers and give means of support to the farmers in helping them in marketing their products as well as providing other agricultural services. Water Users Associations (WUA), or similar institution such as Water Users Cooperative (WUC), can be established in order to help in managing the irrigation projects. WUAs,

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can be defined as “grassroots” organizations formed by a group of individuals who have common interests, and run by a council or board elected by those individuals. The WUA would manage the activities of the WUA to realize the required basic benefit, which is the best possible management and distribution of the available/potentially available irrigation water. This would guarantee the increase of the agricultural production from the aggregate holdings of the WUA, through improvement of the performance of the irrigation system in situ, and according to the principle of fairness towards all the members of the group, within a sound democratic framework based on the interest of the group and not of any particular individuals thereof

Key words: Palestine, irrigation, economics, institution, sustainable irrigation management efficient irrigation management.




Water Quality Improvements in Sandy Loam Soil During Soil Aquifer Treatment

Thaer Abu Shbak¹

Soil aquifer treatment (SAT) system is accomplished by infiltrating the wastewater from basin surface under operation schedule known as cyclic pattern. The water percolates through the unsaturated soil to an underlying aquifer for storage and future use. As it flows through the soil additional treatment of the water occurs as result of physical, chemical, and biological processes. A properly designed and managed SAT system yields treated water that meets quality of our needs for unrestricted irrigation or other uses. One of the most important concerns in a SAT operation is to achieve nitrogen removal, by allowing of nitrification of infiltrating ammonium-nitrogen and denitrification of its by-products, nitrate nitrogen, to nitrogen gas. The purpose of this article is to investigate the effect of carbon to nitrogen ratio on the nitrification and denitrification mechanisms in local loam sandy soil during SAT operation. Three PVC columns were used. The diameter and length of each was 20 cm and 1 meter, respectively. The columns were backed with loam sandy soil passed through 2-mm mesh. The columns were operated by one day wetting followed by two days drying. The wastewater used during this experiment was synthetic. A wastewater with carbon to nitrogen ratio of 3 to 1 was pumped to first column; 1 to 1 pumped to the second, and ratio of 1 to 3 was pumped to the soil in the third column. Soil solution samplers were installed at each 5 cm along each soil column to collect soil solution samples. Ammonium NH_4^+ , nitrate NO_3^- , total organic carbon TOC, inorganic carbon IC, and phosphorous PO_4^{+3} was detected in each sample. The major observation for nitrogen was that SAT systems tend to promote nitrification of NH_4^+ in the applied wastewater and transform the majority of influent nitrogen to NO_3^- , by adsorbing NH_4^+ during wetting time and nitrifying them during

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wetting time. With a short wetting time of one day the attempts to establish denitrifying conditions by manipulating the C:N ratio in a loam sandy soil were successful. Complete denitrification of the applied NO_3^- was achieved with reasonable C:N ratio with 1:1 and 3:1 ratio, but it was unsuccessful with C:N ratio of 1:3. During the experiment, IC of concentration 5 mg CL^{-1} and TOC of 5 mg C L^{-1} were found sufficient reactants allowing both complete nitrification and denitrification of total N of around 40 mg L^{-1} in the applied.

wastewater in a loam sandy soil. The main process of removing PO_4^{+3} from the applied wastewater was found to be sorption to the soil particles as a result of the exchange capacity of the soil during the wetting time. Then this was consumed by the microorganisms causing an effective and noticeable recovery of the active soil sites for the next wetting time. Additionally, short drying time of two days did provide complete nitrification, thus allowing NH_4^+ not to build up in soil. The loam sandy soil was found effective to adsorb both NH_4^+ and PO_4^{+3} and held it there for the drying time to be utilized by the microorganisms, avoiding them from reaching the groundwater. The IC in the wastewater was found not to be a limiting reactant for the nitrification process since it was found all the time in levels higher than the input concentrations. Finally, and in connection with the water quality improvements, and from an environmental point of view, the study has indicated that short wetting time may eliminate NH_4^+ , which is considered as pollutant, from the percolated wastewater. However, a peak in NO_3^- concentration in the percolated wastewater is expected due to the nitrification process which is mainly occurs during drying time.

Key words: water quality, sandy loam soil, aquifer treatment, pollution.



Assessment of Rainwater Harvesting for Domestic Water Supply in Palestinian Rural Areas

Nidal Mahmoud¹, Mira Boullata² and Hanadi Abu-Ghannam²

Abstract

Rainwater harvesting in Palestine is a principal non-conventional water resource that has been adopted since ancient times. Even though, the system had not been so far subjected to a thorough assessment. The main objective of this paper was to assess the feasibility of rainwater harvesting for domestic water supply in Palestinian rural areas with special emphasis on socio-cultural, financial aspects as well as harvested water quality. Different methods were used to collect necessary data from a case study village, including literature review, observations, questionnaires and freshly fallen and harvested rainwater samples analysis. Moreover, domestic water demand and water supply from such a system were compared, and economic feasibility of applying this system was checked. The results revealed that harvested rainwater is a viable resource that can contribute considerably to minimizing water shortage.

Key words: rainwater harvesting, domestic water, water, rural areas.

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A Bayesian Belief Network Model for Assessing Alternatives for Operation of the Gaza Water Resources System

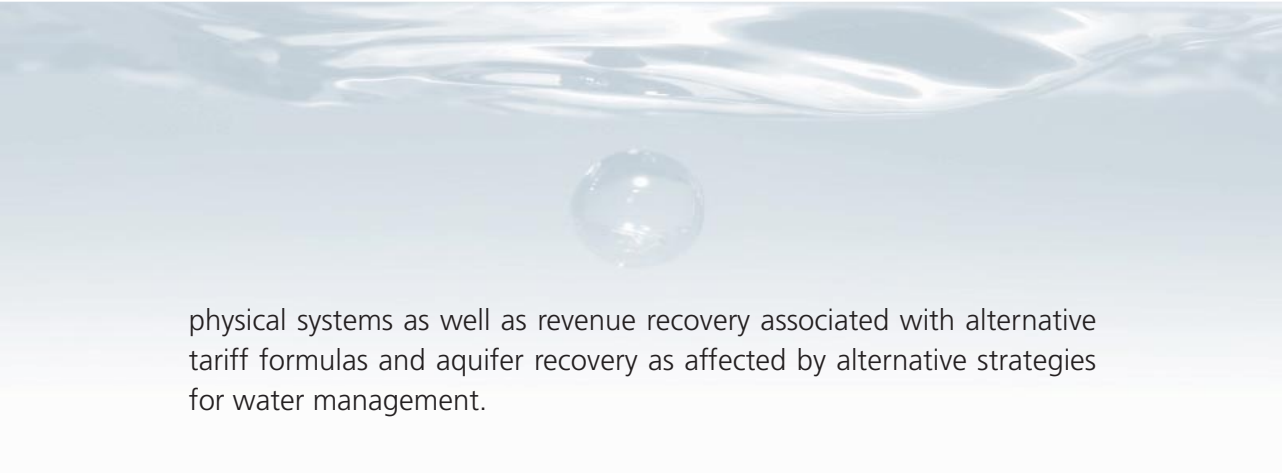
Said Ghabayen¹ and Mac McKee²

Abstract

The only natural source of fresh water in the Gaza Strip is the coastal aquifer, which has become severely polluted and overused in recent decades. A plan is being instituted that will expand the water supply and wastewater infrastructure of the Gaza Strip into an integrated system, including operational policies to provide for recovery of the aquifer. Components of this plan are subject to a great deal of uncertainty, and understanding this uncertainty is a key to the success of the plan. Sources of uncertainty include population forecasts, water demand distribution, current and future water resources availability, the future geopolitical map of the area, water quality levels and proposed treatment technologies, seawater desalination options, wastewater treatment and reuse options, institutional capacity, water tariff structures, and customer behavior and water market conditions. A Bayesian Belief Network simulation model is presented as a tool for characterization of uncertainties in the management of the integrated Gaza Strip water system and for exploring alternative system operational policies. This model represents a new application of probabilistic modeling tools to a large-scale, complex, integrated water resources system. The model simulates the existing and the proposed


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physical systems as well as revenue recovery associated with alternative tariff formulas and aquifer recovery as affected by alternative strategies for water management.

Key words: Bayesian Belief Networks, water supply, water demand, water system management.



Israeli Interest in the Waters of Lebanon

Jalal Halwani¹

Abstract

We will study the claims of Israel on Lebanon's abundant water and the ominous threat of wars in Lebanon. We will present a brief historical review concerning the relation between water and last conflicts in the Lebanon since 1948. We will discuss the Wazzani pump dispute that erupted in 2001 when following Israeli withdrawal, the Lebanese government decided to divert a small amount of its water part from the Hasbani River into surrounding impoverished villages. The dispute exemplifies how water tensions, in an area already fueled by political distrust, can easily inflate into war rhetoric.

Key words: relation of water and conflicts, Wazzani pump and Hasbani River.

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Conflict Resolution over Transboundary Aquifers: Recent Developments and Future Perspectives

Raya Marina Stephan¹

Abstract

This paper aims at presenting the recent developments over transboundary aquifers, arguing that the tendency is more over reaching peaceful cooperation rather than conflicts.

While states have been cooperating over surface water bodies for a long time, this was not the case until recently for transboundary aquifers. The past few years have seen the emergence of first signs of cooperation over transboundary aquifers. Contrary to the case of river basins, there are still very few examples of agreements over a transboundary aquifer, and even fewer examples of joint management on such a resource.

However this trend is evaluating at various levels. If the Franco-Swiss Genevese aquifer remains the unique example of joint management of a transboundary aquifer, States sharing an aquifer are expressing willingness to establish joint cooperation, and are starting to create simple mechanisms among themselves which will hopefully lead to a more achieved cooperation. The case of the consultation mechanism built for the North Western Sahara Aquifer System (Algeria, Libya and Tunisia) is one of the most developed, but other cases are following such as in the lullemeden Aquifer. States cooperation over transboundary aquifers is also developing under various legal frameworks such as the UN ECE Water Convention (1992) or the EU Water Framework Directive (2000).

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On another level, specific projects such as the UNESCO-IHP Internationally Shared Aquifer Resources Management (ISARM) project are developing in various regions of the world and contributing to the growing awareness of the necessity of joint management of transboundary aquifers under specific rules. In some cases the legal component has been identified among the priorities.

And last but not least, in view of filling the gap in international law, the UN International Law Commission adopted in June 2006 at first reading a full set of draft articles on the law of transboundary aquifers.

Key words: transboundary aquifers, cooperation, joint management.



What Price Cooperation? Hydro-Hegemony in Shared Israeli- Palestinian Groundwater Resources

Clemens Messerschmid¹


Abstract

Contrary to the general notion, that “cooperation of any sort” would reduce the conflict and lead to more consensus-driven relations over water or that both sides would benefit in practical terms, the concept of hydro-hegemony supposes a simultaneousness of coercion and consent (Gramsci), rather than a purely coercive pattern or a gradual development towards consensus in transboundary water relations. It assumes conflict and cooperation to appear simultaneously in the same power relation and it incorporates political and socio-economic factors outside the water sphere to understand the working of actual water relationships.

The paper argues that in the Palestinian case, the chronic water crisis is not due to hydrological factors of drought but rather expresses a stable and systematic pattern of political domination inherent to the occupation – but more importantly, also to the Oslo-style cooperation. It shows that the main “achievement” under Oslo was the coercion of Palestinians into cooperation and consent to a water distribution clearly unfavorable to Palestinian interests. The role of the different stakeholders in this process, Palestinian institutions, donor states and the public are investigated.


The paper highlights the role of the new cooperation mechanisms under Oslo and the changes and continuity they provide, compared with the pre-Oslo phase of overt occupation.

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Finally, the paper sets out to discuss some possibilities of challenging the current pattern of hydro-hegemony, i.e. not only to prepare for future negotiations but also to create counter-hegemony while not neglecting the domestic homework till then.

Key words: hydro-hegemony, cooperation, Oslo-II, allocation, water supply, technical discourse, narrative.



Pollution and Water Quality Assessment of Wadi Al Qilt Drainage Basin, Palestine

Ghassan Daghrah¹ and Rashed Al-Sa'ed²


Abstract

The need for sustainable development in Jericho district communities and the protection of both public health and natural resources urge for a water quality assessment of Wadi Al Qilt. This study reports on the sources and types of potential pollutants and presents water quality data for the Wadi Al Qilt drainage basin. Surface water samples were collected over a study period from November 2004, through May 2005 from seventeen (17) sampling stations along Wadi Al Qilt and analyzed for physicochemical and hydrobiological parameters. Results revealed major trends for most of the measured parameters with decreasing tendencies in pollutants concentration downstream. Then Dilution factor caused by spring outflows and the self-purification processes within the Wadi bed might be behind the decrease tendencies. Three Wadi samples were contaminated with trace metal (aluminum, cadmium and lead), while all water samples revealed microbiological contamination signs. Three spring water samples showed high lead and cadmium concentrations exceeding allowable drinking water standards, whereas 50% of the samples were contaminated with fecal coliform of unknown sources. In conclusion, regulatory bodies should work more closely to set integrated water management policies and operating standards appropriate for water, solid and liquid waste treatment facilities and natural protective areas.

Key words: water quality management, Wadi Al Qilt, water pollution, natural resources protection.

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Quality Control of Urban Runoff and Sound Management: Ramallah as a Case Study

Ziad Mimi¹, Amjad Aliewi², Amjad Assi², Jumana Abu Sada², Subhi Samhan³ and Ibrahim Shalash¹

Abstract

Urban runoff pollution sources, including stormwater, combined sewer overflows, and diffuse or nonpoint sources of water pollution are formidable obstacles to achieving water source goals in many municipalities in arid and semiarid climates. Ramallah currently has one of the highest rates of urbanization in Palestine causing a significant increase in surface runoff. This, in turn, causes increased flooding and a significant decrease in water quality due primarily to the accumulation of pollutants. The need exists to manage urban stormwater runoff on an integrated catchment basis, thereby reducing the negative impact of urbanization on the environment and quality of life. Sampling from many selected sampling stations in Ramallah city have been taken and the results will be discussed in the paper. Urban runoff pollution problems are more difficult to control than steady-state, dry-weather point discharges because of the intermittent nature of rainfall and runoff, the large variety of pollutant source types, and the variable nature of source loading. The use of Best Management Practices (BMPs) to reduce the impacts of urbanization on the environment and the effectiveness of BMP's will be discussed and illustrated, based on expertise gained from other studies. Since the expense of constructing facilities to collect and treat urban runoff is often prohibitive, the emphasis of stormwater pollution control will be on developing a least-cost-approach, including non-structural controls and low-cost structural controls./

Key words: water quality, stormwater, best management practices.

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Groundwater Pollution Due to Pesticide and Trace Element in Tulkarem and Jenin Area

Subhi Samhan¹


Abstract

There are 123 types of pesticides used in the West Bank and 14 of these pesticides were internationally suspended, cancelled or banned by WHO. Furthermore, some of those pesticides are still used. It is important to monitor groundwater for pesticides and trace elements because of the heavy industrial activities in the West Bank.

This study aims to determine quantitatively and qualitatively the effect of pesticides such as (2,4-D dichlorophenoxy acetic acids, Paraquat, Atrazine (2-chloro-4-ethylamino-6-isopropylamino-s-triazine), and MCPP 2-(2-Methyl-4-chlorophenoxy) propanoic acid as a part of the organic concentrations found in groundwater due to the agricultural activity in the Jenin and Tulkarem areas. Moreover, trace elements and heavy metals such as cadmium (Cd), lead (Pb), iron (Fe), zinc (Zn), chromium (Cr), copper (Cu) were determined quantitatively for the same period of study starting in April 2004 to May 2005.

Most of the tested wells for lead (Pb) and chromium (Cr) in the Tulkarem area were above the WHO standard for potable water. Trace elements and heavy metals relate to the presence of cationic parameters which can be easily exchanged in the complex compound as investigated in the two areas. In the Tulkarem area it is significant that the polluted samples were (Pb) 90%, Cd 20% and Cr 35% from the tested samples. On the other hand in Jenin the tested wells polluted with Pb were 85%.

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On the contrary, pesticides concentration is greater in Jenin wells compared with Tulkarem tested wells. Moreover, the polluted wells in the studied area by nitrate (NO_3) and potassium (K) were above the WHO guidelines, where as they were free from fecal coliform as pathogenic indicators which leads one to conclude that groundwater well pollution is due to fertilizer from agricultural activity and not to sewage (wastewater) disposal in most of cases.

Results revealed that the groundwater usage for drinking was at high risk from pollution by trace metals and rising amounts of nitrate and potassium in Jenin wells due to the industrial and agricultural activity that is not controlled or monitored. Moreover, results revealed that the Paraquat was not found in the tested wells in the studied area because it was either recently used or biodegradable.

It is recommended to initiate a pilot scale study for chlorinated water using Trihalomethane which is highly carcinogenic as a health indicator that affects human beings. Public awareness campaigns are needed for all related institutions dealing with water, as well as consumer dealing with the issues of water pollution and water treatment for the future. Moreover, work is needed to correlate transport models of trace metals with hydrological issues.

Key words: pesticides, trace and heavy metals, groundwater pollution.



Prevalence and Characterization of Shiga Toxinogenic Escherichia Coli (STEC) in Tulkarem and Jenin Domestic Wells in the West Bank

Marwan Bdair¹


Abstract

Gram negative bacteria are found extensively in ground water systems in shallow water table aquifers. Total coliform have long been recognized as a suitable microbial indicator of drinking-water quality; they were regarded as belonging to genera Escherichia coli, Citrobacter, Enterobacter, and klebsiella (World Health Organization Geneva, 1996). Shiga toxinogenic Escherichia coli (STEC) comprise a diverse group of organisms capable of causing severe gastrointestinal and systemic diseases in humans.

The total coliform bacterial isolates were identified in 63 (67%) of the 94 water samples analyzed. There was no geographic clustering of the bacterial differential of total coliform that was found, in which the frequency of these isolates in Jenin city give indication that it was a more serious domestic water sample contamination than Tulkarem city. Our results as shown that 100% of the chlorinated samples (69%) were potable water samples, but the rate of contaminated samples especially without chlorination system was 83 % (24 / 29) of the non-chlorinated samples which account for about 31% of the total (94) water samples. This finding indicates that the contaminated water is a serious problem in Palestine.


Our results also show antibiotic resistance to at least 3 drugs was found in 39 isolates (89 %) and almost 50% of the isolated strains were resistant to five or more drugs. This gives an indication that the E.coli isolates had a multiple drug resistance to these antibiotics.

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The PCR product of stx-encoding genes (STEC isolates) was not identified in any of the 44 (47% of the total water samples) E. coli isolates in both Tulkarem and Jenin districts wells. The epidemiological study to the E.coli isolates shows 5 distinct patterns on ERIC-PCR identified E1 through E5. E1 isolates were widespread throughout northern Palestine represented by 12 (71%). The remaining ERIC-PCR patterns (E2 to E5) were considered as sporadic since they were found only in a small number of isolates (five).

Key words: Shiga, Escherichia, Domestic wells, bacteria, health risk.



Investigation on Domestic Reverse Osmosis Membrane Contamination in the Gaza Strip

**Rebhy El Sheikh¹, Moustafa EL Baba ²
and Abed AL Nasser Abu Shahla ³**

Abstract

The Gaza Strip is located in a semi-arid region characterized by a continuously deteriorating water quality. People have tended in the last few years to desalinate water using Domestic Reverse Osmosis desalination units at their homes. Their selection of the units is not based on any study to the performance of these units and its relation with feed water and product water quality. The low salinity tasted is the only indicating factor for the good water quality from the consumers' viewpoint.


The commercial size reverse osmosis units are characterized by the automatic back washing of membranes which limits possibilities of fouling, the advantage that is not available with the small scale domestic units and hence leads to possibilities of contamination.

Previous studies on the performance of these units have been concentrated on the assessment of chemical characteristics of water while microbiological contamination has rarely been investigated. This study had examined the total coliform and standard plate count for the inlet water, the filtered water and the membrane itself using the Gramstain technique test to identify the bacteria group. Samples have been taken from 120 locations originally serviced with different municipal water qualities all over Gaza Governorates.

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A lot of factors affect the number of colonies including age of the membrane, routine maintenance and cleaning and the feed water quality. Generally there is similarity between the types of bacteria groups in the samples taken from different places. The G+ Bacillus bacteria group is the type most found in the membranes.

The level of contamination found in the outlet sample exceeds that of the inlet sample in Gaza, Khanyounis, and Rafah Governorates. In the Middle and the North governorates the rate of contamination is almost equal. The level of contamination in RO membranes was 100 % in Rafah, Khanyounis and North Governorates, 95% in Gaza governorate and 95.8% in the Middle governorate. In addition, the study shows that people in the Gaza Strip have a very low knowledge about water quality.

Key words: contamination, membrane, reverses osmosis, water quality.



Sustainability and Institutional Water Resource Regime in the Gaza Strip

Zaki Zoarob¹ and Hans Bressers²

Abstract

The Gaza Strip is located in the southern part of Palestine. The main source of water in the Gaza Strip is the groundwater where its quality and quantity are extremely deteriorated. Municipal water is managed by 25 municipalities. Agricultural water is managed by the Ministry of Agriculture. The Palestinian Water Authority is responsible for developing water policies and strategies. Water as an environmental resource is evaluated by the Environment Quality Authority.


Sustainable use of water resources as a natural resource requires an optimum distribution of the use options among present and future users and use functions. The integration level of the institutional regime had a vital role in achieving the sustainability.

A case study is conducted in order to evaluate the institutional regime of water resource management in the Gaza Strip as well as its relation with sustainability by using standard institutional indicators.

The study showed that the extent of the present institutional regime does not include all significant users. The internal coherence of governance elements is coherent in many aspects. The internal coherence between problem perception and objectives is high. On the other hand the coherence

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between designated responsibilities of water departments and available resources for them is relatively low. The impact of the institutional regime elements (indicators) on sustainability of water resource use is highly significant in terms of internal coherence of governance, external coherence of regime, and extent of regime.

Key words: integrated institutional water resource regime, public governance, sustainability, water management, Gaza, Palestine.



Recent Estimations of Hydrologic Cycle Components in Gaza Strip Catchment

Tamer M. Alslaibi¹ and Yunes Mogheir²

Abstract


Accurate estimation of the hydrological cycle components is essential for efficient water resources management and planning. This is primary where there is a scarcity of water resources like the case of the Gaza Strip. This paper shows the best and the recent estimations of the hydrologic cycle components: average annual precipitation, interception, evapotranspiration, infiltration and the resultant runoff in the Gaza Strip catchment.

Various methods were selected from the literature such as the Thiessen method and Penman Equation and other estimation methods. The data were collected from the water institutions in the Gaza Strip to perform the analyses. The analyses are considered as recent since the data was collected for years 2005 and 2006.

The results revealed that average annual precipitation of rainfall in the Gaza Strip is 350 mm/year and the interception percentage by agricultural, urban, road and industrial uses are 5.8%, 4.3%, 2.3% and 1.8% respectively. The average annual evapotranspiration in the Gaza Strip is 128.2mm/year, which represents 36.6%. In addition, the net rainfall that infiltrates through the soil is 77.8mm/year, which represents 22.2%. Therefore, for the steady state conditions, the water budget of the Gaza Strip indicates that the percentage of rainfall water which is generated as runoff is 27.0%.

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The findings of this paper can be used to update the water budget of the Gaza catchment area. Meanwhile, this could update the water resources management and planning studies which are used regularly by many institutions and researchers.

Key words: Gaza catchment, hydrologic cycle, water budget, management and planning.



Controlling Bacterial Regrowth by Improving the Design of the Household Storage Tanks


Atef Abu Jaish¹

Abstract

Nablus Municipality pumps water intermittently to the consumers due to the limited water supply in comparison to the high water demand. This compels the use of roof tanks and consequently lengthens the storage period of water which might enhance the bacterial regrowth in the tanks due to the depletion of chlorine with time. The main goal of the study is to minimize the bacterial regrowth in the household water storage tanks through modifying the current traditional design of these tanks. An experiment was carried out at the Water and Environmental Studies


Institute at An-Najah National University to consider different designs of roof tanks. Three different designs of the galvanized tanks were manufactured and installed. The first one is the current traditional design which has cubical shape and flat base with a tap 5 cm above the leveled base. The second is similar to the first one but has a 20 cm deep inverted pyramid base. The third one is cylindrical and has a 20 cm deep funnel base. The protocol of the experiment includes filling the three tanks from the mains and leaving them isolated for 7 days. Samples were collected from the three tanks on day 0, day 4 and day 7 of isolation. These samples were subjected to bacteriological and physico-chemical analysis. The tanks were drained at the end of the 7-days isolation period, refilling them from the mains in order to start the second round of analyses. During the whole period of study (6 months), no statistical differences were found between the three types of isolated tanks with respect to residual chlorine,

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temperature, turbidity or pH. The total and fecal coliform bacteria were totally absent in all tanks. Heterotrophic Plate Count bacteria (HPC) had increased during the isolation period day0 to day4 and during day4 to day7 in all isolated tanks. Comparison between the three tanks showed that the HPC was the lowest in the cylindrical design tank whereas the highest was in the traditional design type.

Key words: intermittent; regrowth; galvanized tanks; Heterotrophic Plate Count (HPC).



Health Risks from Microbial Growth and Biofilms in Drinking Water Distribution Systems in Palestine

**Khalid Swaileh¹, Rasmi AbuHelu²,
Rashed Al-Sa'ed³ and Rateb Hussein⁴**

Abstract

Water distribution systems play a major role in determining the final quality of potable drinking water. Pathogenic and toxigenic microbiological agents in drinking water can cause diseases and death to consumers. The health risks associated with these pathogens range from viral and bacterial gastroenteric diseases to infections such as hepatitis A and giardiasis. Drinking water samples (n=24) with a volume of 1000 ml were collected in sterile bottles from the distribution systems at different regions in Ramallah District in Palestine. Moreover, swabs from the inside of the water distribution system of the same regions were taken. Samples were filtered through a 0.45µM membrane, and various tests were conducted on each sample including total coliform, fecal coliform, heterotrophic plate count, *Pseudomonas auroginosa* count, fecal streptococci, sulfite reducing anaerobes, residual chlorine, turbidity, ammonium and nitrate. For protozoa, microscopic examination was done for the swabs transported in saline from the biofilms within the same day of sampling.


Four samples out of 12 (33%) contained too many to count for HPC. The remaining 8 samples contained an average of 26 CFU/100 ml. Five samples

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out of 12 (42%) were found to contain total coliform. The number ranged between 0 and 80 CFU/100 ml. The average number of total coliform was 14 CFU/100 ml. Summer samples were found to have more total coliforms than winter ones. Neither winter nor summer samples were found to contain fecal coliforms. Residual chlorine ranged between 0.08-0.55 mg/L (average 0.24mg/L) and nitrate concentrations in drinking water samples ranged between 4.79-16.26 mg/L (average 9 mg/L). PCR results of the DNA extracted from a total of 25 samples of different origins (pipe water, tank water and biofilm swabs) revealed that 23 samples did not contain the microbes (bacteria and protozoa) considered in this study.

Our results show that the drinking water quality in the distribution system of Ramallah District is of good quality and intermittent water supply should be avoided when possible, as this was associated with an increase in total coliform and turbidity.

Key words: health risk, microbial growth, biofilms, water distribution systems.



Feasibility of Local Fixed Film Materials to Reclaim the Effluent of Waste Stabilization Ponds for Irrigated Agriculture

**Rashed Al-Sa'ed¹, Nidal Mahmoud¹, Maher Abu-Madi¹,
Omar Zimmo² and Abdel Rahman Tamimi³**

Abstract


This paper evaluates the feasibility of using local fixed film media in waste stabilization ponds to enhance their treatment efficacy. A pilot-scale algae-biofilter system (ABS) was investigated, in parallel with an algae-based control (ABP) over a 6-months period to evaluate the treatment efficacy of both systems. Each system entailed 4 equal ponds in series and was continuously fed with domestic wastewater from Birzeit University. The removal rates of organic matter, nutrients and fecal coliforms were monitored within each treatment system. The results obtained revealed that ABS was more efficient in the removal of organic matter (TSS and COD; 86% and 84% respectively) and fecal coliforms (4 log₁₀) than ABP (81%, 81%, 3 log₁₀ respectively). Nitrogen was reduced in the ABS to an average of 24 mg N/L; in contrast the effluent from the control ABP which contained 32 mg N/L. Passive aerated ABS system is thus an efficient, a low-cost and feasible land-saving option to algae-based ponds.

Key words: waste stabilization ponds, rural areas, domestic wastewater, algae-biofilter, rock filter, nitrification, removal efficacy, effluent reclamation and reuse.

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Water Resources Available to Towns and Villages of the Southern West Bank: Pollution and Contamination


Alfred Abed Rabbo¹

Abstract

Water provision for a selected group of towns and villages in the southern West Bank comes from the eastern basin of the Mountain Aquifer. Borehole extraction has been significantly increased since the turn of the millennium. However the lack of adequate wastewater treatment presents serious health and environmental hazards on the surface and in the subsurface karstic aquifer. Water supply for most urban areas and some rural communities is by means of a network supply. Those not included in these schemes may depend on spring discharge, rainfall collection in domestic cisterns and either public or private water tanker delivery. Analyses of samples from each of these sources over a twenty-year period indicate considerable cause for concern. During this time considerable improvements in supply and infrastructure have taken place. Nevertheless it is still the case that most Palestinians in the southern West Bank suffer water stress and the water.

Key words: water resources, pollution, cisterns, water quality.

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Effect of Gaza City Wastewater Treatment Plant on the Underground Aquifer (Chemical Quality)

Mohammed Abu-Jaball

Abstract


This research work was financially supported by the UNESCO/Flander FIT Project: "Capacity Building & Training on Environmental Training & Management Program for Palestinian People.

Six wells around the wastewater infiltration basins that recharge the groundwater near the Gaza City wastewater treatment plant was monitored monthly, from February to October 2005. Parameters monitored were: Nitrite; Nitrate; Detergents; TOM; TDS; and Chlorides. The study compared the results with the WHO standard for drinking purposes, comparison of results with other results of previous years, and comparison with well distance.

We found that the wells are seriously starting to be affected by the partially treated wastewater recharged wastewater. So, a quick remedial action must be taken to stop the groundwater contamination and the effluent wastewater quality must be improved. This improvement to be by improving the operation of the wastewater treatment plant, and integrating the plant to good operation, where it is overloaded. In the meantime, all the wells in the area of the wastewater infiltration basins must be stopped for drinking water purposes, and the people must be provided with good drinking water from another source.

Key words: wastewater, treatment plant, water quality, operation.

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The Occurrence of Trihalomethanes in Recreational Water in Tulkarm District, Palestine

Amer Marei¹ and Amer Kanan²


Abstract

An investigation into the occurrence of Trihalomethanes (THMs) (chloroform, bromodichloromethane, chlorodibromomethane, and bromoform) was conducted for the first time in swimming pools in Palestine. THMs, free chlorine and other water quality and operational parameters were monitored in six recreational water samples from six different swimming pools in Tulkarm City. The six swimming pools use groundwater for recreation. These swimming pools are poorly managed to meet the recommended standards either in water disinfection or in maintaining other chemical and physical water properties. Water samples from swimming pools for THMs analyses were collected in 40 mL brown vials. Pool water samples were obtained from the inside water body at depth not less than 30 cm, quenching reagent (Ascorbic acid) was used. Samples were preserved and transferred for THMs analysis within 14 days.

The pH of 50% of the swimming pools' water did not comply with this pH guideline for swimming pools. The free chlorine residual measured in Tulkarm swimming pools' waters did not achieve the recommended values in 50% of the pools. The EC of the water of some swimming pools was elevated compared to the groundwater that is used to fill the swimming


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pools. Total THMs measured in the samples from the pools ranged from 405.1 to 2853.2 $\mu\text{g/L}$. The average of the total trihalomethanes measured in the swimming pools in Tulkarm is 1452.5 $\mu\text{g/L}$. These values are very high compared to what has been reported in swimming pools waters in other different countries. Chloroform is the abundant trihalomethane and bromoform is the minor trihalomethane measured in five of the six pools tested. Also the water samples with higher EC measurements produced higher levels of trihalomethanes.

Key words: water quality, trihalomethanes, domestic and recreational water.



Assessment of the Spatial Distribution of Chlorine Concentration in Nablus Water Distribution System


Hasan Arafat¹, A. El-Hamouz¹, A. Abu-Safa¹ and M. Almasri²

Abstract

The water distribution network of the City of Nablus suffers from some drawbacks among which is the occurrence of contamination in specific pipelines. This very specific glitch is due to the intermittent pumping and the weariness in the network. As a remedy, chlorine is being added to the water at the different sources. However, due to the expansiveness of the network, the remoteness of the water sources, and the weariness in the network pipes and joints, chlorine concentrations were found to be way below the minimum allowable limits. This study investigates the disinfection problems that exist in the water network of Nablus. A composite database for the last 9 years (1996-2005) was created to facilitate the spatial and temporal assessment. Assessment of the current chlorination practice for a selected area within the Nablus drinking water network was carried out through development of a water network quality model using GIS technology and EPANET. The model simulates the water flow in pipes, the pressure at the supply nodes, and chlorine concentration distribution in pipes and nodes. Results of the analysis of the composite database showed that residual chlorine concentrations in many areas were low. This has led to the bacterial growth in these areas as indicated by total and fecal coliform readings. Model outcome showed that chlorine concentration varies from


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location to location in the network, which is in agreement with field observations. This model could then be used by the Municipality to determine the optimal chlorine dose in order that the chlorine concentration distribution across the network is within the acceptable limits.

Key words: water distribution systems, water quality, chlorine, pipe networks, disinfection.



Anaerobic Strong Sewage Treatment in a One-Stage UASB Reactor and a Combined UASB-Digester System

Nidal Mahmoud¹

Abstract

The treatment of high strength sewage was investigated in a one-stage upflow anaerobic sludge blanket (UASB) reactor and a UASB-Digester system. The one-stage UASB reactor was operated at a hydraulic retention time (HRT) of 10 hours and at ambient air temperature for a period of more than a year in order to assess the system response to seasonal temperature fluctuation. The one stage UASB-reactor was modified to a UASB-digester system after a year of operation by incorporating a digester operated at 35 °C. The UASB-Digester system provided significantly higher COD removal efficiencies than the one-stage UASB reactor. The achieved removal efficiencies in the one-stage UASB reactor for total, suspended, colloidal, dissolved and VFA COD were 54, 71, 34 and 23 %, and -7 %, respectively during the first warm six months of the year, and achieved only 32% removal efficiency for COD total over the other cold six months of the year. The modification of the one stage UASB reactor to a UASB-digester system had remarkably improved the UASB reactor performance as the UASB-digester achieved removal efficiencies for total, suspended, colloidal, dissolved and VFA COD of 72, 74, 74, 62 and 70%. Therefore, the anaerobic treatment of high strength sewage with fluctuating temperature over the year like the case in Palestine in a UASB-Digester system is very promising.

Key words: anaerobic treatment; low temperature; one-stage UASB; sewage; suspended solids; UASB-Digester.

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Using Socioeconomic Indicators for Setting Water Tariff System in Palestine

Abdel Rahman Tamimi¹

Abstract


The instability and fluctuations of political conditions will only lead to a changing socio-economic environment which will affect the efficiency and effectiveness of the organizational management in any country.

The study of the water sector in Palestine which lacks the organizational expertise on one hand and the constant changing social and economic conditions on the other hand led to performance which was paralytic and caused a weakening of local governance. For this reason, a study was carried out of the Tariff Structure taking into consideration socio-economic indicators (in particular the poverty indicator which is the most crucial factor to measure the World Poverty Index (WPI) as an indicator) reflecting better management of resources, water access and services which could help in formulating a Flexible Water Tariff Structure.

The paper also highlights the possible scenarios in which different solutions and conclusions were drawn regarding the creating of a system compatible with political, economic and social conditions, in addition to enhancing performance of water utilities.

Key words: social fairness, water tariff, water poverty index, water pricing.

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Socio-Economic Assessment of Graywater Treatment Systems in Western Ramallah

**Maher Abu-Madi¹, Rashed Al-Sa'ed¹,
Nidal Mahmoud¹ and Jamal Burnat²**


Abstract

The Palestinian rural and peri-urban communities represent more than 60% of the total population. Those communities still lack appropriate management of their wastewater. Most of the rural households are internally equipped with proper sanitation facilities. The problem is mainly about the way of discharging wastewater. Traditionally, each household has a cesspit for collection of excreta that often percolates into the surrounding soil. This is certainly a daunting disposal system since it jeopardizes the already scarce groundwater resources. Besides, when the surrounding soil becomes saturated, these cesspits require frequent emptying by private tankers. Cesspit emptying, on one hand, is a very costly and disturbing, and on the other hand causes environmental pollution. When cesspits are filled, a bad smell is spread all over the neighborhood. The bad smell is even more at the time of cesspit emptying, thus causing more complaints from neighbors. The tankers that empty the cesspits do not follow rules and regulations and discharge the septage within the surroundings of the communities, especially in the agricultural and open fields. This causes point pollution to groundwater and the environment.

Several non-governmental organizations that promote onsite sanitation strategies for rural communities gave special concern for separation of

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black and gray wastewater and utilizing treated graywater in irrigated agriculture, especially at garden level. However, the implementation of such sanitation systems is yet limited to availability of external funding, and to-date the Palestinian rural and peri-urban communities have not reached a stage where they replicate such systems.

This paper studies the economic feasibility of existing graywater systems in Western Ramallah as well as the public perceptions towards them. For this purpose, the researchers surveyed about 30 households that use graywater systems as well as 100 households that use traditional systems for wastewater disposal (cesspits). The results revealed feasibility of graywater systems against cesspits as well as significant cost differences between both systems. The survey results show that the average costs of constructing graywater treatment systems and cesspits at household level are about 180 US\$/person and 250 US\$/person, respectively. The operational costs of graywater systems and traditional cesspits are 10 US\$/person/year and 25 US\$/person/year, respectively. The study revealed that the average share of sanitation expenditure as percentage of households' income is about 0.5% and 2.3% in the cases of GWTS and cesspits, respectively. The household survey results also revealed that 72% of the households are willing to implement graywater treatment systems with external funding against 17% with own funding. The major two reasons behind public rejection to have self-funded graywater treatment and reuse systems at their households are: (i) 54% refuse to restructure the internal piping systems in order to separate black and graywater, (ii) 33% refuse to use the treated effluent for garden irrigation, and (iii) 17% can not afford the high construction costs. The study also shows that households with graywater treatment systems consume less water (average 4.2 US\$/person/month) than those with cesspits (average 7.2 US\$/person/month).

Key words: costs; benefits; household; graywater; perceptions; Palestine.



GWWTP System as Effective Tool for Water Management at Household Level at Household Level in Palestinian Rural Areas


Jamal Burnat¹

Abstract

Wastewater in the West Bank / Palestine is mostly disposed of in cesspits where it infiltrates into the surrounding soil. A few cases use settling tanks that let the solids settle before the wastewater infiltrates into the soil in order to minimize soil clogging. On-site wastewater management systems are very popular as only 30% of the population in the West Bank is served with sewerage networks. All rural communities and the outskirts of the cities rely on cesspits as on-site disposal systems. Cesspits include settling of wastewater, anaerobic digestion of sludge and percolation of liquid into the ground, but the functioning of these systems usually fails after some time. The content has to be removed frequently from the filled cesspits and is currently disposed of into either nearby open areas, wadis or existing treatment plants.

Gray wastewater is produced and recovered from the actions of using sinks, showers, kitchen and washing machine. Black wastewater is produced by the toilets. The gray wastewater contribution to daily household total wastewater (Gray+Black) production can reach 80%. This amount of wastewater when being properly treated can be reused for agriculture resulting in saving fresh drinking water and reducing the desludging frequency of the cesspits. Gray wastewater treatment system

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(GWWTP) which is Septic Tank - Upflow Gravel Filter followed by aerobic filter, has been implemented through ACDIVOCA funding to the Qebia Women Cooperative (QWC). At least 48 households with 7 to 20 inhabitants in each house in Qebia village/Ramallah district were provided with a GWWTP system in year 2005 -2006.

Fresh gray wastewater in Qebia village is found to be heavily polluted with bio-degradable matter (COD 1391 – 2405 mg/l) that should be treated before being reused in the home garden for food production. The installed treatment system reached a high efficiency even at the start up period producing water with (COD 58 – 266 mg/l) which meets WHO standards to be friendly to environment, soil and air. Fecal Coliforms are reduced from 1×10^4 - 37×10^4 cfu/100ml in the fresh gray wastewater to Zero- 1×10^2 in the treated gray wastewater which was reflected positively on public health.

Benefited families reduced their spending on water bills and wastewater disposal, increased the planted land around their houses, decreased the health hazards from flooding cesspits, and reduced the time needed for water and wastewater management at their houses which is mostly done by women.

The practiced technology is low cost and experience and materials are locally available, no need for skilled personnel to operate and maintain their system. Operation, maintenance and energy consumption is at a very low cost (USD 20 per year), and the effluent meets the WHO and Palestinian reuse standards.

Key words: household water management, gray wastewater, environment, low cost technology, rural households, reuse, food production, socio-economic.




Analysis of Socio-Economic Impacts of Wastewater Reuse in Gaza Strip

Jamal Aldadah¹

Abstract


Gaza Strip is suffering from severe water crisis quantitatively and qualitatively. Furthermore, the wastewater sector in the Gaza Strip (GS) is characterized with poor sanitation, insufficient treatment of wastewater, unsafe disposal of untreated or partially treated water. There is no comprehensive pricing policy or prices for water or wastewater reuse in the Palestinian Territories. In addition, reliable financial structure with cost recovery mechanisms and incentives for farmers to use the treated wastewater is lacking in the GS. The aquifer in Gaza Strip is continuously over-pumped and the gap between water demand and water supply increases. The future of water balance in the area will depend upon the portion of effluent reused in irrigation and to recharge the aquifer. Reconciliation relies in the strategy of ensuring additional water supply and wastewater reuse schemes. The reuse of treated wastewater effluents represents a national interest and it is considered an important component of the overall maximization of water resources. Reuse of treated wastewater in irrigation is considered a priority in the Gaza Strip due to a number of factors including the depletion of groundwater resources and the fact that reuse would increase the availability of freshwater resources for domestic and industrial use. A safe and feasible wastewater reuse scheme is a prerequisite to progressively inaugurate large scale projects due to the social, religious and economical aspects. It is concluded that in Gaza Strip, in case of achieving high degree of effluent reuse quality, all the indicators of using treated wastewater emphasize the tendency towards significant benefits, including reduction in groundwater abstraction for irrigation, potential to irrigate areas currently

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rained and increase the crop production economically, fertilizer saving, in addition to activating the job creation programs. Secondary and tertiary treated wastewater is being used successfully in the neighboring countries for irrigation of field crops, landscape and other applications. However, the use of treated wastewater for irrigation is subject to major concerns because of the probable escalating of hygienic, social and environmental problems. The obvious challenge faced by policymakers at present, is how best to minimize the negative effects of wastewater use, while at the same time obtain the maximum benefits from this resource. A comprehensive evaluation of the benefits and costs of these impacts has been explored and investigated through the feasibility studies and questionnaires conducted lately in Gaza Center and the southern area. The paper presents an approach for analyzing specifically the impacts of water and effluent quality, socioeconomic, and environmental aspects of urban wastewater use for irrigation purposes in Gaza Strip.

Key words: Wastewaters reuse, socio-economic, agriculture, irrigation, benefits, groundwater.



Water Ethics as a Tool for Sustainable Water Resources Management in the Arab Region

Magdy Hefny¹

Abstract


This paper examines water use ethics as a tool for sustainable water resources management. The central question is how we can apply new tools and techniques to promote water ethics based on participation of relevant stakeholders in decision making, knowledge and experience transfer among water institutions and organization, and through benchmarking and bench-learning of best practices.

The approach is cultural, that is propagating social learning and have “bottom-up” education and communication functions, as well as “top down” high level applied research aspects with industry and technology participation. Action research is introduced as a method of work in policy-making.

The approach is also based on holistic and comprehensive systemic analysis. This is dependent on examining relationships among different components of the system of water resource management. Such an endeavor requires the choice of appropriate strategies for an integrated system. The systems metaphor also embraces the mental model scientists hold about crucial system properties, such as controllability and predictability. Any strategy must start from an analysis of the coupled “environment-technology-human” system and aim at an improved design (Pahl-Wostl, 2002).

Designing a strategy for actualizing water use ethics in the Arab region

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needs to draw upon the work of UNESCO's COMESTi Sub-Commission on water ethics reports and recommendations. It is timely to give due consideration to these reports and initiate a process to benefit from such important work. COMEST work brought about questions and issues that range from conceptualizing and building a framework for localizing regionally the "Global Freshwater Guidelines" to issues of capacity building, processes of social learning through better participation of different water research centers, education, water suppliers, water regulators, industrial and agricultural users, and organizations concerned with information and exchange and dissemination (Lord Selborne, 2003).

In this regard, this paper addresses four main issues as follows:


First: Defining issues in their relationships and elaborating on concepts of ethics, normative behavior, social responsibility and water ethics. It further, links the concept of integrated water resources management to that of sustainable development.

Second: A proposed cultural approach to actualize Water Ethics by relating water and culture and elaborating on water ethics in religions.

Third: Drawing on COMEST work on water ethics and outlining the ethical principles of water use and management.

Fourth: Highlighting the experience gained in the last three years through the establishment of the "Regional Center for Studies and Research of Water Ethics in Cairo", for propagating and actualizing water ethics locally and regionally; and reflecting on the proposed elements of a strategy for actualizing water ethics in the Arab region.

Key words: water ethics, its relation to law, social responsibility, water and culture, water crisis, knowledge transfer , code of conduct ,best practices, networking, awareness building, social learning, participation.



Potential Mechanisms for Resolution of the Water Conflict between Palestinians and Israelis

Jad Isaac¹ and Hilmi Salem²

Abstract

Water, in particular, is a sensitive and critical issue for all parties involved in the Middle-East conflict. Thus, water has been a major issue that should catalyze the peace process or could inhibit it. Resolving the water conflict between the Palestinians and Israelis, as outlined in this study, is of paramount importance, which is due to the following reasons: 1) It will introduce, for the first time in the region's history, an integrated water management's scheme that, if adopted, will certainly be of great value for resolving the water conflict among all the parties involved in the conflict, including Syria, Lebanon, Jordan, Israel, and the Palestinian people, representing the future State of Palestine. 2) For politicians, it would lessen the chances of conflict; for industrialists and agriculturalists, it would foster stable growth; and for citizens, it would result in guaranteed regular supplies of household water. In this study, the Palestinian-Israeli water conflict is addressed, and mechanisms for resolving it are proposed.

Key words: Transboundary waters, conflict resolution, regulations, water rights.

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