

# **Proceedig of Abstracts**

**EMWater Project Regional Conference 2006**

**“Efficient Management of Wastewater,  
it’s Treatment and Reuse  
in Mediterranean Countries”**

**Amman- Jordan  
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## **Introduction**

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Wastewater reuse is one of the options that all countries in the MEDA region need to deal with to overcome their future water shortages and to secure the increasing water supply demands for their population. Countries like Jordan and Palestine will have in the year 2020 less than 150 CM/p.a. renewable water resources, an amount that is far below the critical amount of 1000 CM /p.a. recommended by the WHO as a minimum for each human being. Such critical situation will face most MEDA countries in the near future.

The largest overwhelming consumer of water across the region is Agriculture (accounting for 66% of demand) and the water crisis should be objectively analysed and adequately addressed through the consideration of agricultural activities. For example an approximate 10% transfer of water away from agriculture would produce a 40% increase in the domestic water supply in Jordan.

To overcome this situation all countries in the region need to establish a sustainable national water strategy that should take all aspects of wastewater reuse and integrated water resources management, seriously in consideration.

Since 2003 the EMWater project with 8 partners from Jordan, Palestine, Lebanon and Turkey and the EU countries Germany and Italy is working hard to elaborate policy guide lines for an efficient management of wastewater treatment and reuse through different activities. Like the conduction of capacity building and public awareness programs for stake holders in the region, and the construction of wastewater treatment pilot plants for research and demonstration purposes.

This regional conference that we are attending these days here in Jordan is an essential part of EMWater project activities; more than 130 participants within them 60 paper presenters from the region are joining this conference and sharing their experience in the field of wastewater treatment and reuse.

We are sure that through the paper presentations, and discussion between all water experts who are attending this conference in these two days a better understanding for the improvement in the situation of wastewater reuse management, will be achieved.

We hope also that all participants coming from abroad will enjoy their stay in such very interesting country like Jordan.

**Dr. Ismail Al Baz**  
**Project Director**  
**EMWater Project**  
**Amman, Jordan**  
**InWEnt, Capacity Building**  
**International, Germany**

**Prof. Dr. Nadhir Al Ansari**  
**Project Manager**  
**Al al Bayt University**  
**Al Mafraq, Jordan**

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## Grey Water Treatment in UASB Reactor at Ambient temperature

Tarek A. Elmitwalli\*, Moataz Shalabi\*\*, Claudia Wendland\*\* and Ralf Otterpohl\*\*

\* Department of Civil Engineering, Benha High Institute of Technology, P.O. Box 13512, Benha El-Gedida, Benha, Egypt (E-mail: t\_elmitwalli@yahoo.com)

\*\* Institute of Wastewater Management and Water Protection, Hamburg University of Technology, Eissendorfer Strasse 42, D-21073 Hamburg, Germany  
(E-mail: moataz.shalabi@tuhh.de; c.wendland@tuhh.de; otterpohl@tuhh.de)

### Abstract

In this paper, the feasibility of grey water treatment in a UASB reactor was investigated. The batch recirculation experiments showed that a maximum total-COD removal of 79 % can be obtained in grey-water treatment in the UASB reactor. The continuous operational results of UASB reactor treating grey water at different hydraulic retention time (HRT) of 20, 12 and 8 hours at ambient temperature (14-24oC) showed that 31-41 % of total COD was removed. These results were significantly higher than that achieved by a septic tank (11-14 %), the most common system for grey water pre-treatment, at HRT of 2-3 days. The relatively lower removal of total COD in UASB reactor was mainly due to a higher amount of colloidal COD in the grey water, as compared to that reported in domestic wastewater. The grey water had a limited amount of nitrogen, which was mainly in particulate form (80-90%). The UASB reactor removed 24-36 % and 10-24 % of total nitrogen and total phosphorous, respectively, in the grey water, due to particulate nutrients removal by physical entrapment and sedimentation. The sludge characteristics of the UASB reactor showed that the system had stable performance and the recommended HRT for the reactor is 12 hours.

### Keywords

Anaerobic digestion; domestic wastewater; ecological sanitation; grey water; UASB reactor

## High-Rate Anaerobic Treatment Followed by Constructed Wetland and UV Radiation as an Appropriate Wastewater Treatment for Mediterranean Countries

Claudia Wendland\*, Joachim Behrendt\*, Tarek A. Elmitwalli\*, Ismail Al Baz\*\*, Göksel Akcin\*\*\*, Gürdal Kanat\*\*\*, Öznur Alp\* and Ralf Otterpohl\*

\*Institute of Wastewater Management, Hamburg University of Technology (TUHH), Germany

\*\* InWent Capacity Building International, Amman, Jordan

\*\*\* Yildiz Technical University, Istanbul, Turkey

### Abstract

This paper describes a new wastewater treatment concept which was assessed to be technically and economically feasible for suburban and rural areas in Mediterranean countries. The treatment consists of a two-step anaerobic high-rate reactor like UASB reactor followed by vertical flow constructed wetland (CW) and UV radiation. It fulfills the defined criteria, as meeting the standards for water reuse, costs especially for energy are low, sewage sludge production is limited and operation and maintenance are simple. Although there are much experience and data available about design and operation of CW and UV radiation, the knowledge about anaerobic treatment of municipal wastewater in UASB reactor at moderate temperature is limited. Therefore bench-scale experiments with pre-settled high-strength municipal wastewater were carried out in a one step UASB reactor of 55 liters. The results show a satisfactory effluent quality at fluctuating HRT. During 9 months of continuous operation, total COD removal was 46% and 60% with HRT of 8 to 16 hours and more than 24 hours, respectively. Below an HRT of 24 hours, the removal of suspended solids was limited; sludge wash-out took place due to fluctuating HRT. The removal of colloidal COD was satisfying with around 60% for all HRT. These results indicate that combined with a second high rate anaerobic reactor and/or a settler after the UASB reactor, constructed wetland and UV radiation, an adequate tertiary effluent for water reuse in irrigation will be achieved.



## **Integrated Anaerobic- Aerobic Treatment of Concentrated Sewage, Getting Out of the Dilemma**

Halalsheh, M.

Water and environmental research and study Centre- University of Jordan, Amman-Jordan. Tel. +96265355000  
ext. 2332; E-mail: Halalshe@ju.edu.jo

### **Abstract**

Jordan is considered one of the most water scarce countries in the world and is continuously searching for new water resources. Due to limited per capita share of fresh water (<100 L/c.d), concentrated sewage is produced with average total COD of 1500 mg/l. The concentrated sewage exerts high energy demand for aeration on the existing conventional activated sludge treatment systems. It can be calculated that aeration requirements needed for treating certain flow of concentrated sewage are three times higher than those needed for treating the same wastewater flow produced in other countries of the world. Moreover, much higher excess sludge is produced, which presents extra operational costs. The resulting dilemma should be managed by considering sustainable options for concentrated sewage treatment. Anaerobic-aerobic treatment of sewage is so far recognized as the most sustainable and cost effective available option. The present article shows that anaerobic pre-treatment in Jordan will reduce energy costs needed for operating wastewater treatment plants and that energy produced by anaerobic processes is surplus of aeration needs for activated sludge post treatment system. Moreover, 40% reduction in the total amount of excess sludge production can be obtained. Keywords Concentrated sewage, anaerobic pre-treatment, UASB reactor, Anaerobic filter, conventional treatment

## The Concept and the Model of the Household Wastewater Reuse System in Urban Area

Y. Feng\*, R. Otterpohl\*\*, K. Wichmann\*

\* Institute of Water Resources and Water Supply, Hamburg University of Technology, Schwarzenberg Str. 95, D-21073 Hamburg, Germany (E-mail: yucheng.feng@tu-harburg.de)

\*\* Institute of Wastewater Management and Water Protection, Hamburg University of Technology, Eissendorfer Str. 42, D-21073 Hamburg, Germany

### Abstract

As a general concept, wastewater reuse can be applied to many different domains, This paper focuses on the household wastewater reuse system (HWWRS) in urban area. The system is analyzed along the common household water using process. The water consumption standards are treated as Water Utilization Patterns according to its relation to the water devices. Four types of water users are categorized which fall into two groups, i.e. indoor users and outdoor users. Three kinds of water quality are identified corresponding to the requirements of users. As normal, the household wastewater is classified into Greywater and Blackwater. Afterwards, three HWWRS are identified: centralized, de-centralized and semi-centralized systems. Subsequently, the basic components of HWWRS, i.e. treatment units and pipe systems, are analyzed. Especially regarding in-situ wastewater treatment facilities (WWTF), two treatment procedures are founded for Greywater and Blackwater, respectively. Then a decision support model for investigating HWWRS is introduced. The model tries to perform as a general platform, so that different types and possibilities of HWWRS can be tested. Being a decision support tool serving the project at its early stage, the model includes no specific treatment techniques. For the same reason, the model evaluates the HWWRS from two aspects: economic assessment and energy consumption. The model offers the function to measure the reuse system either by population or by total water amount. Consequently, the different wastewater reuse ratios are tested in order to find out the optimized point. The model will help the engineers work out the optimized solutions of HWWRS, and provide the convincing options for decision makers.

## **Sustainable Sanitation by Constructed Wetlands in the Mediterranean Countries: Experiences in Small/Medium Size Communities and Tourism Facilities**

Masi Fabio <sup>a</sup>, Conte Giulio<sup>a</sup>, Martinuzzi Nicola<sup>b</sup>

a-Ambiente e Lavoro Toscana ONLUS , via Pier Capponi 9, Florence, 50132, Italy (masi@altnet.it; conte@altnet.it)

b- IRIDRA Srl, Via Lorenzo il Magnifico 70, Florence, 50129, Italy (martinuzzi@iridra.com)

### **Introduction**

Constructed wetlands (CWs) have been adopted by several small/medium size communities as a cost-effective mean of secondary and tertiary wastewater treatment, in order to meet more stringent standards and to lower operating costs. Some small systems have now been in existence for nearly 15 years, while wetland treatment systems for larger towns and small cities have become a more recent trend. As tertiary treatment, CWs have been realised even for several thousand p.e. (some experiences in the order of hundred thousand).

Just to talk about the Mediterranean basin, very successful experiences with Constructed Wetlands have been reported for France (Molle, 2004), Spain (Garcia, 2004), Portugal (Matos, 2002), Morocco (Mandi, 1996), Italy (Conte, 2001; Masi, 2000), Egypt (Awad, 2001; Higgins, 2001), Israel (Brenner, 2002), Slovenia (Bulc, 2003), Croatia (Shalabi, 2004), Greece (Papadopoulos, 2002), Turkey (Yildiz, 2004).

### **Results and Discussion**

The main general conclusion produced by the study of the cited papers is that CWs are surely an efficient wastewater treatment method in the Mediterranean climate and their application for any kind of water pollution problem has to be strictly linked to the treatment scheme choice and the sizing process. The operating experiences generally show a high rate of efficiency in the removal of organic content (BOD, COD), Nitrogen (N<sub>tot</sub>, NH<sub>4</sub><sup>+</sup>, NO<sub>3</sub><sup>-</sup>), Suspended Solids (TSS) and Pathogens (EC, FC, TC), both in secondary and tertiary treatment plants.

Table 1. General performances of Constructed Wetlands systems in the Mediterranean countries (range of removal percentages)

Kind of CW	Organic Content	Nitrogen	Organic Content	Ammonia	Total Solids	Pathogens
HF	73-99	18-76	73-99	18-76	59-96	94-99.999
VF	52-95	-----	52-95	78-99	48-98	96-99.9
FWS	11-63	21-76	11-63	15-82	36-67	90-99.999
Hybrid Systems	86-99	43-89	86-99	85-96	72-84	98-99.9995
VF raw						
WW	82-99.7	66-98	82-99.7	85	95-99.9	-----

Designs are often adapted to take account of different site characteristics, treatment goals and secondary benefits such as the reuse of the treated wastewater or the provision of wildlife habitat. Surface-flow wetlands are increasingly being favoured as tertiary treatment, because of their cheaper investment costs and their higher wildlife habitat values. Subsurface-flow wetlands, however, tend to be more widely applied, due to their effectiveness at filtering out solids and removing BOD per unit land area.

### Conclusions

The use of septic tanks and secondary treatment subsurface CWs for small populations is set to increase sharply in the Mediterranean countries. The use of hybrid designs incorporating both surface and subsurface-flow sections is now becoming more common, as well as the powerful combination of vertical and horizontal subsurface flow systems. Also the treatment of raw wastewater by CWs, without a primary treatment, as suggested by the French experiences, looks very promising for the next future.

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## The Response of Chickpea Cultivars to Irrigation with Treated Wastewater

M. Haddad \*\*, M. Khamis\* A, M. Dakiky \*, A. Manassra \* and M. Qurie \*

\*Faculty of Science & Technology, Al-Quds University, P.O.B. 20002 East Jerusalem, Palestine

\*\*An Najah National University, Nablus, Palestine

E-mail:khamis@planet.edu

### Abstract

In a three years study the response of four cultivars of chickpea, Bulgarit, WIR-32, Jordan and ICC 11293 to irrigation with treated wastewater (TW) and freshwater (FW), using surface and subsurface drip irrigation was investigated. The results indicate cultivars Bulgarit and ICC 11293 can be irrigated with TW without any loss in yield. Factor analysis reasonably favored Bulgarit Cultivar irrigated with treated effluent over other cultivars. WIR-32 and Jordan cultivars showed significant reduction in their growth parameters when irrigated with TW as compared with FW. Surface and subsurface drip irrigation gave similar results in most cases. Soil analysis in this study showed no significant difference between irrigation with TW and FW.

## Chemical Oxidation Approach for Treatment of Olive Mill Wastewater

Bassim Abbassi

Al-Balqa' Applied University  
19117 Al Salt, Jordan  
babbassi@bau.edu.jo

### Abstract

Olive oil industry represents a fundamental economic importance for many Mediterranean countries. However, olive oil extraction involves an intensive consumption of water and produce large amount of olive mill wastewater (OMW), which is partly a liquid fraction of olive juice and the water used during the different phases of olive mill processing. Different research works were conducted in order to treat the OMW to alleviate the negative impact on the environment. Most of these works dealt with biochemical oxidation of organic content of OMW, while very few proposed the chemical oxidation approach. This research work aimed to study the potential of chemical oxidation of OMW using different compounds such as lime, potassium permanganate, hypochlorite, hydrogen peroxide, and Fenton reagent. The oxidation potential of these compounds were tested using a batch reaction principle at different concentrations and contact times. Chemical oxygen demand (COD) was used as an indicator for the organic content of OMW. The results showed that chemical oxidation is an effective mean of treatment of high concentrated wastewater such as OMW. At a high lime: COD ratio of 1:7, 97% COD removal efficiency was achieved. COD removal of about 90% was obtained at  $\text{KMnO}_4$ : COD ratio of 1:25. Using Fenton reaction, more than 98 % of COD removal was observed at contact time of about 2 hrs. Oxidation power was increased as the temperature of the Fenton reagent was slightly elevated. The lowest COD removal was observed using the sodium hypochlorite. In sight of these results and the short required contact time, chemical oxidation has been proven to be an economical-effective alternative to the conventional biological treatment.

## Integrated On-Site Greywater Management for Rural Jordanian Areas

W. Suleiman, B. Hayek, M. Assayed and S. Dalahmeh

Environmental Research Center, Royal Scientific Society, P.O.Box: 1438, 11941, Amman, Jordan  
wael@rss.gov.jo, b.hayek@rss.gov.jo, asthma@rss.gov.jo, moayed1948@yahoo.com

### Abstract

This paper presents interim results of an on-going research project investigating, in close consultation and with active participation of the community, the feasibility of adopting non-conventional greywater management policies for rural-small communities in the Northeastern Badia of Jordan where inhabitants live in 33 small clusters. About two-third of the community indigenously separate greywater from blackwater, greywater is being used for irrigation in an uncontrolled manner and without any treatment. A local stakeholder committee LSC was formed that comprises community members and officials. Several field visits were conducted for the LSC and other community representatives to wastewater/greywater treatment and reuse projects. The LSC was engaged in a training workshop on public participation concepts, participatory rapid appraisal PRA tools and methodologies. Relevant social, economical and environmental data and information was collected utilizing PRA tools as well as formal surveys. One of the clusters (Rawdhat Al-Ameer Ali) was identified as the research site based on specific criteria set by the research team and the LSC. Greywater quality and quantities generated from different fixtures of six households at the research site were investigated. Generation rates ranged (12.0-19.0 Liter/Capita/Day) with an average of (150-200 Liter/Family/Day), of which (50%) generates from the kitchen sink. Organic content, total suspended solids, oil and grease and detergents concentrations were relatively high. In addition, Escherichia coliform (E.coli) levels were also higher than expected. Different cost-effective and technologically-sound alternatives were assessed taking into consideration potential reuse opportunities. Two different treatment options were considered; septic tank followed by intermittent sand filter; and up-flow anaerobic sludge blanket UASB. Two pilot plants were designed, installed and operated in two households at the research site. The septic tank-sand filter system indicated high performance in removing organic and solids contents (BOD5 and TSS removal of 88% and 91% with effluent concentrations of 135 mg/l and 55 mg/l respectively). In addition, E.coli counts were drastically reduced by two logs to levels below (1000 MPN/100 ml). The UASB system showed relatively lower performance (BOD5 and TSS removal of 67% and 73% with effluent concentrations of 305 mg/l and 142 mg/l respectively).



## **Disinfection of Enteric Bacterial Pathogens and Indicators in Biosolids Using Solar Drying in Semi-arid Climates**

N.D. Al-Hmoud \*, S.A. O'Shaughnessy \*\*, W.T. Suleiman\*, G.P. Gerba \*\*\*and C.Y. Choi\*\*

\* Water Quality Studies Division, Environmental Research Center, The Royal Scientific Society, Amman, Jordan.  
(E-mail: nisreen@rss.gov.jo; wael@rss.gov.jo)

\*\* Department of Agricultural & Biosystems Engineering, The University of Arizona, Tucson, AZ 85721, U.S.A.  
(E-mail: soshaughnessy@cprl.ars.usda.gov; cchoi@arizona.edu)

\*\*\* Department of Soil, Water, Environmental Sciences, The University of Arizona, Tucson, AZ 85721, U.S.A. (E-mail: gerba@Ag.arizona.edu)

### **Abstract**

This study focuses on the use of solar drying to reduce the density level of enteric pathogens and indicators in biosolids. Seasonal solar drying studies were conducted in Wadi Hassan/Jordan by studying the die-off patterns of *Salmonella* spp. and fecal coliforms in biosolids. Two experiments were conducted in Wadi Hassan during warm dry periods and one was completed during a cold wet period. Class A criteria for fecal coliforms were met in roughly 20 days for both experiments performed in summer 2004 and spring 2005. *Salmonella* spp. densities dropped below Class A levels on Day 14 and on Day 19 in summer 2004 and in spring 2005, respectively. The probability of infection from ingesting one gram of biosolids is reduced from 89.9% (summer 2004) and 97.7% (spring 2005) at day 0 to 0.56% after solar drying to Class A levels for *Salmonella*. During winter season, the colder temperatures, high relative humidity and rainfall events prevented the biosolids from reaching Class A levels. Solar drying is a feasible method of disinfecting biosolids; however, it is recommended that disinfection by this method be achieved during the warm arid periods, while the biosolids be dried in beds and stored onsite during the cold wetter months.

## Evaluation of Treatment Performance of the Extended Aeration System at Al-Bireh-Palestine

Zimmo O.R.\*, Abu-Sara I.H., Abu-Hamdeh, S.K. and Hujaij S. D.

\*Department of Civil Engineering, Birzeit University, P.O.Box 14, West Bank, Palestine

### Abstract

This paper evaluates the performance of the extended aeration system at Al-Bireh-Palestine since its establishment in the year 2000. The treatment plant was designed to serve 100,000 population equivalents at two phases. The first phase is to serve 50,000 capita and the second phase will serve another 50,000 capita. The plant had been funded by the German government with a total capital cost of 6.745 million US Dollars.

The treatment plant was designed to treat high strength wastewater. COD, BOD<sub>5</sub>, TSS, TKN and TP are 1044, 522, 554, 73, 44 mg/l, respectively and treatment plant was designed to achieve effluent standards (BOD<sub>5</sub>/TSS) of 20/30. Biological parameters were measured for 466 days and physical tests were for 1400 days. Based on the results, Al-Bireh wastewater treatment plant works within a sufficient efficiency level, COD removal efficiencies were between 89-94% with an average of 91%. BOD<sub>5</sub> removal efficiencies were between 96-99% with average value of 97%. TSS removal was almost 99%. Nitrogen removal efficiencies were between 65-89% with an average of 73%. PO<sub>4</sub>-P removal efficiencies were between 41-52% with an average of 47%.

Units of the plant were designed to accommodate the design period. The results from redesigning showed that some units were over designed which means that extra capital and operational costs are involved. The size of the facilities is a very important parameter to be checked several times before construction due to the pre mentioned reasons.

The effect of operational parameters on treatment performance has been studied. The main parameter affecting the efficiency of the plant is the transition periods from summer to winter and vice versa. In spite of these transition periods the efficiency was within an acceptable range, especially the COD effluent concentrations which were affected from April to May 2001 and from February to April 2003. Actions were suggested in order to keep the treatment plant working at the desired efficiency with a minimum operational and maintenance cost.

### Key words

Wastewater, performance, operational parameters, Al-Bireh

## Development of Selection Criteria for Rural Wastewater Treatments Using a Geographic Information System: Case study in Tunisia

S. Chairat Benabdallah\*; Z. Lili Chabaane\*\*; W. Béjaoui\*\*

\* CERTE, Centre for Waters Research and Technologies, Route Touristique de Soliman. BP 95 - 2050 Hammam

Lif - Borj Cédria; (E-mail: sihem.benabdallah@inrst.rnrt.tn)

\*\* INAT / D-GREF, 43 Av Charles Nicolle. 1082 Tunis – Tunisie

### Abstract

To consolidate the infrastructure already installed, the Tunisian national strategy for sanitation aims primarily at reaching a rate of 87% for sewage network connection, a number of 97 treatment plants for urban communities and implementing a national plan for rural regions sanitation providing services for medium and small groups of dwellings. This plan identified 300 localities with 40 urgent areas. The conventional design approach of collective wastewater plants adopted in urban environment can not be possible for rural regions given the dispersion of the rural population, the design difficulties to layout sewage networks, the lack of legislation concerning the maintenance of these small structures. However, efforts are deployed to explore alternatives technologies with lower costs and more adapted to the local and socio-economic context of the rural Tunisia. Within this perspective, this paper presents decision flowcharts based on spatial analysis within geographic information system to help engineers and managers identify the most appropriate designs in rural areas. The methodology is developed after extensive discussions with current managers and with the beneficiary population. Others criteria were determined from the literature and technical reports. The approach was applied to the catchment of Wadi Hlima, an agricultural area covering 87 km<sup>2</sup> to determine the most appropriate treatment for ten rural localities.

## Concepts for Integrated Water and Sludge Management for the Gaza Strip

N. Ghbn\*, J.E. Hall\*\*, K. Brooke\*\*\* and R. Bufler\*\*\*\*

\* KfW/ CMWU PMU Director, Gaza Strip (E-mail: ghbn98@hotmail.com)

\*\* Independent Consultant, Bryn Cottage, HP27 0PY, UK (E-mail: sludge.hall@virgin.net)

\*\*\* Dorsch Consult Wasser und Umwelt, P.O. Box 31-11431, Maadi, Cairo, Egypt (E-mail:  
keith.brooke@dorscheg.com)

\*\*\*\* Dorsch Consult Wasser und Umwelt, Hansastraße 20, D-80686 Munich, Germany (E-mail:  
ralf.bufler.dorsch.de)

### Abstract

The Gaza Strip suffers severe constraints in water supply and sanitation due to its location, confinement, high population density, semi-arid coastal climate as well as specific political boundary conditions. The high rate of population growth is putting the limited water resources, water supply, sanitation and agriculture infrastructure under severe and increasing stress resulting in groundwater depletion, degradation of water quality and reduced crop productivity. Many previous studies have highlighted that the improvement of the management of the water sector is mandatory in order to improve public health and hence make sustainable development of the area possible. In order to answer part of the pressing problems, three regional wastewater treatment plants are planned that will incorporate effluent and sludge reuse. The most advanced of these is the Gaza Central Wastewater project funded by the German Government through the KfW Development Bank in collaboration with the Palestine Water Authority (PWA) and the Coastal Municipalities Water Utility (CMWU) to treat and reuse 60% of wastewater flows in the Gaza Strip. This paper describes the project and its planned impact on the water management situation as well as recommendations for the reuse of treated effluent and sludge, which should provide the framework for reuse planning throughout the Gaza Strip.

## Effect of Depth on the Performance of Algae-Based Wastewater Treatment Ponds

Ashraf A. Isayed<sup>a</sup> and Omar R. Zimmo<sup>b</sup>

a: Palestinian Hydrology Group (PHG), P.O. Box 565, Al-Ma'ahed St., Ramallah / Palestine, E-mail  
ashraf@phg.org or ashrafisaid@yahoo.com

b: Civil Engineering Department, Faculty of Engineering, Birzeit University, P.O. Box 14, Birzeit, Ramallah/  
Palestine, E-mail ozammo@birzeit.edu.

### Abstract

A pilot-scale treatment plant consisted of a UASB-septic tank followed by three parallel pond systems each consists of three stabilization ponds of equal depths and having the same hydraulic retention time (HRT) of 28 day. The setting was intended to investigate the effect of ponds' depth on the performance of algae-based ponds (ABPs). The depth of the ponds in the first, second and third systems were respectively, 90, 60 and 30 cm. The average ambient temperature throughout the experimental period was 24.5 oC. Influent COD to the UASB was  $1275 \pm 84$  mg/L, while influent COD concentration to each pond system was  $330.9 \pm 69$  mg/L. The research results reveal that the performance of the ABPs was inversely proportioned to the depth. COD removal efficiency for the shallowest and deepest ponds were  $54.0 \pm 1.1\%$ , and  $51.6 \pm 3.2\%$ , respectively. Higher ammonium ( $\text{NH}_4^+$ ) removal efficiencies were achieved in the shallowest compared to deepest ponds. The removal efficiencies of shallowest and deepest ponds were  $64.5 \pm 2.8\%$  and  $51.2 \pm 1.9\%$ , respectively. Furthermore, the removal efficiencies of total Kjeldahl nitrogen (TKN) in the shallowest and deepest ponds were from  $45.4 \pm 3.1\%$  to  $61.1 \pm 4.5\%$ , respectively. Negative removal efficiencies for total suspended solids (TSS) were observed in ABPs. Deepest ponds showed higher land requirement ( $7.8 \text{ m}^2/\text{capita}$ ) compared to shallowest ponds ( $3.9 \text{ m}^2/\text{capita}$ ) to comply with WHO guidelines for restricted irrigation.

## Prediction of Colloidal Particle Deposition in Porous Media Using the Non-Destructive Technique

A. Djehiche\*, \*\*, \*\*\*, H. Bertin\*\*, A. Omari\*\*\*, Z. Derriche\*\*\*\*\*

\*LRGC, University Amar Telidji Laghouat, Algeria  
(E-mail: a.djehiche@mail.lagh-univ.dz)

\*\* TREFLE, ENSAM, 33405 TALENCE

\*\*\* LMDA, ISTAB, 33405 TALENCE

\*\*\*\* LPCM, I C I (U.S.T. Oran) 31045, Oran-El-Mnouar, Algeria

### Abstract

The flows of colloidal suspensions in porous media find many applications in fields such as Petroleum, Hydraulic engineering, deep-bed filtration. For each application, the scientific problems can be summarized the flow in porous medium of a colloidal suspension whose particles having characteristic dimension is considerable in comparison with the pores dimension.

In certain cases one can observe a deposit of particles on the surface of the pores which results in a significant modification in the physical properties of the porous medium.

The objective of our study is to use a non-destructive experimental method, the attenuation of g-rays, to study the influence of the number of Peclet on the deposit of latex particles in a consolidated porous medium. The first results obtained show a good agreement between local and global measurements of the deposit of the particles in porous medium. The deposit takes place in a progressive way along the porous medium and leads to a monolayer deposit of which the average thickness is of about the size diameter of the colloidal particles.

## **Amendment Of The UASB Reactor to An Integrated UASB-Digester System For Sewage Pre-Treatment Under Low Temperature (15 °C) Conditions**

Nidal Mahmoud+, Grietje Zeeman++, Jules B. van Lier, Huub Gijzen+++ and Gatze Lettinga++

+ Institute for Water Studies (IWS), Birzeit University, PO Box 14, Birzeit, The West Bank, Palestine (nmahmoud@birzeit.edu).

++ Department of Agricultural, Environmental and Systems Technology, Sub-Department of Environmental Technology, Wageningen University, PO Box 8129, 6700 EV, Wageningen, The Netherlands (grietje.zeeman@wur.nl; gatze.lettinga@wur.nl) +++ Department of Environmental Resources, UNESCO-IHE Institute for Water Education, Westvest 7, 2601 DA, Delft, The Netherlands (hug@ihe.nl)

### **Abstract**

Promotion of high rate anaerobic technologies for sewage treatment in Palestine/ the Middle East was the main aim of this work. The sewage characterisation in Palestine showed that it is of high solids content (~1000 mg CODss/L), and low temperature of almost 15 °C during wintertime. Thus, simple model calculations suggested that the UASB reactor should be designed at an HRT of more than 22 hours to ensure methanogenic conditions. Alternatively, the UASB reactor was amended by incorporating a digester for further sludge stabilisation and generation of methanogens to be re-circulated over to the UASB reactor. The digester operational conditions were optimised by operating eight CSTRs fed with primary sludge. The results showed a major achievement of sludge stabilization at SRT=10 and 15 days at process temperatures of 35 and 25 °C, respectively. Running a pilot-scale UASB reactor (6 hours and 15 °C), and afterwards modification to a UASB-Digester system (digester at 35 °C) fed with domestic sewage demonstrated the latter technical viability. It achieved removal efficiencies of total, suspended, colloidal and dissolved CODs of respectively 66, 87, 44 and 30%. Preliminary model calculations indicated that a total reactor volume (UASB-Digester) corresponding to 8.6 hours HRT might suffice for sewage treatment in Palestine.

## Impacts of Domestic Septage Co-Treatment on Albireh Wastewater Treatment Plant Efficiency

Taghreed M. Hithnawi\* and Rashed M.Y. Al-Sa'ed\*\*

\* Geographic Center and Technical Support Directorate, Ministry of Planning, P.O. Pox 4557 Albireh, West Bank, Palestine. \*\* Water Studies Institute, Birzeit University, P.O. Box 14, Birzeit, West Bank, Palestine  
Tel.: +9722-2-298 2070; Fax: +972-2-298 2120  
E-mail address: rsaed@birzeit.edu

### Abstract

The collection and safe disposal of domestic septage, produced from septic tanks, and cesspools of urban and rural Palestinian communities is becoming an important environmental issue in Palestine with respect to environmental and economical aspects. At present, uncontrolled septage disposal methods in Palestine pose a challenge to public health, environment and receiving water bodies as of its high pollution load. All urban Palestinian sewage works receive domestic septage of unknown quantity, quality and lack knowledge on their potential impacts. The impacts of domestic septage co-treatment on the treatment efficiency of Albireh Wastewater Treatment Plant (AWWTP) based on septage quantities and characteristics were investigated. Septage daily flow rates were measured in different months and a detailed sampling program was undertaken to determine the characteristics of the septage received and treated. Using ANAwin, a German software package for sewage works design, the results obtained from septage lab analysis were utilized to simulate the impacts of daily septage loads on the oxidation ditch design parameters (sludge age, biosolids production rate, specific oxygen uptake rate), treatment efficiency and annual running costs. The septage received at AWWTP was of a heterogeneous origin, with a variable volume (115-176 m<sup>3</sup>/d) and reached an average daily volume of 153 m<sup>3</sup>. The results of the investigation lead to an annual septage generation rate in Albireh city of about 1.2 m<sup>3</sup> per capita (44.5 million cubic meter). The ANAwin software package confirmed the negative impacts on unit operations design and deterioration of effluent quality during wet weather flows.



## **Wastewater Management and Reuse in Mediterranean Countries: A case Study on Turkish Urban Wastewater Treatment Plants**

I. Arslan-Alaton, S. Ovez, M. Gurel, G. Iskender, A. Tanik & D. Orhon

Istanbul Technical University, Faculty of Civil Engineering, Department of Environmental Engineering, 34469,  
Maslak- Istanbul, TURKEY

(E-mail: arslanid@itu.edu.tr; sovez@ins.itu.edu.tr; mgurel@ins.itu.edu.tr; giskender@ins.itu.edu.tr;  
tanika@itu.edu.tr; dorhon@ins.itu.edu.tr)

### **Abstract**

Wastewater treatment and reuse has become a critical issue in Mediterranean countries such as Turkey. The present study refers to the outcomes of a survey on the current situation of Turkish Urban Wastewater Treatment Plants (UWWTPs). The survey covers the identification of the population served by UWWTPs, presentation of the current wastewater treatment technologies (physical, biological or advanced) applied, the prevailing effluent disposal criteria and the elucidation of needs for upgrading the selected UWWTPs to comply with current and future discharge consents and irrigation water quality criteria. Following an extensive data collection and evaluation step, Turkey's recent situation in the number and performance of UWWTPs, effluent produced in Turkish municipalities both quantity and quality-wise, urban wastewater treatment types and disposal methods as well as reuse potential of treated urban wastewater have been presented and discussed herein.

## **Biogas Production in Anaerobic Codigestion of Olive Mill Wastewater and Swine Manure**

Hassan Azaizeh and Jeries Jadoun

Research & Development Center (affiliated with Haifa University, The Galilee Society, Shefa Amr 20200, P.O.  
Box 437, Israel. Hazaizeh@yahoo.com

### **Abstract**

Agricultural wastes originating from olive mills, swine and poultry, and other animals contain high concentrations of organic compounds with great unused energetic potential. Swine wastewater (SW) and olive mill wastewater (OMW) are two problematic wastes that have become major causes of health and environmental concerns. Although SW contains considerable amounts of different antibiotics and probably pathogens, it is simply discharged into the environment either without proper treatment or completely untreated. The OMW is produced during the olive oil extraction process in large quantities in olive-growing regions. In addition to sugars and pectins, OMW contains high concentrations of toxic materials such as phenols, tannins, and lipids, which are well documented phytotoxic and antimicrobial compounds. Currently, much of the OMW in our region is discharged directly into sewage systems and water streams, or concentrated in cesspools, despite the fact that both of these practices are prohibited. Among several wastewater treatment strategies, codigestion has gained considerable interest due to many benefits stemming from wastewater mixing. In this project, the efficiency of the codigestion strategy for treatment of SW and OMW mixtures was evaluated. In the first stage, batch reactor experiments were carried out to assess the potential of different sludges to biodegrade mixtures of SW and OMW. Out of five different sludges tested, Gadot and PriGat sludges were the best in COD removal capacity and biogas production. In the second stage, the biodegradation process of OMW and SW mixture was optimized in a continuous bioreactor, the up-flow anaerobic sludge blanket (UASB). During the 170 days of operation, both sludges showed high biodegradation potential. The highest COD removal (85-98%) and biogas production (0.55 l/g COD) was obtained at a mixture consisting of 33% OMW and 67% SW. Increasing the rate of OMW in the mixture up to 40% resulted in reduction of the COD removal capacity (70%) and biogas production apparently because of the toxic effects of the phenolic compounds. The results obtained in this study strongly suggest that codigestion technology using UASB reactors is a highly reliable and promising technology for treatment of OMW and SW wastes.

## **Investigation on Textile Industry Wastewater Reuse: From Methodology Definition to Full Scale Demonstration of Specific Bat**

Loredana De Florio, Andrea Giordano, Davide Mattioli

ENEA PROT IDR UNIT Water Resources Management, via Martiri di Montesole, 4, 40129 Bologna, Italy

### **Abstract**

With the objective of assessing ways of reducing water consumption in the textile sector, optimization of water use schemes within the factory and reuse options were investigated in the framework of a multicriteria integrated methodology set up in the European funded R&D project Towef0 (Toward Effluent Zero), EVK1 – CT – 2000 – 00063. The conclusions drawn put the basis for the analysis of the sector needs hindering the implementation of good environmental practices. The methodology allows the implementation of measures which proved their potential in reducing environmental impact of industrial activities. In order to scale up the results of the Towef0 project, a full scale application is going on in a textile SME, to stand as guideline target for the overall sector.

## Effluent and Sludge Management in Yemen

J.E. Hall\* and R. Ebaid\*\*

\* Independent Consultant, Bryn Cottage, HP27 0PY, UK (E-mail: sludge.hall@virgin.net)

\*\* MWH Arabtech Jardaneh, PO box 16327, Sana'a, Yemen  
(E-mail: yarabc@y.net.ye)

### Abstract

Yemen has rapidly declining water resources as a result of over-exploitation for crop irrigation and the incidence of water-borne diseases is high due to the low provision of sanitation services. Significant improvements to public health are being made by the construction of sewerage systems and wastewater treatment plants in some towns, but none of the wastewater projects have considered how effluent and sludge should be managed safely, and farmers in particular are highly exposed to risks of infection through uncontrolled reuse practices. This paper describes the strategy that was developed by MHW Arabtech Jardaneh, in association with GKW Consult, to achieve sustainable reuse of effluent and sludge in Yemen by adopting simple and pragmatic measures that ensure maximum recovery of the agricultural resource value of wastewater while protecting human health within limited financial and institutional resources.

## **Which Role for Stakeholder and Donor Organizations in a Multi-criteria Analysis of Different Wastewater Management Options for the Wadi Nar/Kidron - an Israeli – Palestinian Trans-Boundary Basin**

Simone Klawitter<sup>1</sup>

<sup>1</sup> Department of Environmental Economics and Policy, Technical University Berlin, Germany, E-mail:  
mail@klawitter-berlin.com,

### **Abstract**

Often political and hydrological boundaries do not match. In these cases, water managers have proposed to establish joint institutions and management options for integrated river basin management. Describing and analysing briefly alternative wastewater management options for the Kidron Valley/Wadi Nar, a trans-boundary Israeli-Palestinian basin, it is analysed which stakeholders and donor organizations are involved in the decision making process and what their roles are, while discussing the actual institutional structure. It is examined which role the identified unbalanced power between Israel and Palestine plays in identifying appropriate alternative waste water treatment options and the development of joint water management regimes for trans-boundary water basins. In addition the role of donor organizations in water regime creation is analysed.

### **Key words**

Water regime, waste water treatment, stakeholder analysis, donor organizations, Palestinian Territories, Israel, Wadi Nar, Nahal Kidron

## **The Application of Oxidation Reduction Potential ORP as Control Parameter to Regulate Nutrient Removal in An Activated Sludge Plants Receiving High Strength Wastewater.**

Dr. Jamal A. Radaideh

Balqa Applied University/ Huson University College  
Water & Environmental Eng. Dept.  
E- mail. Jamal@huson.edu.jo

### **Abstract**

More recently stringent quality standards are being applied to plant effluents in Jordan, limits on nitrates, ammonia, phosphates, and suspended solids, etc.. are applied to outfalls. This has caused operators to turn their focus to the biological activity in the aeration basin. The continual monitoring and the on-line control of aeration tank operation is an important key to high-efficiency pollutant removal and energy savings. One of the aims of this study was to examine the benefits for using redox potential (oxidation-reduction potential [ORP]) to indicate wastewater quality on-line in aeration tanks treating high strength (chemical oxygen demand [COD] of 2000 - 2500 mg/L) wastewaters. Also determining the required time period to allow simultaneous nitrification/denitrification in aeration tank. The field-scale data obtained from (Ramtha WWTP) provide a good relationship between ORP values and nutrient removal along the length of the aeration tanks. The ORP values increased dramatically as organic matter was removed (oxidized) along the aeration tanks, indicating the improvement of the bulk liquor redox status. Dissolved oxygen in the range of (0.8 – 2.0 mg/L) was necessary for good biodegradation and improvement of the solution redox status. Nitrification occurred at higher ORP values (-----) than was the case for organic substrate oxidation (--- mV). This verifies that different metabolic processes dominate in different ORP ranges.

**Accurate on-line measurements and regulation are needed to ensure that the process is efficiently optimized.  
The Efficiency of Some Jordanian Wastewater Treatment Plants and the Environmental Impacts of their Effluents**

Rania H. El Hammouri and Elias Salameh

University of Jordan

**Abstract**

Inflows and outflows of some wastewater treatment plants (WWTP) in Jordan are studied to determine the concentration of total dissolved organic matter, humic acids, and to identify ionic and nonionic surfactant and oils.

Wastewater biomass (dissolved organic matter, DOM) samples containing aromatic protein and humic acids were characterized as bacterial soluble microbial products. Excitation – emission matrix (EEM) fluorescence spectroscopy was used to characterize dissolved organic matter (DOM) in the water samples.

The measurements were delineated into two excitation – emission regions based on fluorescence of model compounds. EEMs aided in differentiating DOM between inflows and outflows of treatment plant.

Ultraviolet visible absorption spectra have also been used to characterize non fractionated DOM, and specific UV to characterize antibiotic, surfactant and oils.

As a result it was found that the different treatment plants are capable of partly removing the DOM, and that these plants differ in their removal capacities. The effluent of some treatment plants still contains substances, which are harmful to the environment and to consequent water uses.

**Keywords**

Treatment plants, Effluents, DOM, Surfactants, Oils and Grease

## Low Cost Sanitation: An Overview of Available Methods

Alicia Hope Herron

A paper for the Woodrow Wilson International Center for Scholars,  
Environmental Change and Security Program

### Abstract

The toll that unsanitary conditions and contaminated drinking water take on both the health of the human population and the health of the environment amounts to one of the most crippling costs worldwide. Approximately 40 per cent of the world's populations (2.6 billion people) do not have access to improved sanitation. Besides the indignity suffered by those lacking the provision of sanitation, this situation results in the preventable deaths of millions in the developing world from disease contracted through direct and indirect contact with pathogenic bacteria found in human excreta. Infectious diseases such as cholera, hepatitis, typhoid, and diarrhea are waterborne and can be contracted when untreated wastewater is discharged into water bodies. Over half of the world's rivers, lakes, and coastal waters are seriously polluted from wastewater discharge. The cost of inadequate sanitation translates into significant economic, social, and environmental burdens. As 2 billion of the 2.6 billion people lacking sanitation live in rural areas, it is critical to parallel large-scale urban investments with low cost, on-site technologies that also target rural communities. Much work has been done to improve low cost sanitation options, especially regarding the reuse of sewage for agriculture or aquaculture. Low cost sanitation options that target rural communities include technologies that utilize both dry and wet sanitation methods to achieve primary treatment. This paper will describe the technologies included in the framework of wet and dry sanitation options and provide examples of different methods that have been employed in the field.

This paper is not meant to be a technical review, nor is it meant to be a design manual. Rather, this is an attempt at consolidating the current literature and available information in order to present several low cost options. It is also an attempt to frame these low-cost options within the murky context of necessary considerations - the importance of providing multiple flexible options to ensure community acceptability, cost-effectiveness and sustainability. With sanitation more so than water, it must be remembered that, to be effective, each approach must incorporate a complex set of variables ranging from cultural consideration and cost-effectiveness to geology and climate. Not only are these considerations important for efficacy and sustainability, but the lack of consideration of one variable in sanitation planning has the potential to effect serious community health damage, exacerbating rather than ameliorating an inadequate situation.



## **Treatment of Cuttlefish Effluent by UF and MF Ceramic Membranes: Comparative Study Using Commercial and Elaborated Tunisian Clay Membranes**

S. Khemakhem<sup>1</sup>, S. Saïdil and R. Ben Amar<sup>1</sup>

1-Laboratoire des Sciences de Matériaux et Environnement, Faculté des Sciences de Sfax, Route de Soukra Km 4, 3038, Sfax, Tunisie.

2-Institut Européen des Membranes, UMR 5635-CNRS, ENSCM, UMII, 1919 Route de Mende 34293 Montpellier Cedex5, France.

\*Corresponding author. Tel: +216 97 894904, Fax: +216 74 274437  
E-mail address: Khemakhem\_sabeur@yahoo.fr (S.Khemakhem).

### **Abstract**

Cuttlefish effluent treatment was investigated using ceramic Ultrafiltration and Microfiltration tubular membranes. The comparison of performances between commercial ceramic membranes based on alumina material and elaborated membranes based on Tunisian clay material were studied. Microfiltration and Ultrafiltration tests were carried out respectively with 0.2  $\mu\text{m}$  and 5 nm commercial membranes and 0.18  $\mu\text{m}$  and 15 nm prepared membranes for effluent clarification. The results obtained show that the treated wastewater using clay membranes was of a superior quality than that obtained from commercial membranes in term of COD and turbidity retention. Besides the permeate flux from clay membranes was 20% superior to that from commercial membranes.

## The Use of a Pilot-Scale Membrane Bioreactor in Treating Domestic Wastewater with Variable Characteristics for Potential Water Reuse on a University Campus

N.O. Yigit<sup>1</sup>, I. Harman<sup>1</sup>, G. Civelekoglu<sup>1</sup>, H. Koseoglu<sup>1</sup>, N. Cicek<sup>2</sup>, L. Yilmaz<sup>3</sup>, R. Arviv<sup>4</sup>,  
M. Kitis<sup>1,\*</sup>

<sup>1</sup> Dept. of Environmental Engineering, Suleyman Demirel University, Isparta, 32260 Turkey

\*corresponding author e-mail: mkitis@mmf.sdu.edu.tr

<sup>2</sup> Dept. of Biosystem Engineering, University of Manitoba, Winnipeg, MB Canada R3T 5V6

<sup>3</sup> Dept. of Chemical Engineering, Middle East Technical University, Ankara, 06531 Turkey

<sup>4</sup> Zenon Systems Ltd., 20 Hataas St. Bet Hapaamon Kefar Saba, 44425 Israel

### Abstract

The aerobic treatability of domestic wastewater from university campus area with diurnally and seasonally variable characteristics was investigated using a pilot-scale submerged membrane bioreactor (MBR) operated for eight months. Operating conditions including sludge retention time (SRT), mixed liquor suspended solids (MLSS) concentration, permeate flux, and hydraulic retention time (HRT) were varied during the operation to investigate their impacts on overall treatment performance, water production and membrane fouling. Although the influent characteristics were highly variable, including sudden sharp increases in total dissolved solids (TDS) and organic matter concentrations, and wastewater temperatures were as low as 6 Co during winter months, the MBR system performed well throughout its operation. The treatment performances was not negatively influenced by variations in F/M ratio, MLSS and DO concentrations, temperature, SRT, organic loading rate, specific substrate removal rate, and permeate flux. Sustainable nitrification and organic carbon removals were achieved even during periods with extreme conditions. Irreversible fouling of membranes did not occur during the eight months of operation. No chemical cleaning was performed during the six months of operation at normal flux (23-25 L/m<sup>2</sup>-h), except routine back-pulsing with permeate. For the high flux operation (36-39 L/m<sup>2</sup>-h), chemical maintenance cleaning was employed two times over two months, which consisted of back-pulsing membranes with chlorine dosed (250 mg/L) permeate for five minutes without draining the MBR tank. No further intensive chemical cleaning was necessary even at high flux conditions. Overall, eight months of pilot-scale tests indicated the robustness of MBR process in terms of achieving very high quality of treated water without any operational limitations including fouling and permeability reduction problems. This study will guide the decision on a potential full-scale MBR application and reuse of the treated wastewater for irrigation in the campus area.

## The “ Smart Project “An Integrated Water Resource Management project in the Lower Jordan Rift Valley.

H. HOETZL, W. ALI, L. WOLF, H. WERZ

(SMART Project Coordination team, Karlsruhe University, Germany)  
Corresponding author: Dr. Wasim Ali, E-mail: Wasim.ali@agk.uka.de

### Abstract

The German federal Ministry for Research and Technology, considering the Resolution 58/217 of the United Nations dated 20. December 2000 is supporting a research program „Integrated Water Resources Management (IWRM)“ in regions with water shortages. The SMART project „ Sustainable Management of Available Water Resources with Innovative Technologies“ in the lower Jordan Valley is one of these projects. 21 different Universities, research centers, companies and NGOs are working together in the consortium of this project. This new project (start July 2006) will be coordinated mainly through a team from Karlsruhe University.

The project structure of “SMART” consists of eleven Working packages (WP) or sub-projects with the objectives to implement the IWRM concepts and guiding principles in this region. The (WPs) are inter-related, requiring thus integration of resources and mechanisms of communication and data transfer between partners and between this project and other ongoing projects of similar nature in the lower Jordan Valley.

The Eleven working packages are dealing with Project management and coordination, Data and Information Management, Geology Hydrogeology and Geochemistry, Water budgets, Technologies - Managing Waste Water for Reuse, Tools for scenarios, Tools for socio-economic assessment, Precision irrigation and artificial recharge, Definition and assessment of IWRM scenarios, Impact of IWRM Scenarios, Dissemination, training and technology transfer.

The main objective of this project is to reduce the water shortage in this region. This will be achieved by the development and testing of innovative technologies and management concepts. A significant improvement of the water situation and the general development of this semiarid area are expected. The main idea of SMART is to include all water resources of the Lower Jordan Valley like ground water, waste water, saline water, flood water as water resource bodies, which can be developed with new technologies. All factors such as water quality, water quantity, water- and waste water losses from pipes or from water distribution and drainage systems should be included in the water management model. In addition to technical aspects the socio-economical influences will be considered.

## **A Case Study on Alternative Integrated Sanitation Systems in Rural Egypt - Selection Tools and Evaluation.**

Hisham S. A.Halim<sup>1</sup>, Walid Abdel-Halim<sup>2\*</sup>, and M.Nazih<sup>2</sup>

E-mail: [hishama.halim@access.com.eg](mailto:hishama.halim@access.com.eg)

<sup>1</sup> Cairo University, Faculty of Engineering. <sup>2</sup> Housing and Building Research Center, Cairo, Egypt.

\* Currently: Institute of Water Quality and Waste Management, Hannover Uni., Germany

### **Abstract**

Maintaining social justice for every one in Egypt is one of the most important duties of the government, and in this thought maintaining health and well being for individuals has been considered in Egypt's Basic Legislation. Wastewater is one of the greatest environmental problems in Egypt, where more than 3000 local villages and sub-villages with a total population of about 25 millions have no facilities of wastewater treatment and/or wastewater collection. To provide these villages with the required facilities of wastewater collection, treatment and disposal, some of evaluation and selection tools must be done starting with selection of villages with high priority, selection of suitable sanitation system and ending to the implementation of the most eligible system in terms of technical and economical eligibility. Governorate of Sohag GOS was selected to be a case study of this study. It is located in Upper Egypt, 467 km south of Cairo, consists of 11 central units, 10 cities, 51 local units, 270 mother villages and 1217 small villages. Total population is 3,113,012 capita, 78% of them live in rural areas, and 67% of them need sanitation facilities and suffering from lack of infrastructure utilities and economic plans. The main objective of this study is producing of selection tool as well as a simplified computer program to assist in choosing suitable sanitation systems for different villages depending on a technology selection leading to a single or group of options for the sanitation technologies as well as economical comparison between the selected options to get the most economical option. The selection of sanitation options was based on the state-of-art technologies for different components of the system. Moreover, this study assists in determination of the preference factors to get the villages' priorities for implementation. The proposed selection tool and the developed software was tested for a group of villages in GOS and proved successful and simple applicability.

## **Fixed Bed Technology as a Biological Treatment Method**

Wakeileh, N. A.

Nabil Ayoub Wakeilh Company, Amman- Jordan

### **Abstract**

Biological treatment process can be divided into two main categories: Suspended growth processes and attached growth (biofilm) processes. In Suspended growth processes, the microorganisms responsible for treatment are maintained in liquid suspended by appropriate mixing methods. While In Attached growth processes, the microorganisms responsible for the conversion of organic materials are attached to an inert packing material.

Fixed Bed technology is an example of attached growth process where more than 55% of the tank is packed with plastic media, while the remaining voids can be used as a suspended growth.

Submerged fixed bed technology has been applied on several small to medium remote (de-centralized) WWTP, the technology has proved to be an economical solution for such remote plants as it was very simple to operate, self regulating, minor operations & staff, and no need for a highly trained / expert operators.

In this paper we present the Jarash University Wastewater Treatment Plant as a case study of the Submerged Fixed Bed technology that shows a 99.4% removal of BOD5 and 99.3% removal of TSS.

## **Reuse of Reclaimed Wastewater in Jordan: A Comparison Study of the International vis-à-vis Jordanian Standards**

Dr. Iyad. A. Hussein

(Dr.iyad@index.com.jo)  
Consulting Engineering Center  
Amman - Jordan

### **Abstract**

The purpose of this paper is to compare the Jordanian standards of the reclaimed wastewater with the international standards for the same issues. The Jordanian standards were changing and updating in accordance with the development of the infrastructure and the high demand for the usage of reclaimed water for the different purposes.

Two international standards were considered for the comparison exercise; World Health Organization (WHO) and Environmental Protection Act (EPA) guidelines, which are considered from the most common legislations with this regard. The results of the study showed the positive and negative aspects of the Jordanian standards. The shortcomings were identified and the necessary clauses were recommended. It was concluded that with the current legislations of the reclaimed water and treated sludge, it is difficult to utilize these products in an efficient way with achieving the highest benefits for the country. A number of recommendations were suggested at the end of the paper, these can be considered by the decision makers in Jordan and other regional countries.

## Natural-Oriented Municipal Wastewater Treatment and Re-use (NOWTR) - Answering for Sustainability?

Walid Abdel-Halim\*\*, Dirk Weichgrebe\*, Johan Verink\*\*\*

\* Institute of Water Quality and Waste Management, Hannover of University,

\*\* Housing and Building Research Center (HBRC), Cairo, Egypt  
(E-mail: abdel-halim@gmx.de)

\*\*\* UCY-Concepts, Hannover, Germany

### Abstract

Most of developing countries often suffer from the absence of efficient institutions; lack of technological knowledge and empirical Know-How of wastewater treatment processes and their implementation; also inappropriate management practices. Trying to get some solutions of the wastewater problems in those countries, NOWTR will be implemented as a naturally oriented low cost technology for wastewater treatment and re-use, where the wastewater will be anaerobically treated using a natural UASB pond reactor (UCY Pond Type UASB-reactor) to win all of the anaerobic treatment benefits as winning of biogas as an alternative source of energy as well as less quantity of sludge with a very good stabilization status, and cost effective benefits as low capital, operation and maintenance cost. The treated wastewater will be naturally disinfected in polishing/disinfection pond at low cost manner by means of sunlight, then the produced disinfected treated wastewater will be re-used for the agriculture purpose as a potential to recovery of the high valuable nutrients in wastewater like Nitrogen, Phosphor, and Potassium which have an effective value for soil reclamation and its productivity improvement. Also the NOWTR Concept include an effective solutions of safe sludge hygienization and drying for disposal and/or re-use.

## **Assessing Jordanian Grey Water Characteristics for Determining Treatment Requirements and Reuse Options**

Abu Ghunmi, L., 1,2 Zeeman, G., 1 Lier, J. Van, 1 and Fayyad, M., 2

1. University of Jordan; WERSC; PO. Box 1300, Amman, Jordan

2. Wageningen University; Section Environmental Technology; PO Box 8129,  
6700 EV Wageningen; The Netherlands.  
lina.abughunmi@wur.nl.

### **Abstract**

This work aims to study the quantity and quality characteristics of grey water at different areas in Jordan, in order to assess the possible reuse option and treatment requirements. To achieve these objectives the characteristics of grey water, generated at rural and urban residential areas and dormitory places, were discussed in terms of events distribution, volume, flow patterns, physical properties and chemical and biological constituents. Moreover, grey water production from shower, kitchen, laundry and dormitory grey water was analyzed to discuss grey water treatment options. The results showed that for combined grey water, generated in different areas, quantities exceed indoor and outdoor (on-site) reuse demand. For reuse, Jordanian individual and combined grey water need to be stored, and treated in terms of solids, COD and pathogens. Physical treatment produces a primary sludge, that needs to be handled and unstable effluents. Biological treatment can produce stable effluents with quality that meets all the reuse requirements in terms of solids and COD.



## Reuse of Treated Wastewater Effluent for Irrigation

A. Al-Omari\*, M. Abu-Zant\*\*, and M. Fayyad\*\*\*

\*Assistant researcher, Water & Environment Research & Study Center, University of Jordan, Jordan Tel. 962-6-5355000 ext. 2944, Fax 962-6-5355560, e-mail abbasm@ju.edu.jo

\*\*Professor, Faculty of Agriculture, University of Jordan

\*\*\*Professor of analytical chemistry, Director Water & Environment Research & Study Center, University of Jordan

### Abstract

The suitability of the effluent from a constructed wetland that treats domestic wastewater for irrigation was evaluated based on Ayers and Westcot and WHO guidelines for interpretation of water quality for irrigation. Other guidelines and regulations such as State Reuse Regulations and Guidelines and recommended revised microbiological guidelines for treated wastewater use in agriculture are also considered. The effect of irrigation by wetland effluent on crop yield and heavy metals accumulation in soil and plant was studied. Results showed that the effluent is suitable for irrigating cereal crops, industrial crops, fodder crops, pasture and trees. As the effluent FCC was in the order of 105, supplemental measures to protect farmers' health such as farmers' education are necessary. Two fodder crops which are Yellow corn and Kochia scoparia were planted in four replicates each and irrigated by the wetland effluent. Three control plots for each crop were planted and irrigated by fresh water. The area of every plot was 5m<sup>2</sup>. Yellow corn was cut, weighted and analyzed for the presence of certain heavy metals at the milky stage and at full bloom. Kochia scoparia was cut, weighted, and analyzed for the presence of certain heavy metals at pre-bloom, mid-bloom and full bloom. Soil was sampled at 30 cm depth at all plots before planting and after harvesting and analyzed for the presence of specific heavy metals. Results showed that dry matter weight of Yellow corn at the fully mature stage irrigated by wetland effluent was about two and a half folds that irrigated by fresh water. At full bloom, dry matter weight of Kochia plant irrigated by wetland effluent was about one and a half folds that irrigated by fresh water. No significant differences in heavy metals concentrations in the root zone were observed between plots irrigated by wetland effluent and plots irrigated by fresh water. It was also observed that heavy metals present in the treated wastewater were detected in the plant and those not present or present at very low concentration were not detected, which means that heavy metals are taken by plants when available in the irrigation water.

## **The Contribution of Waste Mud to the Fertility of the Ground and the Barley Yield (*Hordeum vulgare* L. jaidor variety)**

Boudjabi S1., Kribaa M2., Tamrabet L2

1 Centre universitaire de TEBESSA  
2 Centre universitaire Larbi Ben M'hidi Oum El Bouaghi

### **Abstract**

In the absence of the organic matter of vegetable origin, the regeneration of the ground becomes difficult, and this last one, loses its physical and biochemical fertility. With the aim of a replacement of this organic matter by waste mud's, The present work concerned the study compared by the physical properties of a cultivated soil in barley at the double end, also the contribution of this mud to the production of this forage plant. In this objective, we led an experiment which consists of the application of the increasing doses of waste mud's compared with contributions of nitrogen in the form of urea; these treatments are compared with a not fertilized witness.

The follow-up was realized on morphological and physiological variables, as well as the productivity to the barley also the contribution of this mud to the production of this forage plant. The parameters of the taken into account ground are of hydro-physical order: the porosity, the hydraulic conductivity, and biological: the content in organic matter.

## **Feasibility of Treated Wastewater Re-use in Agriculture: A Case Study from Hebron District in Palestine**

Imad Al-Zeer<sup>1</sup>, Issam A. Al-Khatib<sup>2</sup> and Hafez Q. Shaheen<sup>3</sup>

<sup>1</sup>Water Department, Hebron Municipality, West Bank, Palestin. E-mail: Alzeerj@yahoo.com

<sup>2</sup>Institute of Community and Public Health and Faculty of Engineering, Birzeit University, West Bank, Palestine. E-mail: ikhatib@birzeit.edu

<sup>3</sup>Civil Engineering Department, An-Najah National University, Nablus, West Bank, Palestine. E-mail: Shaheen@najah.edu

### **Abstract**

In Hebron district and due to the insufficient water supply, the amount of water used for irrigation purposes is minimal and the percentage of irrigated land does not exceed 1% of the total agricultural area. The rich agricultural area is 18250 hectare owned by nearly 330 farmers and located mainly between, Yatta and Bani-Naem south of Hebron city. The irrigation water needed to supply this land is 10,493,750 m<sup>3</sup>/a. Therefore, it is urgent to start implementing wastewater reuse as one of the strategies defined by the PWA strategic plan.

In this paper, a detailed financial analysis and economic feasibility for wastewater reuse in Hebron district is performed, including investment needs, operating expenses and revenue. US\$ 0.25/m<sup>3</sup> introductory price for treated effluent is considered competitive compared with the US\$ 1.2/m<sup>3</sup> Hebron Municipality price for drinking water and the US\$ 2.4/m<sup>3</sup> price for purchased water. The financial indicators applied are the Net Present Value (NPV = US\$ 363,549), Internal Rate of Return (IRR = 13.5%), and the payback period (PBP = 6.6 years).

To solve the environmental and health problems of wastewater disposal and to guarantee effective use of agricultural land in Hebron District, it is necessary to implement wastewater reuse. It is feasible, economic and urgent.

## **Treated Wastewater Re-Use Policies, Practices and Prospects in Palestine: A Special Focus on Agriculture**

Issam Nofal, Ministry of Agriculture, issamnofal@hotmail.com  
Omar Zimmo, Birzeit University, ozammo@birzeit.edu

### **Abstract**

Water is a particular concern of life in the Mediterranean and Middle East regions. In fact, this is the poorest region of the world in terms of water resources, both globally and per inhabitant. Indeed, water scarcity in the West Bank and Gaza Strip (WBGS) is resulted mainly from the Israeli control over the vast majority of the Palestinian water resources as well as the arid and semi arid climate conditions prevailing. Therefore water scarcity in the WBGS represents a critical constraint to further expanding or even maintaining existing irrigated areas. Historically, agriculture plays an important role in the Palestinian economy and life, while, availability of water forms the most decisive factor in defining the role played by this sector. The Agricultural sector is the major consumer of water in the WBGS, utilizing up to 65% of the available water and the irrigated area constitutes less than 11% of the total Palestinian cultivated areas.

The gap between demand and supply is widening while the demand for domestic and irrigation is ever increasing. Therefore, using local reclaimed sewage water in Palestine becomes one of the most cost effective alternatives for improving the efficiency of water use in agriculture. However, since treated wastewater (TWW) has so far hardly been tapped, there is a serious lack of information and practical know-how among both the water policy makers and the end users of such alternative water resources on how to best it for crop irrigation.

Despite the fact that the legal and institutional frameworks for the sustainable management of TWW have been articulated in the Palestinian development plans and have been under focused in the policies and strategies of the Ministry of Agriculture (MOA) and the Palestinian Water Authority (PWA), the enforcement of such issues are still lacking. Eventually, the re-use of TWW in agricultural production in Palestine is still on the pilot scale and the Palestinians lacks the proper experience in using this resource in a safe and sound way.

## **Water Recycling as Part of An Integrated Concept for Wastewater and Biowaste Treatment**

Jan Streese-Kleeberg; Olaf Bade; Rainer Stegmann,

Hamburg Institute of WasteResourcesManagement, Hamburg University of Technology, Harburger Schloßstrasse  
36, D-21079 Hamburg, Germany (E-mail streese@tu-harburg.de)

### **Abstract**

An integrated concept for decentralised treatment of wastewater and biowaste has been developed and realised. The process includes membrane treatment of the raw wastewater and anaerobic fermentation of the produced wastewater concentrate together with food waste from kitchens and restaurants. The permeate from the membrane can be used, for example, for irrigation in gardening and agriculture. The solid fermentation residues can be further composted or directly be used as a soil conditioner in gardening or agriculture. The biogas produced during fermentation can be used for production of heat and energy. No residues for disposal are produced in this process.

Investigations have been carried out both in laboratory scale and in a fully automated container scale plant which is set up at a municipal wastewater treatment plant. By using a 250 kD submerged ultrafiltration membrane, a good permeate quality complying with German limit values for wastewater discharge was produced. When operated properly, the membrane permeability remained stable over several weeks without chemical cleaning. A crucial issue for an economical operation of the biogas fermenter is the achievement of a high concentration factor in the membrane step in order to increase the organic load and reduce the hydraulic load at the same time.

## **The EMWater Project - Promoting Efficient Wastewater Management and Reuse in Mediterranean Countries**

Luigi Petta\*, Annika Kramer\*\* and Ismail Al Baz\*\*\*

\* ENEA, PROT-IDR, Bologna, Italy; Tel: +39 0516098759 Fax: +39 051609830  
e-mail: luigi.petta@bologna.enea.it

\*\* Adelphi Research, Berlin, Germany; e-mail: kramer@adelphi-research.de

\*\*\* InWEnt, Project Office Amman, Jordan; e-mail: emwater@batelco.jo

### **Abstract**

Given the fact of water shortage in the Mediterranean Countries, the EMWater project (Efficient Management of Wastewater, its Treatment and Reuse in the Mediterranean Countries) aims to increase the security and safety of water supply through creation of public awareness and implementation of innovative and suitable solutions in wastewater treatment and reuse.

The EMWater project contributes to these goals through training programmes for technicians, engineers and employees of authorities and non-government organizations (local, regional and web-based); public awareness campaigns; design and construction of pilot plants applying low-cost techniques, as well as through the development of policy guidelines for wastewater treatment and reuse. Such activities will contribute to general objectives such as: promoting transfer of appropriate wastewater treatment technologies, such as low-cost technologies for rural areas; strengthening of local capacities and regional co-operation through the creation of co-operative networks of professionals in the field of integrated water resource management; enhancing public awareness of the insufficient respectively wrong wastewater treatment, of the necessity of an improved hygienically safe disposal, and the potentials of water reuse.

The main target countries of this project with a 4 years total duration are Jordan, Lebanon, Palestine and Turkey.

The paper is aimed to present the state of implementation in the EMWater project after the 3rd year, especially focusing on the main steps in pilot plants design and construction activity and in development of guidelines for decision-makers in wastewater management and planning. It further addresses the progress in implementation of capacity building programs.

### **Keywords**

Optimal Water Management; Wastewater Reuse; Policy Guidelines; Capacity Building

## **Groundwater Contamination as Affected by Long-Term Sewage Irrigation in Egypt**

Khairy A. Guindi<sup>1</sup>, Hussein I. Abdel-Shafy<sup>2</sup> and Nevien S. Tawfik<sup>1</sup>

Desert Research Centre, Mataria, Cairo, Egypt.  
Water Research & Pollution Control Department, National Research Centre, Dokki, Cairo, Egypt.

### **Abstract**

In Cairo, Egypt there are two sewage farms that were established around Cairo sandy soil desert using treated domestic wastewater for irrigation. One of them is Abu-Rawash farm that was established on 1944. Seepage water beneath the irrigated land is a result of the continuous use of sewage irrigation. Such seepage water or so called "groundwater" is the only source for domestic use including drinking by the farmers. The physical and chemical as well as level of heavy metals characteristics of sewage irrigation water were studied extensively. The quality of the resulted groundwater was also investigated through 36 samples to investigate level of the contamination. The permissible limits and the suitability of this groundwater for human risk consumption were also evaluated.

## Water Quality Improvements During Soil Aquifer Treatment of Secondary Treated Wastewater: Pilot Scale System.

Thaer H. Abushbaka\*, Jens R. Jensenb

aCentral Laboratory for Water and Soil, Ministry of Agriculture, Palestinian National Authority, Gaza Strip  
bDen Kgl. Veterinær-Og Landbohøjskole, Agrohydrology and Bioclimatology Laboratory, 2630 Tåstrup, DK

### Abstract

A considerable nitrification in soil aquifer treatment (SAT) systems for wastewater treatment is a prerequisite for gaining sufficient nitrogen removal by denitrification. The purpose of this study is to investigate the nitrification denitrification processes in pilot scale basins at conditions corresponding to SAT systems under different combination of wetting drying times and different soil textures. Time-dependent depth profile of nitrogen compounds and ultraviolet absorption at wavelength 254 nm (UV254) was developed during wetting time. The adsorption of  $\text{NH}_4^+$  to the soil particles was found to be the dominant process for removing  $\text{NH}_4^+$  from the percolated water. A one-day wetting time was sufficient for 100% removal of  $\text{NH}_4^+$  in the upper 120 cm sandy soil profile. The presence of sandy clay loam at the basin floor limited the nitrification process during drying time. Two days as drying time was found not enough to oxidize the adsorped  $\text{NH}_4^+$  in this basin. As a result, accumulation of  $\text{NH}_4^+$  in the soil profile was observed. A peak of  $\text{NO}_3^-$ -N ranged from 200 to 300 mg L<sup>-1</sup> in the water at the beginning of the wetting time was detected. This was minimized to around 100 mg L<sup>-1</sup>  $\text{NO}_3^-$ -N in case where fine-textured soil is presented on the surface. The denitrification of  $\text{NO}_3^-$  was not significant during this experiment for the one day wetting time. This has been enhanced by increasing the wetting time. With two days and three days as wetting time, 22% and 66% reduction in the  $\text{NO}_3^-$  concentration was predicted, respectively. A reduction of about 30% in the UV254 of the applied wastewater in the sandy soil infiltration basin was observed. This was improved to 46% by adding 10 cm sandy clay loam above the basin floor.



## Impact of Heavy Metals on the Anaerobic Digestion of Sewage Sludge

Hussein I. Abdel-Shafy<sup>1</sup> and Abeer A. Al-Saharty<sup>2</sup>

1. Water Research & Poll Control Depart., National Research Center(NRC), El-Behous St., Dokki, Cairo, Egypt.
2. National Institute of Oceanography & Fisheries, Al-Anfoshy, Alexandria, Egypt.

### Abstract

Sewage which is collected from mixed industrial and domestic population may be contaminated with metals and industrial chemicals. On the other hand, sludge digestion process generates methane which on some plants is collected and used as a source of energy. The aim of the present study is to investigate the effect of heavy metals on the anaerobic digestion process for the treatment of sewage sludge. The selected metals are Hg, Cd and Cr III. The Toxic effect and the inhibitory impact of the digestion process are among the objective of the study. The fate and toxic effects of heavy metals on the biogas production was determined.

The sewage sludge samples separated from the black water of the Zer0-M project at the National Research Centre, TDC site. An anaerobic pilot plant was installed at the Zenien Sewage Treatment Plant (STP), Giza, Cairo. The effect of heavy metals on the efficiency of the anaerobic digester was studied. The inhibitory and toxic level of metals was determined in this study. The general ranking of heavy metal toxicity appears to be  $Hg > Cd > Cr(III)$ . The present investigation reveals that heavy metals addition to the anaerobic digester decreased the efficiency of the process. A Significant decrease in gas production and volatile organic matter removal was obtained. It was also noted that an accumulation of organic acid intermediates was obtained as a result of methanogenic bacterial inhibition. This accumulation was limited during the pulse feed of metals. This is due to the rapid poisoning of the active bacterial forms in the digester.

## The Effect of Pesticide Residues and Heavy Metals on the Water Quality in Gaza Strip and Their Impacts on Health

Amani Alfarra<sup>a</sup> and Mazen Hamadah<sup>b</sup>

A- Bank of Palestine Center Bldg. Gaza El Rimal, App.910/911, P.O.BOX:1388, Gaza - Palestine, Email:  
amani.alfarra@gmail.com

B- Al Azhar University Gaza, Faculty of Science – Chemistry Department, Gaza Strip -Palestine , Email:  
mazenhamada@hotmail.com

### Abstract

Gaza Strip in Palestine is located on the southern shores of the Mediterranean Sea. It is like many arid and semi – arid countries water is becoming an increasingly scarce resource. The groundwater quality of the Gaza Strip is generally very poor. Water quality of the coastal aquifer underlying the Gaza Strip has deteriorated severely for a number of reasons. The most important reasons are saline water intrusion, wrong solid waste disposal, the agricultural pollution of the groundwater by the use of fertilizers, pesticides and soil amendments and the uncontrolled discharge of the wastewater over the soil surface. The groundwater quality changes in both horizontal and vertical directions. Water sources also receive inputs of many different chemicals such as heavy metals, leaching from dumping the solid waste, and there is also concern about the impact of such heavy metals on the health of the Palestinian people in Gaza Strip.

This paper has the following objectives:

- ♦ To demonstrate the occurrence of pesticide residues and heavy metals on the quality of water in Gaza Strip.
- ♦ To highlight the environmental and health impact of misuse of pesticides and heavy metals in drinking water.
- ♦ To describe how improvement of management usage of pesticide and solid waste lead to protect health of people and reduce related diseases.

It is estimated that 96.6% of irrigated land is treated with pesticides. The total quantity of pesticides used in Gaza strip is almost equal to that in West Bank despite the difference in agricultural areas. People who formulate and apply pesticides are risking both acute and chronic diseases. Many severe poisoning cases have been registered at al Shifa and AlAhly Hospitals in Gaza caused by the misuse of the forbidden Pesticides. The number of cancer patients in Gaza Strip was increased drastically in the last years. There are no available data about the concentration of pesticides in the water systems of the Gaza Strip except the lonely analysis done in 1997 for some wells by Israelis laboratories. In this paper we will focus on the dangerous impact on health due to pesticide and heavy metals contaminations of drinking water.

## **The Impact of Some Heavy Metals (Cd, Cr, Pb, Zn, Cu, Ni) Dissolved in Treated Wastewater on Soil and Groundwater: A Case Study of Mornag (North Tunisia) and Zaouit Sousse (the Tunisian Sahel) Irrigated Zones**

Abdelkrim CHAREF, Sami KLAY, Malika METHAMEM, Zouheir AYADI and Ammar M'LLAYEH

Centre of Sciences and technology of waters; Techno Park of borj Cedria- BP 95, 2050 Borj Cédria, Tunisia.  
E-mails : Abdelkrim.Charef@inrst.nrnt.tn, Methamem.malika@inrst.nrnt.tn, klay\_sami@yahoo.fr, ayadi\_citet@yahoo.fr and a\_mlayah2001@yahoo.com

### **Abstract**

The reuse of no conventional water resources for the agriculture irrigation can be dangerous source of pollution. So, it is necessary to study the impact of the reuse of Treated Waste Water (T.W.W.) on soil and ground water.

We are interest, for this work, to heavy metals accumulation (Cd, Cr, Pb, Zn, Cu, Ni) in soil and groundwater. The irrigated perimeters of Mornag (North Tunisia) and Zaouiat-Sousse (Tunisian Sahel) are selected for this study.

The Mornag and Zaouiat-Sousse perimeters are respectively irrigated by the Treated Waste Water for 14 and 16 years.

Heavy metals Contents of Zaouit Sousse T.W.W. lies between 14 and 2506 ppb. The heavy metals concentrations of Mornag and Zaouit Sousse soils which irrigated by T.W.W. are respectively between 1.6 and 62 ppm and 0.1-3.7 ppm. These tenors are higher than the other perimeters which irrigated by conventional waters.

For Mornag ground water, the heavy metals tenors are between 0.1 and 49 ppb and under the Tunisian standards. At Zaouit Sousse wells, they are higher (43-12780 ppb).

For ground waters, on the one hand we have Mornag where waters are not polluted and on the other hand the Zaouit Sousse water table where you observed obvious pollution.

The data show that all metals are probably absorbed by the cultivated plantations and/or adsorbed by the sediments of the unsaturated zone when it have a weak permeability us we have in Mornag perimeter. But the one part of pollutants can migrated toward the deep zones of Zaouit Sousse because we have a high permeability of the unsaturated zone.

## **Socio-Economic Aspects of Wastewater Reuse in Gaza Strip**

Al-Dadah, J.Y.

M.Sc. in Agricultural and Environmental Science  
Palestinian Water Authority, Gaza Strip

### **Abstract**

The aquifer in Gaza Strip is continuously over-pumped and the gap between water demand and water supply increases. The agriculture is the main consumer of groundwater. Wastewater reuse could be an option to cover part of the demand. The future of water balance in the area will depend upon the portion of effluent reused in irrigation and to recharge the aquifer. Safe and feasible wastewater reuse schemes is a prerequisite to progressively launch 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 rainfed and increase the crop production economically, moreover to activating the job creation programs.

## **Water Transformations: From Socio-economic Good to Water as a Human Right**

Odeh Al-Jayyousi

IUCN-Regional Director  
Amman-Jordan

### **Abstract**

This paper aims to explore the transformations of the meaning of water from being a public good to a social good with an economic value (or socio-economic good) to water as a human right. The transformations of how water was viewed and acknowledged in the 20th century are addressed in light of globalization and the emergence of the concept of water as a social good with an economic value. The relevance of “water as a human right” to the Millennium Development Goals (MDGs) will be discussed.

Water governance and its implications on human right are discussed to demonstrate the necessity for strengthening water governance models and setups to ensure appropriate implementation of water for human right. Conclusions and recommendations are outlined with emphasis on the value of seeing the synergies in the 3-global visions which are water for people, food and nature.

## **Sustainable Community Water Project Implementation in Jordan**

Samira Smirat, Stan Benjamin and Noel Keough,  
PLAN:NET Ltd.

### **Abstract**

Since 1998 PLAN:NET Ltd., a Canadian development consulting company with offices in Amman, Jordan has been involved in two local water management projects in Jordan. The first project, initiated in 1999, (Jordan Valley Integrated Waste Management Project (JVIWMP)) focused on the design and installation of a zero effluent septage treatment facility, and farming operation in the central Jordan Valley. JVIWMP was jointly funded by the Government of Jordan and The Canadian International Development Agency. The executing agency was Komex Engineering of Calgary, Canada. The second project, initiated in 2004, (Greywater Treatment and Use for Poverty Reduction in Jordan (Phase II)) is an applied research project designed to test the feasibility of the scaling-up of household greywater treatment and reuse systems in five peri-urban communities of the Karak Governate in the south of Jordan. The Greywater project is being funded by Canada's International Development Research Centre (IDRC). The executing agency for this project is The Inter-Islamic Network on Water Resources Development and Management (INWRDAM). In both projects PLAN:NET Ltd. was invited to play an enabling role as facilitator of a community participation process to ensure successful installation and operation of the wastewater and greywater technologies.

This paper begins with a summary of the water management context in Jordan and internationally. This is followed by the two case studies. Each case study will describe the project communities and the technologies employed. We then present the participation and sustainable development models informing in the execution of the community participation component (CPC) of each project. Next the paper presents the activities associated with each project, the major issues encountered and the community outcomes achieved. Finally, the paper discusses lessons learned that the authors believe are of value to future water management projects in Jordan, MEDA countries and beyond. Of particular importance, in our view are the reflections on the relationship between the technical and cultural dimensions of local water management. We anticipate that the lessons learned from our experience will inform the ways in which such collaborations can be strengthened to the mutual benefit of the communities in which water projects are being implemented, of governments who look to such projects to deliver clean and sufficient water to communities, and of water management professionals whose business it is to design safe and effective water systems.

## Experimental Aquasave Project in Households

B. Failla (ENEA-PROT-IDR)

B. Failla; ENEA.PROT.IDR (Section of Wastewater Treatment and Water Cycle); Via Martiri di Montesole, 4; 40129 Bologna (Italy). Fax: +39 051 6098584; Telephone: +39 051 6098572; E-mail: biagio.failla@bologna.enea.it B.

Failla, L. Stante, ENEA [Italian National Agency for New Technologies, Energy and Environment (Section of Wastewater Treatment and Water Cycle); Via Martiri di Montesole, 4; 40129 Bologna (Italy), ARPA (Environment Regional Agency of Emilia Romagna); Az.USL (Bologna City Health District); G. DOZZA Cooperative society; Scagliarini (Architect); Hera S.p.A. (Emilia-Romagna Company for Energy, Environment and Water); Bologna Municipality.

### Abstract

#### Objective

Water is a precious resource for life and its needs; it must be protected and used in an appropriate way. Water management analyses show water demand in the world always high and water resource availability not unlimited. In geographic areas where the resources are not able to satisfy the demand, water saving on traditional consumption could be a way to contribute to satisfy the demand needs. Drinkable water use in household is not always appropriate; only a small consumption percentage is used for drinking and for food preparation (~4%), the remaining part is consumed for other uses (e.g.: toilet flushing, floor and cloth washing, etc. ). According to these considerations, it could be interesting to identify a new way of water management able to save part of traditional consumption of drinkable water in the city, and in particular part of the one used for toilet flushing, cloth washing, etc. A model could come from feasibility studies and experimental developing tests of new ideas like the following ones:

- using rainwater coming from roofs, e.g. for cloth washing
- reusing water consumed for body washing, e.g. for toilet flushing feeding
- water consumption reduction by installation in households of components at low water consumption and of course by minimizing water consumption excess (e.g. the one due to piping ruptures, tap leakages, forgetfulness of open taps). According to this aim, our Aquasave Project (AP) deals with consumption saving of potable water in cities by integrated use of water resources in households. Tests have been conducted to study and evaluate the potentiality of drinkable water saving in households by means of an experimental new model of water resources use management implemented in the city of Bologna in Italy. The European Commission, with the decision "Life 97 Environment /IT/000106" in the framework of the life-environment actions, has financed 50% of the project total cost.

Experimental technologies The experimental technologies of the water management model, installed in new residential building, are described below. The model maximizes reuse by a) grey water reuse system: it collects, Treats and sends grey water (coming from showers, bathtubs, and washbasins located in bathrooms) to toilets flushing; b) rainwater use system: it collects, treats and sends rainwater (coming from roof) to dishwashers and washing machines [these appliances use treated rainwater at washing cycle beginning and drinking water at washing cycle ending (of the total water consumed in the appliances ~66.7% comes from the rainwater treatment system, and ~33.3% comes from the drinking water supply system)]. The treatment plant is automatic. The model minimizes waste production by installation in the flats of components (e.g.: taps, toilets, appliances) at low water consumption. Separated water distribution and discharge systems have been adopted; in this way, there is no possibility of drinking treated grey water or treated rainwater. A dedicated "ad hoc" system allows consumptions monitoring of the AP proposed model. In order to monitor water quality, to optimize and to evaluate the plant performance, a dedicated "ad hoc" sampling system allows drawing and characterization (by chemical, physical, and microbiological laboratory analyses) of any kind of liquid flowing both in the piping of the separated discharge networks (e.g.: liquid coming from kitchen sinks, bathroom washbasins, showers, washing machines, etc.) and in the piping of the treatment plant. The building, where the technologies are installed, has eight flats distributed on three storeys; the construction phase was completed by autumn 2000. The roof surface is about 200 m<sup>2</sup>. The plant room surface is about 90 m<sup>2</sup>. The persons living in the flats are 22.

### Results

The results obtained show a valid possibility for drinking water saving in households. The main results, accomplished from November 2000 till November 2001, concern:

- consumption comparison between the AP proposed system and the traditional one
- consumption percentage of components at low water consumption (taps, washing machines, dishwashers, toilets), installed in the flats, by means of the water consumptions monitoring system
- complete disinfection (with faecal coliforms up to zero) of the rainwater and grey water by means of appropriate peracetic acid dosage. In particular, the potential water saving percentage of the AP proposed system [whose average consumption is ~74 litres / (day, person)] compared to the traditional one [whose average consumption is ~167 litres / (day, person)] is ~50% of potable water; of this water saving: a) ~30% is achieved by means of the components at low water consumption, b) ~15% is achieved by means of



the grey water reuse system; c) ~5% is achieved by means of the rainwater use

System. The treated grey water percentage, coming from body washing, is ~33% of the total water consumed in the flats; and, it is enough to feed 23% of the water consumed for toilet flushing installed in the same flats. The treated rainwater use allows ~8% saving of the total water consumed in the flats. Moreover, the Aquasave innovative techniques proposed have been analysed and compared with the existing drinking and wastewater treatment systems of the Bologna metropolitan area by means of Life Cycle Assessment (LCA); LCA results highlighted that the adoption of the techniques proposed does not place a significant additional environmental burden on all the environmental impact categories analysed. The 50% potential reduction of water extraction from the environment can be considered as the availability of a new water resource. Experimentation continuation can produce new data and information on the sustainability of water saving technology; which could be developed in order to improve water quality and to reduce realization costs.

## Environmental Assessment for Gaza Emergency Sewage Treatment and Infiltration

S. Ghabain<sup>1</sup>, R. Rustom<sup>2</sup>, Y. Sarraj<sup>3</sup>, S. Taha<sup>4</sup> and A. Mushtaha<sup>5</sup>

<sup>1</sup> Water Quality Expert, Engineering and Management Consulting Center, Gaza, Palestine, aidghabayen@yahoo.com <sup>2</sup> Associate Professor of Civil Engineering, Islamic University – Gaza, Palestine, Rustom@mail.iugaza.edu

<sup>3</sup> Associate Professor of Civil Engineering, Islamic University – Gaza, Palestine, ysarrag@ccast.ps

<sup>4</sup> Consultant Engineer, Engineering and Management Consulting Center (EMCC), Palestine, emcc@p-i-s.com

<sup>5</sup> Hydrologist, Palestinian Water Authority, Gaza, Palestinian Authority, ashraf@mushtaha.net

### Abstract

Due to the escalating environmental problems of the existing Beit Lahia wastewater treatment plant (BLWWTP), the World Bank has agreed to finance an emergency sewage treatment project in the Northern Gaza (Figure 1). Phase I of the project comprises construction of nine infiltration basins in a new site at the eastern borders of Gaza and conveying the partly treated effluent from the existing BLWWTP to these new infiltration basins. Phase II comprises the construction of a new wastewater treatment plant at the new site. Based on the World Bank operational policy 4.01, this project is classified as category A (projects that are likely to have significant adverse impacts that are sensitive, diverse, and unprecedented). Category A projects requires a comprehensive environmental assessment (EA) including a detailed Environmental Management Plan (EMP). This paper presents the main part of the conducted EA focusing on the groundwater aquifer issues. A finite difference groundwater modeling tool was utilized to assess the impacts of the proposed project on the aquifer and to identify the mitigation and monitoring requirements. The proposed project was found to improve the water availability and the chloride concentration in the aquifer. On the other hand, the project may cause noticeable increase in the nitrates concentration in the aquifer underneath and in areas within 1,500 meters from the infiltration basins unless certain precautions and mitigations are implemented. The proposed EMP delineates the required mitigation measures, monitoring actions, and the needed institutional arrangements to assure that the negative impacts are well contained.

## **Cost Benefit Analysis for Centralized and Decentralized Wastewater Treatment System (Case study in Surabaya-Indonesia)**

Maria Prihandrijanti<sup>1</sup>, Almy Malisie<sup>2</sup>, Ralf Otterpohl <sup>2</sup>

<sup>1</sup>Centre for Environmental Studies, University of Surabaya, Raya Kalirungkut, Surabaya 60293, Indonesia

<sup>2</sup>Institute of Wastewater Management and Water Protection, Hamburg University of Technology (TUHH),  
Eissendorferstrasse 42, 20173 Hamburg, Germany

Email Address: prihandrijanti@ubaya.ac.id<sup>1</sup>, almy.malisie@tu-harburg.de<sup>2</sup>

### **Abstract**

#### Introduction

Around three million inhabitants of Surabaya, the second biggest city in Indonesia, still dispose their wastewater to water bodies. This is mainly caused by lack of adequate wastewater treatment system. However, large-scale centralized wastewater treatment is not an economical option particularly for people living in low-income urban areas. Decentralized wastewater treatment systems that are more affordable are being developed.

In order to have a sustainable wastewater treatment system, an integrated assessment of each alternative based on its economical, environmental, social, health and institutional aspects is necessary. This study explores the economical aspects of three scenarios of wastewater treatment system, with Kalirungkut sub-district, a densely populated urban area in Surabaya, as a case study area. The costs and benefits of alternative interventions are evaluated using the cost benefit analysis (CBA) method to support the decision making process by bringing elements of transparency and objectives.

#### Centralized Treated Wastewater System

In 1996, a master plan for sewerage and sanitation development was written for the city of Surabaya. In this Master Plan for the year of 2020, the wastewater would be treated in off-site modules by using shallow sewerage as conveyance system and Imhoff Tanks as treatment technology. Unfortunately this master plan has not been implemented yet due to some constraints and lack of funds. To solve water pollution from domestic wastewater, decentralized wastewater systems have been constructed in some areas.

#### Decentralized Treated Wastewater System (DEWATS)

The DEWATS-Indonesia project is publicly funded private cooperation between the German and Indonesian non profit organizations, Bremen

Overseas Research and Development Association (BORDA) and Institute for Rural Technology Development (Lembaga Pengembangan Teknologi Pedesaan). DEWATS is based on the principle of low-maintenance since most important parts of the system work without technical energy inputs and cannot

Be switched off intentionally. DEWATS applications provide state-of-the-art-technology at affordable prices because all of the materials used for construction are locally available. DEWATS applications are based on basic technical treatment modules which consist of baffled upstream anaerobic reactors for greywater treatment and anaerobic digester for blackwater treatment.

Another decentralized wastewater treatment alternative that this study considers is Ecological Sanitation (Ecosan) that follows similar ideas as DEWATS. In addition, Ecosan aims to full reuse of nutrients. Another Ecosan principle is to prevent the mixing of pathogenic bacteria from human waste with the wastewater that are going to be returned to the environment. Furthermore, Ecosan is able to recover valuable nutrients from domestic wastewater, particularly in human urine and faecal matter. These nutrients would not be recoverable if they are diluted with large amounts of wastewater in the conventional sewerage systems.

The Ecosan pilot plant in the case study area separates wastewater into brownwater (human faecal+flushing water), yellowwater (human urine+flushing water) and greywater. Brownwater is contained and treated separately into compost using worms (vermicomposting), while yellowwater is stored separately for 6 months to have a hygienisation process. Greywater, which originates from bathing and washing activities contains less organic matter and is treated with horizontal flow sub-surface constructed wetland.

#### Cost Benefit Analysis (CBA)

In this study, CBA is used to compare the investment costs with the expected benefits, expressed in monetary units and discounted over a certain period. The viewpoint and boundary condition of this analysis are:

- economical (construction, operation and maintenance costs)
- society (direct expenditures avoided due to less illness from diarrhoeal disease)

However, there are still many intangible costs as well as benefits, which are not constituted or represented by a physical object and very difficult to measure and are not included in this study, such as the:

- impact of different effluent quality from several wastewater treatment system
- - benefits from the reduction of soil infertility through usage of human excreta as soil conditioner, etc.

This study is conducted using three scenarios: Sewerage system based on the Surabaya Master Plan; DEWATS system and Ecosan system. A number of sensitivity tests are carried out to show how changes in certain parameters would affect indicator values. Results of this test showed a sensitivity to changes

In construction cost and benefit start.

### Conclusions and Recommendations

The results of cost benefit analysis in this study showed that the decentralized system was more feasible economically for this case study, since the centralized wastewater treatment system had the highest net present value cost and the lowest cost benefit ratio. To support decision making regarding the sustainable wastewater treatment system for this area, further assessment on environmental, health, social and institutional aspect are recommended.

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### **Keywords**

ecosan, centralized, cost-benefit, DEWATS, wastewater

## Zer0-M, Shifting Wastewater From a Disposal Problem to An Asset

Martin Regelsberger\*, Ahmet Baban\*\*, Latifa Bouselmi\*\*\*, Hussein Abdel Shafy\*\*\*\*,  
Bouchaib El Hamouri\*\*\*\*\*

\*AEE INTEC  
Feldgasse 19, 8200 Gleisdorf Austria  
m.regelsberger@aec.at

\*\* Tübitak - Marmara Research Center, Gebze, Turkey \*\*\* Centre de Recherches et des Technologies des Eaux  
Laboratoire Traitement et Recyclage des Eaux usées, Soliman, Tunisia \*\*\*\* National Research Center, Cairo,  
Egypt

\*\*\*\*\*Institut Agronomique et Vétérinaire Hassan II, Rabat, Morocco

### Abstract

Zer0-M, short for Sustainable concepts towards a zero outflow municipality, is a project financed by the MEDA Water programme of the European Union (EU). Zer0-M aims at concepts and technologies to achieve optimised close-loop usage of all water flows in small municipalities or settlements (e. g. tourism facilities) – the Zero Outflow Municipality.

A key idea in Zer0-M is to integrate water supply, wastewater treatment and reuse. Actually it is about abandoning the concept of “waste” water, because on one hand there is no water to waste, and on the other disposal is a poor concept, which so far has proved very unsafe. From a disposal problem we should shift to an asset, which has to be developed. In order to encourage implementation of this concept in real systems Zer0-M is presently building so-called training and demonstration centres on one side, with a great variety of different techniques to be tested and shown, and pilot plants on the other side to implement and demonstrate the same techniques under real conditions.

First results about grey water in MEDA countries will be discussed. Water demand and saving measures in rural areas of MEDA countries as well as simple potable water substitution techniques will be presented on the basis of studies and implementations of Zer0-M.

## Pharmaceuticals in STP : Results of a Program in France

FENET Hélène\*, GOMEZ Elena, LECLERC Marie, CASELLAS Claude

UMR 5569 Hydrosiences Montpellier, Université Montpellier I, Av. C. Flahault, 34060 Montpellier, France. \*

Corresponding author : FENET Hélène

UMR n° 5569 Hydrosiences Montpellier (Cnrs-Ird-UM1-UM2)

UFR des Sciences Pharmaceutiques et Biologiques

Université Montpellier I

15 Avenue Charles Flahault BP 14491 34093 Montpellier Cedex 5

Tel : direct 33 (0) 4 67 66 81 85 Fax : 33 (4) 67 54 86 95 - E-mail: hfenet@univ-montp1.fr

### Abstract

Pharmaceuticals and/or their metabolites are released continuously into the aquatic environment primarily by the means of sewage treatment plants (STP) after their therapeutic or diagnostic use. They are not always readily eliminated and might reach surface waters. Pharmaceuticals are substances or mixtures having curative or preventive properties with regard to human or animal diseases and can thus interact with specific biological targets. Within the framework of the National Program of Ecotoxicology in France some drugs were quantified in influents and effluents of two wastewater treatment plants. Carbamazepine, an anti-convulsivant, was found in the studied sites at concentrations reaching 0.35 µg/l. Fenofibrate and gemfibrozil, were detected in influents at concentrations close to 1.5 µg/l; these two fibrates, when detected, were found at low concentrations (0.05 µg/l) in effluents testifying of an important rate of elimination by STPs. Ibuprofen and diclofenac, were detected in influents at concentrations close to 3 µg/L; in effluents, they could not be quantified. Ecological and human risk assessment related to the presence of drug residues in waters need to be addressed.

## **Effects of Effluent Irrigation on the Carbon Dynamics in Soils of The Middle East**

Jüschke, E. and Marschner, B.

Department of Soil Science/Soil Ecology, Ruhr-University Bochum, Universitaetstr. 150, 44780 Bochum,  
Germany (E-mail: Elisabeth.Jueschke@rub.de, Bernd.Marschner@rub.de)

### **Abstract**

In many arid and semi-arid regions, the demand for freshwater as drinking water and other domestic uses is constantly growing due to demographic growth and increasing standard of living. Therefore, less freshwater is available for agricultural irrigation and new water sources are needed. Treated wastewater (TWW) already serves as an important water source in the Middle East. Related to its high loads with nutrients, salts and organic materials its use as irrigation water can have major effects on the soil physical, biological and chemical properties, in the worst case leading to soil degradation. Organic compounds reach the soil with the effluent water and microbial activity is stimulated therefore. Soil organic carbon seems to accumulate in the topsoil and tends to decrease after long-term irrigation with secondary TWW in the subsoil. Priming effects could be found in the soils and were stronger for subsoil (1 m depth).



## The Response of Corn to Irrigation with Treated Waste Water in Semiarid Area in Palestine

Jihad Mustafa<sup>1</sup>, Claude Elama<sup>2</sup>, and Jaber Maslaha<sup>3\*</sup>

<sup>1</sup>Department of Environmental Science, College of Science and Technology, Al-Quds University, P.O.Box20002, Jerusalem-Abu Dies, Palestine, tel.: + 972 2 2522287. E-mail: jahadjar@yahoo.com

<sup>2</sup>Department of Food Science, College of Science and Technology, Al-Quds University, P.O.Box 20002,

Jerusalem-Abu Dies, Palestine, tel.: + 972 2 2799753, fax: + 972 2 279690, email: elama@science.alquds.edu  
<sup>3</sup>Department of Life Science, College of Science and Technology, Al-Quds University, P.O.Box 20002, Jerusalem-Abu Dies, Palestine.

### Abstract

Treated wastewater can be considered as a solution for saving fresh water and mineral fertilizers and obtaining the same or better economic results. The effect of irrigation with treated wastewater on the growth rate, fresh weight, yield, chemical composition, and nutrient concentration of corn (*Zea mays* L.) tissues at two different growth stages was studied under field conditions. The results had shown that irrigation with treated wastewater significantly increased corn growth rate, fresh weight, and yield compared to the fresh water irrigation. The chemical composition of corn tissues was not significantly different between both treatments. Protein content was higher in corn tissues irrigated with treated wastewater but not significantly different compared to fresh water irrigation. Increase in growth rate, fresh weight, and yield of corn irrigated with treated wastewater compared to that irrigated with fresh water may be attributed to the increase of nutrient uptake.

## Quality Aspects of Reclaimed Water and Reuse Standard in Jordan

Uleimat, Ahmed Ali

Head, Environmental Monitoring and Assessment Division, WATER AUTHORITY of JORDAN, P.O BOX 3466  
CODE 13111, Amman – Jordan. Fax 00962-6-5825275, e.mail: ulimat\_jor@yahoo.com.

### Abstract

This paper, presents a summary about Jordan experience as a developing country in quality aspects of reclaimed wastewater and wastewater reuse standard. The following subjects will be discussed, wastewater quality & quantity, Reclaimed wastewater standard and guidelines, monitoring activities, treatment plants efficiencies, and the Characteristics of wastewater. Raw wastewater is mainly comprised of water (99.9%) together with relatively small concentrations of suspended and dissolved organic and inorganic solids and the contaminants of greatest concern are the pathogenic micro- and macro-organisms. Jordan has very limited renewable water resources of only 143 cubic meter per capita per year which is basically at the survival level .As a result ,reclaimed water as a non-conventional water resources is one of the most important measures that have been considered to meet the increasing water demand of the growing population and industrialization . Over 60% of the Jordanian population is connected to sewerage system and raw wastewater is discharged to 22 wastewater treatment plants to be treated for minimum discharge standards and reuse requirements. The most common treatment processes in Jordan are activated sludge, Stabilization ponds and few trickling filters facilities. With the current emphasis on environmental health and water pollution issues, there is an increasing awareness of the need to dispose wastewater safely and beneficially depending on a comprehensive standard. In Jordan, appropriate standards and guidelines for water reuse are an important requirement to rely on reclaimed water as a resource. The previous water reuse standards were reviewed, and issued in 2002. The revised standards allow for a wide range of water reuse activities including, where economic conditions allow, highly treated reclaimed water for landscapes and high-value crops, and for lower cost smaller-scale treatment and reuse activities with restricted cropping patterns. Wastewater use will result in the conservation of higher quality water and its use for purposes other than irrigation. Properly planned use of municipal wastewater alleviates ground and surface water pollution problems and not only conserves valuable water resources but also takes advantage of the nutrients contained in sewage to grow crops.

### Key Words

Reclaimed water, reuse, Domestic wastewater, sustainable

## Evaluation of Wastewater Treatment Plant in Sana'a, Yemen

Fadhl Ali Al-Nozaily\*; Fath Khidhr Radhwan\*\*; Abdulwahab Ismael Salah\*\*\*

\*Sana'a University, College of Engineering and Water and Environment Centre, P.O. Box 13790, Sana'a, d-fadl@maktoob.com.

\*\*National Academy for Environment, Amman, Jordan, fath\_Radhwan@yahoo.com

\*\*\*Ministry of water and Environment, Sana'a water supply and sanitation local corporation, Sana' a

### Abstract

The Activated sludge- Extended aeration wastewater treatment system in Sana'a is considered as a flexible and powerful technology expected to achieve high performance and eventually produce effluent with pollutants concentrations safe to the environment. However, this treatment system is operated and maintained at high cost compared to other technologies. This is due to the underestimated design parameters applied in 1985 and not updated when updating design in 1994. The applied design parameters have changed due to the drought period Yemen have experienced and led to low water consumption causing higher concentrations of pollutants in the incoming wastewater. The existing BOD5 is higher than 1000mg/L which is two times higher compared to the design value of 500mg/L. This resulted in an overloading of 200% higher than the design loading although it has not yet reached the design hydraulic loading. This overloading has resulted into lower efficiency and therefore high pollutant concentration at the effluent compared to the design values. Additionally, the drying beds are malfunctioning due to the inadequate operation and maintenance. In spite of addition of polymer to the wet sludge in order to coagulate and ease to separate the water from sludge, the drying period is 20 days compared to the design drying period of 10 days. Therefore, the drying beds at the moment are not able to absorb all the excess sludge at the aeration tank. This caused accumulation of sludge in the aeration tank and re-suspension of sludge from the final settling tank with effluent water. These problems require precise and scientifically sound steps for operation in order to achieve effluent at concentration safe for environment. The aim of this paper is to assess the Sana'a wastewater treatment plant performance in order to overcome the difficulty and malfunctioning of the plant and to correct the operational problems to achieve better performance. The results were summarized in a couple of operational measures towards corrections of the malfunctions of the treatment plant such as: A movable trap with crane could be installed at the inlet chamber; Conducting awareness

campaign among people to explain the problems created at the WWTP from disposing big solids, oils and storm water to the wastewater network; An extension of the inlet pipe to separate the return sludge from the influent; Desludging frequently at 40% DS and the sludge cake is tendered to a private company to be composted and sold as fertilizers; Replacing the top layer of sand in the drying beds to speed up

The drying process; Impose on the workshops to install oil traps or pretreatment before discharging into network; Install Oil separation at the inlet of WWTP; Decrease the MLSS concentration up to the design value of 4000mg/L.

he drying process; Impose on the workshops to install oil traps or pretreatment before discharging into network; Install Oil separation at the inlet of WWTP; Decrease the MLSS concentration up to the design value of 4000mg/L.

**Key words**

Sana'a, Activated sludge, BOD, overloading, operational parameters, drying beds, evaluation.

## Management Practices of Sludge and Bio-solids in Jordan

A. Shraideh\*, S. Malkawi\*\*, W. Suleiman\* and A. Ulaimat\*\*

\* Environmental Research Center, Royal Scientific Society, P.O.Box: 1438, 11941, Amman, Jordan  
E.mail: asma@rss.gov.jo, wael@rss.gov.jo

\*\* Water Authority of Jordan, Ministry of Water & Irrigation, P.O.Box: 2412, 11183, Amman, Jordan  
E.mail: saleh\_malkawi@mwi.gov.jo , ulimat-jor@yahoo.com

### Abstract

The Royal Scientific Society RSS of Jordan, in cooperation with the Water Authority of Jordan WAJ, carried out a field survey during the period Aug.-Dec. 2005 to investigate and assess current management practices of sludge and bio-solids in Jordan including treatment, handling, testing, disposal and application. The survey which involved All MWTPs operated by WAJ revealed that thickening and natural drying are the most predominant sludge treatment processes in Jordan. Solids loadings for thickeners at some plants exceed typical design values. Moreover, drying beds capacity need to be increased at some MWTPs. About 300,000 m<sup>3</sup> of liquid sludge as well as 15,000 m<sup>3</sup> of dewatered bio-solids are generated annually at the designated sites. Liquid sludge is transferred on daily basis to adjacent dumping sites while dewatered bio-solids is either buried within the premises of the treatment plant or piled in an open area to be transferred later to dumping sites. The survey emphasized the need for a definite strategy for bio-solids management at MWTPs and the potential beneficial uses in Jordan. The capacity of governmental stakeholders need to be upgraded to help set and implement relevant policies/action plans. Outreach programs need to be designed and implemented to indicate potential beneficial uses and proper handling practices.

## **Integrated Water Resources Management, Aquifer Storage And Recovery Modelling in Langat Basin**

Prof Rakmi Abd Rahman<sup>2</sup>, Prof madya Abdul Ghani Rafek<sup>3</sup>, Prof Mazlin Mokhtar<sup>4</sup>, Dr  
Noor Ezlin Ahmad Basri<sup>1</sup>, Mohammad Fawzi Al Ajlouni<sup>1</sup>

<sup>1</sup>Department of Civil and structural Engineering <sup>2</sup>Department of Chemical and Process <sup>3</sup>Center of Environmental  
Sciences and Natural Resources Studies  
<sup>4</sup>Institute of Environment and Development

### **Abstract**

Competitions for water will increase in Langat basin, with increases in population and with new and continuing efforts to stimulate economic development, improve income levels and achieve food security. Water scarcity and the inefficient allocation of water can limit the pace of economic development in any regions, particularly when nations are unable to implement agreements that enhance the sum of net benefits generated with water resources.

Meeting the public's every increasing demand for potable water is becoming a major problem for every country, The purpose of this research project was to deals with the important subject of water scarcity in Malaysia following a work plan on how to deal with this problem by means of an Integrated Water Resource Management an overall understanding of the integrated water resources management, through researching the following tools of Integrated Water Resources Management:

- (i) Water resources.
- (ii) Runoff storage.
- (iii) Wetlands.
- (iv) Aquifer storage and recovery.

This project focuses on determining the relationship between the volume of water storage in the aquifers and the ASR well recovered water efficiency. Modelling the relationship between the hydrological component using advanced water budget model, which we can apply the data from many resources to get the change in storage for the wetlands, aquifers, so, For each well we can know exactly when to stop recovering water. Proof of this study capability is given by comparing our Study results with some other studies.

### **Keywords**

Water resources t, Runoff storage, Aquifer storage and recovery, water budget modeling..

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