Development of an Approach for Drought Monitoring and Drought Planning For Jordan

Fayez Abdulla[1], Nassim Al-Abed[2], Jumah Amayreh[2]

Abstract

The potential for the occurrence of drought and the associated adverse consequences for the economy, polity, and society are an ever-present concern in arid region such as Jordan. Drought has been a prevalent feature of the Jordan landscape during the later part of the 1990s till year 2000, producing serious socioeconomic and environmental consequences. The recent experiences with drought have renewed concern about the inadequacy of government contingency planning efforts and the lack of coordination for assessment and response efforts between different levels of government. The general objectives of the study are: to develop a method for drought monitoring for Jordan as well as to prepare drought contingency plans for the government of Jordan that can be included with the overall water management planning activities. Such plans will intend to improve mitigation efforts through more timely, effective and efficient assessment and response activities. The specific objectives of this research are: (1) to develop a drought monitoring method using combination of truncation level, duration, and conditional probabilities of four indicators (precipitation, temperature, streamflow, groundwater drawdown); (2). To develop a planning process that can facilitate the preparation of drought contingency plans. This process can be followed by government decision makers to develop and implement plans to improve drought mitigation effort through timely, effective, and efficient assessment and response activities.

This research represent part of the role of the Jordan University of Science and Technology through the Queen Rania Al-Abdullah Center For Environmental Science and Technology in serving the local community as well as the government of Jordan in facing the drought problems in more efficient and scientific way.

Development of Guidelines and Assessment of Rainfall Harvesting from Rural Areas in Jordan

Majed Abu.Zreig[1], Fayez Abdulla[2], Abdallah Malkawi[3]

Abstract.

Water scarcity in Jordan demands the use of every raindrop in Jordan. The annual amount of rainfall is about 8500 million cubic meter of which only 5% is beneficially used as surface water and the rest is lost to evaporation and uncontrolled flood. Therefore minimizing runoff losses is of the highest priority to the government of Jordan.

Collecting the rain that falls on a building to be used nearby is a simple concept. Since the rain you harvest is independent of any centralized system, you are promoting self-sufficiency and helping to foster an appreciation for this essential and precious resource. Collecting rainwater is not only water conserving, it is also energy conserving since the energy input required to operate a centralized water system designed to treat and pump water over a vast service area is bypassed.

Water harvesting from rural and urban areas can increase the water supply for domestic and agricultural use. The use of microcatchments and sand ditches to increase soil water has been tested under Jordanian conditions (Abu.Zreig et al., 1999 a,b). However, rainfall harvesting from rural catchments has not received large attention in Jordan. In the absence of runoff sewer lines in Jordanian rural areas, rainfall harvesting from roads, parking lots and rooftops can increase water supply for various domestic uses and help combating the chronic water shortages in the country. It is the objective of this research proposal to investigate various methods of rainfall harvesting in rural areas and estimate the quantity and quality of runoff collected from different areas. Since Jordan does not presently inspect or enforce any guidelines regarding captured rainfall, in this project we will develop guidelines to rainwater harvesting.

The broad objective of this project is to assess rainfall harvesting in rural areas for various domestic uses such as irrigation of public parks, washing of streets, and building construction and to formulate some guidelines for water collection and storage. The specific objectives are:

1. To estimate the quantity of runoff that can be collected from various facilities such as roads, parking lots, public parks and roof tops.
2. To evaluate the quality of water collected from various surfaces
3. To investigate methods of collection and storage with minimal costs
4. To setup guidelines for water usage according to its quality and quantity
5. To investigate methods of onsite treatments of collected runoff such as sand filtration and sedimentation

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[1]Assistant Prof., Department of Agricultural Engineering and Technology, Jordan University of Science & Technology, Irbid 22110, Fax: 962-2-7095018, Jordan,

[2] Associate Prof of Water Resources & Environmental Eng.,Director of Queen Rania Al-Abdullah Center for Environmental Sciences & Tech.,Jordan University of Science & Technology, Irbid 22110, Fax: 962-2-7095044, Jordan,

[3]Associate Prof. of Geotechnical Engineering and Consultant to Ministry of Water and Irrigation-Jordan Valley Authority, Civil Engineering Department, Jordan University of Science and Technology,Irbid 22110 – JORDAN, E-mail: mhusein@just.edu.jo

1 Associate Prof of Water Resources & Environmental Eng.,Director of Queen Rania Al-Abdullah Center for Environmental Sciences & Tech.,Jordan University of Science & Technology, Irbid 22110, Fax: 962-2-7095044, Jordan,

2 Assistant Prof., Department of Agricultural Engineering and Technology, Jordan University of Science & Technology, Irbid 22110, Fax: 962-2-7095018, Jordan,

Shallow aquifers of the Tulul al Ashqaf, NE Jordan

Nizar Abu-Jaber
Yarmouk University, Earth and Environmental Sciences
Irbid, Jordan

Shallow aquifers in the Tulul al Ashqaf area in NE Jordan are actually perched aquifers confined to the thick alluvium in the area. They are recharged locally and seem to result from rapid infiltration into the permiable course-grained alluvium via surface runoff.

The significance to these aquifers is two-fold. The obvious significance arises from the potential use of these waters in areas where such resources are sorely lacking. In another sense, they represent windows into the process of recharge in arid regions. Thus they may help us to understand why, where and how much recgharge occurs in these areas. Moreover, knowlegde of why recharge is so high in these areas may help in determing how to enhance recharge in other arid areas. Recharge may be into shallow aquifers, as is the case here, or into the deeper upper aquifer. In both cases, water which would have been subject to evaporation and pollution at the surface would be protected and potentially used later, at the convenience of the user.

The area has been the subject of intense study over the past two years. Satellite photographs of the area were used in order to try and determine where new shallow aquifers may be in the area. The idea is that while three areas are known to have shallow water reserves, it is quite conceivable that there are more of them in the area. Satellite data was used to identify areas which may potentially have these aquifers. Inormation used include geomorphic and soil humidity and plant density data. Based on this initial survey, a ground survey was conducted in order to find the best areas for future exploration. Subsequent geoelectrical surveys suggest four new locations which seem to contain shallow water. Wells are being planned in the very near future in the areas which have been identified as being promissing in the geophysical surveys.

A detailed study of surface runoff characteristics of the area is also being planned as part of a doctoral research program to be conducted by Khaldoon Qudah, who is working towards his Ph.D.

ACSAD Experiences on the Use of Low Quality Irrigation Water in Middle East Countries

Gilani Abdelgawad, Abdelrahman Ghaibah
Soil and Water Use Adminstration
ACSAD-Arab-League
Damascus, Syria

In arid and semi arid areas in the Middle East countries, farmers who built their livelihoods on a reliable supply of freshwater are now faced with a critical shortage of this vital resource, impinging on all aspects of their relations with the environment. However, and over the past decade ACSAD had focused research on seeking the opportunities for improving agricultural productivity through the efficient use of semi saline and saline water. Major achievements have already been accomplished among which identification of salt tolerant crops, water requirements of strategic crops, management of two quality water resources, identification of the tolerance of phonological stages, monitoring salt balance as well as chemical equilibrium, suitability of irrigation method, doses and frequency of irrigation, leaching management, and optimum advantage of rainfall water. Research findings were obtained on open large filed experiment plots and in farmers fields and effort was made on extraction of such achievements in spread sheets guidelines and data basis covering water resources and their qualities, soil properties, climatic conditions and available plants tolerance data base.
Topics will cover:
-Yield functions of strategic crops versus salinity of irrigation water
-Moisture extraction pattern of some crops based on three years data and direct measurement of soil moisture with depth and growing period.
-The relation between ionic composition of saline water and ionic composition of soil solution extracted in field experiments using ceramic cups at field capacity.
-The impact of saline irrigation water on fruit and grain quality for some crops covering total sugars, carbohydrates, Vit.C, --
-The effect of management practices on yield; ie; alternate, continuous, cyclings, etc.
-Soil chemical equilibrium and precipitation of gypsum and CO3Ca .
-The impact of saline water on the ionic composition of water table.

The above said furnish the background for the inclusion of economic aspects, however, the economic aspects of using saline water was tackled by several researches such as Bresler etal 1983, Lefknoff and Steven 1990, knaps and Dinar 1984 and Dinar etal 1986. The key tool was linear programming procedures to determine the optimum solution based on experiences and targets and prices.

The procedures presented in the paper is appropriate for spreadsheet, software employing optimisation techniques (EXCEL) and actual constraints and the prevailing economical conditions using actual obtained relations and discussing the impact of threshold theory suggested by Mass and Hoffman(1986) and the validity of such concept on economical evaluation. Maximum profit takes also in consideration the boron content of irrigation water and the necessity of soil amendments with and without threshold.

Economical assessment considers the prices and constraint under Syrian conditions, however the spread sheet keys can be modified for other countries in the region.
Theoritical consideration are also presented.
Data are extracted from the research station belonging to ACSAD in Algeria, Morrocco, Tunisia, Lybia,Jordan, Iraq and Syria.
Key words:
Guidelines of saline water, irrigation management, salinity, optimisation.

BIOLOGICAL TREATMENT OF GROUNDWATER POLLUTED BY OIL USING AERO-FILTER WITH TUFFA FILLS

Dr Amjad Mourad Agha
Faculty of Civil Engineering
University of Aleppo, PO Box 6838, Aleppo, Syria

Syria is a country situated in semi arid zone and shares surface international water with surrounding countries. Need for water is increasing with time due to the development of agriculture and industries and the standards of life

Oil industries pollute the surface water resources and ground water reservoirs by infiltrating into the ground layers to the aquifers. If this phenomenon continues, it will pollute the surface and ground water resources.

Removing oil from ground water may take a long time, and the rapid reaction to stop oil from infiltrating is very important in order to prevent oil from reaching the aquifers

The decrease of nitrate concentration from (10 mlg/l) to (1 mlg/l) in the surrounding wells of an area of infiltrated oil to the ground water in calcareous rock. In case the amount of infiltrated oil is high, one can use the most known method of extracting oil from ground water table, which consists of local lowering of water table under the area of oil by ground water withdrawal. See fig. (1)

Industrial water coming from oil treatment factory contains higher concentration of substances that can be extracted by ether than the petroleum.

The problem in sewer systems is the degradation of hydraulic head due to presence of oil in the drainage network or other substances that oil facilitate its sedimentation on the pipes, leading to increase the roughness of this pipes and reducing the diameter of the drainage network.

Even if the oil does not affect the internal surfaces of the pipes by increasing the roughness or decreasing the diameter, it makes the entertainment of the network dangerous on health of the persons executing entertainment.

In pumping station of drainage systems, absorption well may be constructed in order to allow sedimentation of big size substances, and the small size substances to float on surface, and because it is rare that the water is pumped, the oil accumulates on the surface causing a big problem, very expensive to solve, for entertainment and cleaning of the pumps.

The oil locks the filters and the pipes of the pumped sludge and causes additional loads on the cleaning equipment, loosing time and money for entertainment.

If oil is not removed from pre-treatment plants, it may reach the biological treatment tanks, and then the filters.

In general, the oil substances increase the time and the budget of treatment plants, then removing it is very necessary.

Oil also may prevent oxygen diffusion resulting in the bad treatment work.

The initial and final sludge resulting in pre-treatment of sewer water containing oil must be removed out of treatment plants. This sludge contains oil substances the drainage to agricultural land is prevented.

IRRADIATION TREATMENT OF WASTEWATER IN JORDAN, THROUGH THE ESTABLISHMENT OF A PILOT PLANT IRRADIATION FACILITY ON THE EFFLUENT OF A WASTEWATER TREATMENT PLANT.

SARA ARAFAT, MINISTRY OF ENERGY AND MINERAL RESOURCES (MEMR), NUCLEAR ENERGY DEPARTMENT (NED), AMMAN, JORDAN

Like other neighboring countries in the Middle East, Jordan face challenging water shortage problems, scarcity of water in Jordan is not the only problem, but water pollution is another important one, it is obvious that trends in the quantity and quality of the pollution load has undergone various changes.

There is a potential to lessen the burden of these problems through the use of wastewater for irrigation after it has been disinfected and the contaminants have been removed using ionizing radiation in combination with conventional techniques.

The use of nuclear technology to recycle wastewater, particularly for irrigation purpose is foreseen to be a viable alternative in a semi-arid country as Jordan where the 16 existing treatment plants receive an inflow in excess of 200,000 Cubic meters per day.

According to the importance of water problems in Jordan NED received a support of a national project from International Atomic Energy Agency under the title “Pre-feasibility Study for the Reuse of Wastewater Through Radiation Processing” (JOR/8/006). This project will be implemented in co-operation with Water Authority of Jordan. The results of the study will provide information for the Government to base a decision on regarding the feasibility of a wastewater recycling pilot plant using ionizing radiation, where farmers would have additional water resources at their disposal for growing crops without tapping into precious fresh water supply.

Characterizing the water quality and contamination level of groundwater Along the Ceil Zarqa River Using the Fuzzy Logic Approach in GIS Environment

William Bajjali (wbajjali@nets.com.jo)
Institute of Archeology and Anthropology & Department of Earth and Environmental Science, Yarmouk University, Irbid, Jordan

GIS system was used to analyze, interpret and manage the quality of groundwater and characterize the most vulnerable locations for contamination along the groundwater flow path between the capital Amman and Zarqa areas.

To perform the study various geological, hydrogeological, wells, chemical, and environmental isotopes data digitized, georeferenced and integrated into GIS system.

Three parameters Total Dissolved Solids (TDS), NO3, and radioactive tritium (3H) were used as an input function to characterize the hydrochemistry, quality, and the residence time of the groundwater along the flow path. Three color-coded maps represented the TDS, NO3, and 3H were created. Each map demonstrates the distribution and describes the level of each parameter in the groundwater along the flow path.

The results show that significant variations occur in groundwater chemistry for the TDS and NO3- concentrations. These elevated values at various locations are attributed mainly to anthropogenic sources located in the study area such as, Ain Ghazal wastewater treatment plant, septic tanks, and Ruseifa landfill.
These contaminants have severely deteriorated the quality of groundwater of the upper carbonate aquifer. The presence of radioactive tritium in the groundwater shows that the residence time of the groundwater ranges between 1 and 50 years. Some groundwater wells of specific location demonstrate tritium levels equal to the tritium level of the precipitation in measured in Amman area, which indicates direct infiltration. These groundwater wells are also reveals high NO3 and TDS concentration.

The three maps were combined using a fuzzy logic model and a new color map was created. The map reveals the susceptibility of the aquifer to contamination at various locations along the groundwater flow path.

These GIS maps provide significant environmental information that could be used to manage the groundwater resources and protecting them from further contamination. The produced GIS color-coded map could also be used as a key factor in the public awareness and to promote the value of groundwater.
Teachings are an important step that could lead to improve the consciousness of the population about the water and its value for life and for future generation.

GUIDING PRINCIPLES AND OPTIONS FOR ACCELERATED EXTENSION OF WASTEWATER MANAGEMENT SERVICES TO SMALL COMMUNITIES IN MENA COUNTRIES

Hamed Bakir,
Sanitary Engineer and Regional Advisor on Rural Environmental Health
WHO Regional Centre for Environmental Health Activities, Amman, Jordan
Email: bakirh@who-ceha.org.jo

The paper presents the guiding principles and options for wastewater management in small communities in the Middle East and North Africa (MENA) which were adopted by the expert group consultation convened by WHO Regional Centre for Environmental Health Activities in November 2000. The paper also proposes promotional pathways for action.

In the water stressed countries of MENA, every drop of water including wastewater, must count. The water resources and wastewater management policies must come together in addressing the water cycle in a holistic manner. Water must be used efficiently to reduce the consumptive use of water and wastewater flows. Wastewater flows must be managed effectively to safeguard public health, and protect the freshwaters from pollution. They must be reintegrated safely in the water cycle and accounted for in the water budget of the household, community, industry, and the agriculture.

The costly and water intensive large centralized wastewater systems are currently the preferred choice of planners and decision makers. In many situations in MENA, centralized systems have actually aggravated the problem they were set to solve. Money is often not available to build centralized systems. Wastewater management needs remain unmet and pollution continues to consume the scarce freshwater resources.

The guiding principles call for a shift from centralized to decentralized wastewater systems to facilitate accelerated and environmentally responsible extension of wastewater services to small communities. Decentralized small wastewater systems at the scale of the household or neighborhood offer robust, efficient, and equally convenient solutions at much lower cost. They accommodate the necessary domestic water conservation efforts, reduce freshwater inputs in wastewater transportation thus eliminate unnecessary demand on freshwater, reduce associated environmental risks and increase reuse opportunities.

The enabling technologies and tools are well tested and established. Water conservation tools can reduce wastewater generation. Onsite systems must be improved to control pollution and to recover water. Greywater can be separated and used in non-potable applications. If total onsite management is not possible because of the site conditions, modular wastewater systems can be built using the lower cost and less water dependent settled sewers to collect the partially treated septic tanks effluent to a simplified neighborhood or community treatment facility after which the effluent is brought back into the community for beneficial use.

Decentralized systems are often met with resistance from conventional engineering practices often due to the lack of knowledge. Institutional reform must be introduced to recognize the decentralized systems. Rational planning processes are needed in order to analyze the spectrum of available development alternatives and to tailor the solutions to the social, environmental and economic circumstances in the target areas. Knowledge of the decentralized wastewater management options must be introduced to the policy makers, project planners and designers, project implementers, operators, and the community members through: college education; training of technical service providers; advocacy with planners and decision makers; networking to develop an informed community of agents of change; information exchange services; and research and demonstration interventions.

Optimal Management of Dam Water Storage in Arid Condition

BEN ALAYA Abdallah[1], SOUISSI Abderrazek[1], TARHOUNI Jamila[2], and NCIB Kamel[1]

Abstract:

The aim of this study is to identify an optimal management rule of the water storage of the Nebhana on the basis of historical available data. This dam is located in the central part of Tunisia and was been constructed in 1967 for irrigation purposes mainly.

The time series of water inflow (water volume runoff to the dam) and outflow (evaporation, infiltration, seepage, spilled way and crops water needs) are constructed and analysed firstly. In a second step, probability distribution function and forecasting models were been calibrated respectively for the water inflow and outflow series.

A dynamic stochastic model was been applied to carry out the optimal management rule of the water storage in the Nebhana dam. This rule will permit to estimate the optimal water volume that could be used for irrigation on the basis of actual storage water volume in this dam. In the dynamic stochastic model, the variability of the water inflow is expressed by its occurrence probability, the water outflow losses by theirs forecasting models and the management goals by weighting coefficients.

In the case of the Nebhana dam, the inflow water series is characterized by its comparative high variability, a non-normal statistical distribution and a decrease tendency. The water volume losses by seepage and infiltration throughout the dam are highly correlated to the stored water volume, this correlation is of quadratic type with a very high significant level. Compared to the stored volume, these losses are not negligible. Also, the lost water volume by evaporation are important and are related to storage water volume by linear model that is specific of the considered month.

The management objectives considered in this study are conflict and concern both the agricultural water demand satisfaction and a minimal water storage safeguard in the dam. By considering different weighting values affected to these objectives, different optimal management rules were been obtained. The identification of the best optimal management rule is accomplished by taking into account descriptor indicators deduced from simulation analysis. These indicators characterising the risk, the vulnerability and the resilience of the phenomena, such as water storage failure, spilled way volume or unsatisfactory of the water demand, are useful to analyse the system performance.

The predicted optimal spill way water volumes by means of the best optimal management rule identified in this study vary from one month to another and depend upon the stored water volume; in all the cases, they are rather lower than the maximal agricultural water needs of the hall irrigated area.

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1. *Ecole Supérieure d'Agriculture de Mograne, 1121 Mograne, Tunisia*
2. *Institut National Agronomique de Tunisie, 43 Avenue de Charles Nicolle, 1082 Tunis-Mahrajène, Tunisia*

Wastewater Treatment Using Constructed Wetlands Technology

Atef Hamdy° – Vito Sardo°°

ABSTRACT

A research was conducted by six partners in the Mediterranean area (Spain, Italy, Greece, Jordan, Egypt, Morocco) in order to assess the efficiency of phytodepuration in constructed wetlands to recycle wastewater for irrigation. Each partner installed six to seven depurating ponds of approximately 100m2, filled with gravel and coarse sand, where depurating plants were grown.

While reeds were a plant common to all the partners, each of them planted additionally a second species in order to compare their depurating efficiency. Generally, reeds performed better than the other plants tested, both in terms of depurating efficiency and of biomass production.

Results obtained by the partners were generally in a good agreement and can be summarised as follows:
-Transported solids, COD, BOD, were evidently impacted, with reduction rates ranging between.
-Opposite to that, no appreciable influence could be detected with most microelements (Cd, Cr, B, Br, Sr, Fe), with pH, EC; only Pb resulted consistently reduced.
-Also macronutrient content was affected to a various extent.
-Bacterial population was reduced to an extent that not always met the standards set by the WHO and EU regulations.
-The technology of constructed wetlands as experienced is simple, economic and straightforward, nevertheless some problems were experienced which must be taken into account in the future activities; such problems, once detected and focused, can be easily solved, however.

° Director of Research, CIHEAM/Mediterranean Agronomic Institute, Bari-Italy
°° Full Professor, Hydraulic Institute, Faculty of Agriculture, Catania University, Italy

The Intelligent Agent for the sustainable management of the territory: An experimental approach using an Expert System for the management of complex phenomena.

Borri D., Giordano R.
Dipartimento di Architettura e Urbanistica,
Politecnico di Bari, Via Orabona 4, 70125, Bari

The knowledge of the territory and the evaluation of the impact of local anthropic activities on it need a dynamic and relational approach to represent the qualitative variables of the environment for providing decision makers an helpful tool in planning the management of the territory.

This paper deals with the development of a system for the definition and implementation of a Decision Support System (DSS) – Expert System (ES) carried out combining the algorithmic potentialities of DSS (based on "formal" information) with those resolutive of an ES (based on "informal" information i.e. heuristic, personal judgments).

The developed system can be considered as a useful planning tool, able to provide information on the environmental impact of anthropic activities by examining their effects on groundwater quality. Anthropic activities, in fact, through different mechanisms, can worst groundwater quality because of chemical-, physical- and biological-pollution rising from civil, industrial and agricultural activities.

In the present study the municipal area of the Bisceglie town (southern Italy) has been investigated.

Given the peculiarity of such as area, characterized from a prevailing agricultural landuse, the problem matched in this study has been the local groundwater pollution caused by the use of pesticides. Therefore a methodology has been developed to assess the intrinsic vulnerability of a specific local aquifer by implementing the mathematical equations contained both in standard procedures (CNR – GNDCI method) and in a parametric managerial model (SINTACS), with relationships describing the interactions between different chemicals and subsoils.

According to such methodology, when a phenomenon cannot be modeled using it is necessary the integration the outputs of the GLEAMS model (a mathematical simulation to evaluate the effects of the agricultural practices on the groundwater) (Leonard, et al., 1987), and qualitative representation obtained from expert people.

To the Expert System, it has been specifically implemented with information concerning either the degradation of pesticides to form metabolites as well as their diffusion through unsaturated zone and groundwater. This approach allowed avoiding the construction of a complex computational model where the determination of the variables would result extremely difficult because of the interactions among different pollutants. The results of such approach have been compared with chemical analyses carried out in groundwater samples.

The used methodology makes the developed system capable to face unstructured problems characterized by an elevated degree of uncertainty, such as the one considered, and also to forecast, in an appropriate way, the decision of a decision maker, this represents the purpose of cognitive science i.e. the base of Artificial Intelligence.

Changes in arid land surfaces detected from space: from observing the effects towards modelling the impact on water balance

Richard ESCADAFAL,
CESBIO, 18, av.Edouard Belin, 31401 Toulouse Cedex, France
phone : +33 5 61 55 85 23 / fax: +33 5 61 55 85 00

Abstract

Among the recently funded INCO projects several address the question of desertification of the Mediterranean basin. The approach followed in CAMELEO has been to document land surface changes on the long term and to relate them to the degradation patterns observed on the ground. Results of this study on the Tunisian test site evidence a strong variability of vegetation cover and even of soil surface composition, with important sand movements linked to dry periods. However field experiment have also shown that sand sheets at the surface increase the water infiltration and overall efficiency of the rain. Other studies have focused on determining the water fluxes of typical ecosystems, mainly with field measures. Aiming at merging the two approaches, an innovative project is currently undertaken on a test site of Morcocco to determine, with ground measurements of ETR, satellite-data and SVAT models, the impact of land surface changes on the water budget, and the water use efficiency in natural and cultivated systems. Those themes are of interest to several research teams from Mediterranean area and could be developped with them into a proposal of regional dimension, developping refined tools for the global management of water for agriculture in dry regions.

CLIMED: Effects of climate change and climate variability on water availability and water management practices in the Western Mediterranean

Coelho, C.O.A.[1], Borrego, C.[1], Ferreira, A.J.D.[1,2], Miranda, A.I.[1], Keizer, J.J.[1], Laouina, A.[3], Ritsema, C.J.[4] & Regaya, K.[5]

1 = Department of Environment and Planning, Coastal Zone and Sea Research Centre, University of Aveiro, 3810-193 Aveiro, Portugal.
Tel.: +351 234 370831; FAX: + 351 234 429290; e-mail: coelho@dao.ua.pt
2 = Department of Exact and Environment Sciences, Escola Superior Agrária de Coimbra, IPC, Coimbra, Portugal.
3 = Faculté des Lettres et Sciences Humaines, Université Mohammed V, Rabat, Morocco.
4 = Land Use and Soil Processes Team, ALTERRA Green World Research, Wageningen, The Netherlands.
5 = Institut National Agronomique de Tunisie, Tunis-Mahrajene, Tunisia.

The main aims of the CLIMED project (ICA3-1999-30026) are to improve the knowledge and understanding of the foreseeable climatic changes in the western Mediterranean and of their direct and indirect hydrological consequences; and to contribute to the development of management strategies and tools that allow adequate responses to the likely changes in water resources.

The CLIMED project involves four main stages. The first stage relates to climatic change assessment, and will use a Global Circulation Model and a Regional Circulation Model, assessed by synoptic and climatic field data to give a high resolution forecast both in terms of rainfall amounts and spatial and temporal distribution patterns for different atmospheric CO2 concentrations.

The second stage addresses the problem of climatic change impacts on fresh water resources. It studies the impact of various land uses on evapotranspiration and catchment runoff, by using small catchments of dominant land uses. Nevertheless, this scale is too small to identify any socio-economic constraints. Therefore, upscaling exercises will be performed based on statistical approaches to determine the frequency and magnitude of extreme (flood and drought) events. A further upscaling approach will be performed through the comparative analysis of the application of physical based model LISEM to different catchment scales. Since in the western Mediterranean traditional techniques of fresh water harvesting, storage and management are still important for local communities, an assessment of those techniques will be performed, as well as the impacts of climatic variation upon them. A further aim is to study the rational principles that can improve water management at a larger scale.

The third stage relates to the socio-economic dimension, and starts with the establishment of relations between fresh water availability and socio-economic impacts. This will be performed with data for the last decades on hydrological parameters and statistics on productions and revenues for the agriculture. Furthermore, an analysis of planning strategies and policies related with the water, together with interviews directed at the key actors, will provide the necessary framework to bottom up participation in the improvement of legislative and planning tools.

The final stage is related with the improvement of policy and planning tools, in addition to a conceptual model, designed to support decision-making systems, which will synthesise all the other stages, and will be composed by a risk assessment and a risk management model.

Development of cost-effective reclamation technologies for domestic wastewater and the appropriate agricultural use of the treated effluent under (semi-) and climate conditions (CORETECH)

Wendy Sanders[1], Grietje Zeeman[1], Rashed Al-Sa'ed[2], Manar Fayyad[3], Ghada Khassab[3], Andreas Angelakis[4], Fatma El Gohary[5], and Jules B. van Lier[1]

[1] Subdept. Environmental Technology, Wageningen University, P.O.Box 8129 EV Wageningen, The Netherlands.
[2] Birzeit University, P.O.Box 14, Birzeit - Westbank, Palestinian Authorities
[3] Water Environment Research and Study Centre, University of Jordan, P.O.Box 1300, Amman, Jordan
[4] National Agricultural Research Foundation, P.O.Box 1841, 71110 Iraklio, Crete Greece
[5] **National Research Centre, Tahreer street, Dokki, Cairo, Egypt**

Abstract

In regions with arid climates, like the Middle East, there is a shortage of water. Improvement of sanitary techniques and use of the treated wastewater could reduce the demand on fresh water sources in these regions. The general objective of the research in the CORETECH project is therefore to integrate sanitary engineering with environmental and agricultural engineering for a cost-effective optimisation and safe usage of the limited water and nutrient resources in the region. Moreover, to diminish the discharge of raw domestic sewage in the environment, stimulate the use of treated wastewater for irrigation and fertilisation in agriculture, therewith to reduce the health risks and environmental pollution.

Due to the limited presence of water as resource, the conventional sanitation system is highly questionable under arid climate conditions. Minimising water consumption at the household requires other sanitation techniques. Source separation of solids at the household could be an alternative, particularly for rural areas. In such systems house-on-site (modified)-septic-tanks (Zeeman&Lettinga, 1999) for the treatment of domestic sewage, can be combined with small bore sewer systems, which are connected to a community-on-site (post)-treatment to meet the required effluent criteria. Separation of black and grey wastewater is to be considered in areas where so far no, or limited, sanitary services are available. The latter option has the advantage that the toilet waste water which contains the bulk of the pathogens, nutrients and salts, is separated from the diluted water streams, which has important advantages for the post-treatment and use of diluted streams. When toilet waste water is collected with or without a very limited amount of flushing water, the so called night soil production, it could be digested in accumulation systems (Zeeman et al. 2000). The digested slurry can be used in agriculture as soil conditioner and fertiliser.

Depending on the type of agricultural usage of the treated effluent, the anaerobically pre-treated water requires some additional post-treatment. In the post treatment a multiple approach is chosen, covering natural extensive systems which can be implemented in rural areas and villages, but also compact systems suitable for implementation in highly densely populated areas. The treatment systems include:

a. the soil-based or land-treatment systems (slow rate or rapid sand filtration, overland flow systems, constructed and natural wetlands) and
b. the aquatic-based systems (aquatic plant treatment systems, constructed and natural wetlands, and pond systems) (Angelakis and Tchobanoglous, 1995).

Development of appropriate irrigation/fertilisation methodologies will be coupled to the (community) on-site treatment systems. Its goals are to select the most suitable agricultural crops, including the cropping pattern, which can be grown on the treated sewage, to study the environmental impact of the usage of treated sewage on the soil and underground water reservoirs with regard to the fate of micro pollutants. Moreover to assess and develop improved methods for the identification and enumeration of various kinds of pathogenic organisms -in treated effluents, crops and soils. Agricultural aspects will be discussed in an additional paper.

Starting from households, the chosen sanitation strategy determines the collection and treatment systems. However, from the project no general 'sanitation solutions' can be expected since local conditions determine to a large extent the most cost-effective method.

Appropriate agricultural use of treated effluent under (semi-) arid climate conditions

Ernst-Jan Martijn[1], Frans Huibers[1], Manar Fayyad[2], Ghada Khassab[2], Andreas Angelakis[3], and Jules B. van Lier[4]

[1] Subdept. Irrigation and Water Engineering, Wageningen University, Wageningen, The Netherlands.
[2] Water Environment Research and Study Centre, University of Jordan, P.O.Box 1300, Amman, Jordan
[3] National Agricultural Research Foundation, P.O.Box 1841, 71110 Iraklio, Crete Greece
[1] Subdept. Environmental Technology, Wageningen University, P.O.Box 8129 EV Wageningen, The Netherlands.

Abstract

The paper comprehends the set-up and the preliminary outcome of the agricultural work in the frame work of the EU Inco-Med project *Development of cost-effective reclamation technologies for domestic wastewater and the appropriate agricultural use of the treated effluent under (semi-) arid climate conditions*, with the acronym CORETECH.

One of the goals of the CORETECH project is to stimulate the appropriate usage of treated domestic wastewater in irrigated agriculture. “Appropriate” usage of this potential resource may refer to a number of issues such as efficiency, productivity, sustainability, safety (human, animal and environmental health), cost-effectiveness and public acceptance. These issues relate more or less to the typical characteristics of treated wastewater, which thereby constitute a negotiable link between wastewater treatment and agricultural use. The first input in the CORETECH project is, therefore, the provision of a document with the ‘state of the art’ technical information concerning agricultural use of treated wastewater specifically organised according to treated wastewater characteristics.

A review of recent literature has produced a list of 7 main treated wastewater characteristics that directly or implicitly relate to the design and management of wastewater reclamation and agricultural systems. These are in random order: 1) bio-degradable organic matter and suspended solids, 2) inorganic soluble salts, 3) plant macro nutrients, 4) trace elements, 5) pathogenic micro-organisms, 6) effluent flow-rate, and, 7) disinfectant by-products. An agricultural system must deal with these characteristics as well with the implications, in addition to other considerations that apply to all types of irrigation water. On the other hand, a wastewater reclamation system can be tailored to change these characteristics up to a level desired from both the agricultural system and the general environmental point of view. The general environment in this case relates to the environment beyond the agricultural system and refers to issues such as public health and groundwater, for example in the case of nitrate leaching. It is made implicit that an agricultural system has the potential, responsibility, and is often mandated, to incorporate concerns for these general environmental aspects.
CORETECH basic assumption is that the optimisation to reach appropriate treatment, and use of the treated effluent, is best achieved in a multi-disciplinary integrated approach, in which the mutual benefits and beneficiaries are better recognised and costs and responsibilities can be shared.

P O S T E R

NEW DEVELOPMENTS IN DECENTRALIZED SANITATION SYSTEMS FOR PALESTINIAN RURAL COMMUNITIES

Rashed Al-Sa'ed, Omar Zimmo*, Nidal Mahmoud*, Ziad Mimi**, Amin Nawahdah** and Wa`el Hashlamoun***

**) M.Sc. Program in Water Engineering, Faculty of Graduate Studies, Birzeit University, P. O. Box 14, Birzeit, Ramallah, West Bank, Palestinian Authorities*
***) Faculty of Engineering, Birzeit University, P. O. Box 14, Birzeit, Ramallah, West Bank, Palestinian Authorities*
Email: RSAED@BIRZEIT.EDU

Abstract

Within the framework of the regional EU Inco-Med CORETECH research project, this paper entails the preliminary outcome of the disk study on development of the most suitable onsite and community onsite sanitation and treatment system. A literature study conducted on the present status of wastewater management facilities in the West Bank revealed that, small Palestinian rural communities, in which about 60% of the total population in Palestine are living, face a variety of environmental infrastructure and public health issues. One of the urgent issues is the provision of safe drinking water and reliable wastewater collection and treatment facilities. Great emphases have been made on the historical development, key issues for wastewater management policies and strategies to be implemented. Also lessons and recommendations gained from pilot projects and case studies implemented by non-governmental organizations (NGOs), like the Palestinian Hydrology Group (PHG), Palestinian Agricultural Relief Committees (PARC) are presented. Several rural sanitation projects were assessed and small onsite sewage treatment plants were visited and evaluated, personal contacts to many NGOs and review of published reports of Palestinian institutions, donors and funding agencies, and UNDP and DFID were made. It was found that major sanitation problems are due to the weak economy and low income, low level of technical operating expertise and very limited access to the existing advance wastewater treatment technologies. Moreover, the absence of public awareness, lack of environmental education and market competition exacerbate the limited social acceptance of the beneficiaries in small rural areas for the idea of reusing the treated effluent for agricultural purposes. A review of recent implemented onsite rural sanitation systems reviled that non-governmental organizations like the PHG, PARC and ANERA act as a catalyst to promote sustainable sanitation facilities in the poor rural Palestine. To introduce and enhance the application of UASB technology on a wide scale in rural Palestine, several M.Sc. research students within the CORETECH project, being implemented at Birzeit University, will investigate the process performance and unit design parameters of using the modified UASB technology for black and domestic wastewaters. Recent research findings (Zimmo, et al., 2000 and 2001) showed that naturally based technologies (duck weed and algal ponds) are economically sustainable and environmentally feasible post treatment options.

A Decision Support Systems for Mitigation Measures of Drought

Impacts in the Mediterranean Regions-Jordan Case Study

INCO IC18-CT97-0169
Dr. Adnan Al-Salihi
Water and Environment Research and Study Center
University of Jordan, Amman, Jordan

Abstract

Drought identification and characterization were carried out for two regions; Wadi Kaferin and Wadi Hisban in Jordan. A comparison between the identified droughts was carried out through local and regional analysis. Regression analysis has been used to fill the missing data. The analysis showed excellent correlation between the rainfall stations. Rainfall factors were developed for each station to take into account the rapid increase of rainfall with altitude and stations at the boundary of the area.

Comprehensive analyses of data for stationarity and randomness has been carried out on the series of each station. Three tests; Student's t test, Kendall's τ test, and Turning point test, were applied. The calendar year, water year, and trimester time scales were considered. In all cases, a significance level of 0.05 was used and October as the beginning month of the water year was applied.

Drought characteristics were computed using annual; calendar and water year, and three months rainfall. For each series four different thresholds were used; mean, median, mean – standard deviation, and 35% quantile. The number of the drought periods, for the calendar series, are almost the same for all stations and about 50% of the period is less than the mean. Different periods and percentages are noticed with water year series with no consistency in results between the stations. Trimester series are with more drought periods and longer.

Situation and future prospect of salt balance and adapted irrigation scenarios in the agricultural land of Egypt.

Gad, A. and Abdel-Samie, A. G.
National Research Center, Soils and Water Use Dept.,
Cairo, Egypt

The study is based on recent collected accurate data on volumes and salinities of drainage waters and official data on available irrigation waters. Studying the change in drainage water salinity between years 1986 and 1988 revealed, in general, improvements in areas characterized by drainage water salinity of 750 to 2000 gm/m3. However, areas whose drainage water salinities ranged 2000 to > 3000 gm / m3 recorded an increase.

Salt balance data were calculated in four separate pilot areas with a total area of 150, 000 Feddans. Deposition of salts was found associated with low volumes of applied irrigation waters. Calculating the salt balance on the national level revealed a removal of 13.3 million tons of salts in 1990, from an irrigated area of 7.2 million feddans.

Future prospect for the year 2017 was analyzed on view of the plans to increase the cultivated area by 3.4 million feddans. The estimated salt balance in the year 2017 indicates an addition of 62.2 million tons of salt every year to the irrigated soils, not constituting salts. Salts added also through other sources such as chemical fertilizers and manure. These figures urge the necessity of a tight control on water use for irrigation combined with adoption of modern irrigation and efficient drainage systems. An ultimate necessity to face such situation is to breed and grow high salt- tolerant crops.

Key words: Salinization, Salt balance, Irrigation, drainage, Nile-Valley, Egypt

POLICY GUIDELINES FOR WASTEWATER MANAGEMENT IN THE GAZA STRIP

Amal Naciri-Göttlich
Carl Duisberg-Gesellschaft e.V.
Lützowufer 6-9, 10785 Berlin, Germany

The Gaza Strip is a land area located along the Mediterranean Sea Southwest of Palestine and north of Egypt. The size of the area is ca 365 km^2. Due to the tremendous population increase, the water demand increased sharply. The yearly replenishment of the aquifer represents about 60% only. Groundwater is getting more and more salty. The reuse of wastewater could be one of the main alternative options to develop the water resources in the region.

Experiences with the reuse of wastewater in the Mediterranean region

Wastewater reuse in the Mediterranean countries with semiarid climate is essential. This is already practised in many countries in the Mediterranean region. Different quality standards are applied in the region, the standards differ from very low requirements to very strict one.

For the Gaza Strip the following types of reuse are recommended:

irrigation in agriculture
groundwater recharge

For irrigation in agriculture many quality standards are available. The most important parameters are the microbiological standard requirements. To cover these parameters some countries recommend the application of chlorination of the wastewater effluent. This however may lead to the formation of halogenic organic compounds (THM) which mostly are carcinogenic for human beings. Therefore other treatment procedures for desinfection should be applied.

For groundwater recharge a decrease of the nitrogen concentration is necessary due to nitrate limitation in drinking water supply. According to WHO standards for water quality, nitrate concentration in drinking water supply systems shall not exceed 50 mg/l NO_3.

Selection of irrigation methods

By regarding the different available irrigation methods only these should be applied which distribute the irrigation water beneath the soil subsurface. In this case the evaporation losses are highly reduced, additionally water can be used more efficiently and a higher economical benefit in the long term can be achieved.

Technical issues for reaching the required quality

In case of agricultural irrigation a secondary (biological) treatment will be recommended, but without nitrification/ denitrification. For the removal of bacteria and other microbial contaminants the membrane activated sludge system is a suitable method. The overall costs (investment and running costs) are similar to the „normal“ activated sludge process (with final clarifier).

In case of infiltration in the underground a higher effluent quality is necessary (nitrogen removal). According to a water balance of one treatment plant separation of wastewater streams into one portion treated to high quality effluent for infiltration and another portion for storage and irrigation will be recommended.

Costs

The calculation of the specific costs of wastewater treatment and reuse has always to include construction and operation costs. If the treated wastewater will be reused for irrigation, wastewater storage, transport to the fields and distribution have to be considered. Basically, investment and running costs have always to be combined.

Policy Guidelines for the Gaza strip

The feeling of responsibility for the municipality or the functional association is essential for a good operation of a wastewater system. This is created when the decisions are made by the municipality and when the plant is operated by the municipality.

The inhabitants shall pay for wastewater treatment. This is a method to transfer responsibility to the inhabitants and to encourage them to decrease drinking water consumption and wastewater production.

Innovative and Adapted Technologies for Wastewater Recycling and Reuse in Arid Countries

Sven-Uwe Geißen, André Weidemeyer, Bernd Fitzke, Alfons Vogelpohl,
Technical University of Clausthal, Germany
Fax +49.5323.723570, e-mail gei@itv.tu-clausthal.de

The water demand as well as the pollution of water is increasing with the developing industrialization and growing population. The world population will rise from 6 to 8.9 billion people in the year 2050. Nowadays about 65% of the 4.8 billion people in Developing Countries have no access to clean water.
The industrialization can be defined by the Gross National Product (GNP) which is rising by approx. 1 to 3 % per annum in the Mediterranean Countries. In combination with the arid conditions in most of these countries and the extensive agriculture it is obvious that the supply of water will be one of the central problems during the next decades. Even now a strong decrease of the natural water resources, an increasing salination and pollution of the tap water is perceptible.

The textile industry is very typical for Developing Countries and, therefore, the water consumption and the environmental pollution caused by this industry is quite large. Most of these factories have or will have a pretreatment plant. However, the water quality of the effluents is not sufficient for recycling and the effluents contain recalcitrant compounds. Municipal wastewater has the highest potential for reuse because of its large quantity and the containing nutrients. Germs and recalcitrant compounds are limiting the agricultural reuse of municipal wastewater.

Textile effluents and municipal wastewater are used to develop and adapt the solar catalytic wastewater treatment and aerobic as well as anaerobic membrane bioreactors (MBR).

Solar catalytic treatment is a process which uses sun light for the oxidation of pollutants. Posttreatment by the solar-catalytic process in sun-rich countries is an economically feasible possibility to reduce wastewater compounds as shown in an recent EU Avicenne project. Pretreatment plants of two factories in Algeria and Tunisia are optimized and part of the effluents as well as process streams in the factories have been treated by photocatalysis in batch tests. The Thin-Film-Fixed-Bed-Reactor (TFFBR) was used for continuous experiments because its design is simple and it showed a high performance in previous investigations with similar wastewater. Comparison of modified catalysts with synthetic and textile wastewater and tests with different support materials (e.g. plastics, ceramics, concrete) were carried out with the objective to reduce the necessary surface area and to minimize investment costs. A pilot plant for the solar photocatalytic posttreatment of textile effluents is under construction in Tunisia and starts in operation in May 2001.

Membranes are used for complete biomass separation in MBR's to avoid problems with activated sludge bulking, germs in the effluent, large quantities of excess sludge and large space requirements. Low cut-off ultrafiltration as well as nanofiltration membranes are used in this project for additional rejection of larger molecules. Most of these molecules can be degraded by the activated sludge due to the extremely long residence time in the system. Aerobic MBR's are used for the posttreatment and recycling of textile effluents and anaerobic MBR's for the treatment and agricultural reuse of municipal wastewater. Investigations started to reduce energy and investment costs. Bench-scale plants in Tunisia (municipal wastewater) and Algeria (textile wastewater) are installed for the adaptation to real wastewater.

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Building Local and Regional Expertise in Water Desalination

Ziad Al-Ghazawi[*], Hani Abo-Qdais[*] and Mahmoud Al-Hadidi[**]

Jordan is a country with very limited water resources. The severity of water shortage in Jordan has made the consideration of non-conventional resources indispensable. Not only does Jordan suffer from scarcity of water being an arid/semi-arid country, but also many of the available resources have been suffering a deterioration in their water quality especially ground water reserves in Azraq and Dhulail.

Jordan has invested a lot in wastewater collection, treatment and reuse in irrigation. This has been indirectly securing some good quality water for domestic uses. After almost two decades of reuse practices, treated effluents have come to be realized as a strategic non-conventional resource of water by both the Jordanian public as well as decision makers in the water sector.

Desalination of sea water has not been considered seriously 20 years ago mainly because of the high cost of desalination technologies at the time. Recently, such technologies have been scientifically and technically available at lower cost than before. This has brought up desalination as a viable alternative for Jordan. This is especially important when we consider those brackish waters in aquifers that have been salinized due to over pumping especially in Azraq and Dhulail regions. Such aquifers used to supply Amman and other cities with drinking water before the deterioration in their water quality. The infrastructure of transporting water from those aquifers to populated areas does still exist, which makes the feasibility of desalination plants at those salty reserves of ground water worthy of study.

In a word, desalination is an alternative that seems feasible to solve part of Jordan's chronic water supply problems. However, little expertise exists in the country in this area as there has been no major desalination projects in the country so far. Thus, enhancing technical expertise in desalination is an urgent priority for the country.

To achieve that, there is a pressing need to start a focal point on desalination issues and technologies that can be in the form of a center hosted by Jordan University of Science and Technology (JUST). This center will be as a resource body on all aspects of desalination including capacity building, training, research, curriculum development, and public awareness.

In more detail, the objectives of the proposed desalination center can be summarized in the following:

1. Development of the necessary human resources and expertise for locally and regionally adaptable and sustainable desalination technologies through training and capacity building.
2. Conducting desalination experiments and testing of processes and products under environmental conditions of the region, and promoting technology transfer
3. Development of desalination courses and curriculum at the post graduate level in JUST and other Jordanian universities
4. Enhancing the public awareness about desalination technologies and the needs and issues associated with them.
5. Establishing the grounds for participation of all stakeholders including local communities as well as creating partnerships for the planning, implementation and management of specific desalination projects on the local, regional and international levels.

* Water Resources and Environmental Engineering Program/Civil Engineering Department at the Jordan University of Science and Technology/ Irbid/ Jordan.

** Ministry of Water and Irrigation/ Amman/ Jordan

REGIONAL ACTION PROGRAMME ON WATER RESOURCES MANAGEMENT IN THE MEDITERRANEAN REGION

Atef Hamdy,

Director of Research, Mediterranean Agronomic Institute of Bari,

CIHEAM/MAIB, Italy

Abstract

Water scarcity is one of the major limiting factors of agricultural, economic and social development in the arid and semi-arid regions of the Mediterranean. In the region, we are confronted with increasing population, fast urbanisation and the associated expansion of economic activities, all of them require more water, putting strain on the already limited and fragile land and water resources. An increasing number of developing Countries of the Mediterranean are approaching full utilisation of their available water resources, which means that there is no more room to increase the supply and that water demand management is the clue issue of new water strategies. Taking into considerations the above-mentioned aspects of land and water situation in the arid and semi-arid Mediterranean regions, the Mediterranean Agronomic Institute of Bari in co-operation with National Water Research Centre (Cairo, Egypt) and with many other Southern Mediterranean Institutions has started in 1998 the Regional Action Programme (RAP) on ***Water Resource Management*** within the frame of the European Union DGI programme. The RAP will last for four years and will aim to elaborate the concept of demand management into implementation policies, programmes and actions, particularly in irrigation sector, as the main consumer of water (about 80%) with major water losses (more than 50%) and where huge water saving could be achieved. The activities within the RAP Programme (1998-2002) are mainly oriented to the sustainable use of water resources in irrigation sectors emphasising the following major technical issues:

- Non conventional water resources practices and management for sustainable use;
- Water use efficiency;
- Design, management and optimisation through performance analysis of collective irrigation systems;
- and the aid to decision making through the themes of:
- Participatory Irrigation Management (PIM); and
- Economic aspects of water mobilisation and use.

The RAP includes also the logistic support to the Southern Mediterranean countries to introduce and to enhance Information and Communication Technology and on-distance learning. Actions under the technical part of the Programme are developed through the activities of the Land and Water Resources Management Collaborative Network of the Mediterranean Agronomic Institute of Bari and the Collaborative Research Project "Water Saving in Irrigated Agriculture (WASIA)", which is under implementation in eight different experimental sites located in Egypt, Turkey, Morocco, Tunisia and Syria. The sub-programme on "Participatory Irrigation Management" (PIM) is developed in cooperation with the Economic development Institute of the World Bank with the aim to promote training of high ranking civil servants and exchange of information and experiences among decision makers, senior management and politicians in the Mediterranean region. The sub-programme on "Economic aspects of water mobilization and use" provides an aid to decision makers, politicians and high technical staff on two important and critical issues as they are water valuation and cost recovery and water use and allocation efficiency. The overall objectives of the RAP are to improve the institutional capacities, the development of human resources, strengthening regional co-operation, technology transfer and exchange of experiences between the Southern and Northern part of the Mediterranean through training, promotion of research, networks and communication of scientific and technical information in the field of water resources and irrigation based on the concept of “centres without walls”.

Impact of Treated Water Effluent from Ramtha

Wastewater treatment Plant on Forage Crop Quality, Soil Conditions and Animal Performance

Nabil Bani-Hani
NCARTT, Water & Environment Program, Jordan

ABSTRACT

Water is the major constraint for agricultural development and sustainability in arid lands. Jordan suffers from water scarcity. This scarcity will become more critical as urban and industrial sectors place higher and higher demand on water. Total demand for water exceeds the available resources. The annual potential available ground and surface water in Jordan is estimated to be 980 MCM. In this year, the estimated total water requirement is expected to be 1548 MCM. The water consumption for all sectors was divided as follows: 460 MCM for domestic and industrial purposes, and 1088 MCM for agriculture. The main source of irrigation water is the surface water in the Jordan Valley, and the groundwater in the highlands. There are evidences that the quality of groundwater is deteriorating due to over pumping and contamination from N-fertilizers and treated wastewater.

Treated wastewater is a potential non-traditional water source, which can be used for irrigation. During the year 2000, Jordan had a total number of 50 wastewater treatment plants serving about 65-80% of the total population. Wastewater effluents from these treatment plants are estimated to be more than 60-80MCM.

Several factors and conditions restrict the use of treated wastewater in agriculture. The most important of these are:

- Crop type; cultivated crops should not be fresh consumed by human such as lettuce and cucumber.
- Irrigation systems should minimize environmental hazard and avoid direct contact between irrigation water and crops.

The objective of this research is to assess and monitor the environmental pollution of soil, plants and animals through using effluent water from Ramtha wastewater treatment plant as a source of irrigation. Moreover to establish safe levels of forages irrigated with wastewater for animal health in order to ensure secure consumption of animal products by man. This objective will met through monitoring the accumulation of salts and other hazardous chemicals in soil, and the quality of animal products (milk and meat).

Roofwater Harvesting: the Neglected Option

An EU research project (INCO-DC) is generating reliable information

Hans Hartung
FAKT Consult for Management,Training und Technologies
Kanalstr.23, 97990 Weikersheim, Germany
Tel. +49.7934.990030,Fax +49.7934.990031, e-mail: hfhartung@cs.com

Successful large scale application in specific regions all over the world show the relevance of roofwater harvesting. But only scarce information covering the important aspects of rainwater harvesting exist. The aim of an ongoing EU funded research is to generate reliable information for policy planners, supply professionals and ultimately householders. The research project is entitled “Domestic Roofwater Harvesting in the Humid Tropics". This zone is generally poorer than the Mediterranean and is used to low levels of water consumption. Its rainfall is generally higher and better distributed through the year. However some of the programme findings have relevance to Mediterranean needs.

Institutional values and decision making

Water professionals have 4 areas of concern when asked about rainwater harvesting:

- water quality
- economics of the system
- project design to introduce, promote and spread rainwater harvesting
- the information gap on what rainwater really is, its advantages and disadvantages, opportunities and potential.

Technology

It has been found that the two cheapest ways of achieving a substantial storage capacity at modest cost are to use

(a) a simple underground 10000 litre pit lined with thin mortar and covered by a ferro-cement cone set on a low wall or
(b) a very shallow 6000 litre cistern whose superstructure is built of informal local materials and whose lining is folded from a standard 5m x 4m rip-stop plastic tarpaulin.

Water Quality

(a) Coliform contamination of rainwater can arise from dust particles besides human and animal sources.
(b) The first 2 mm of rainfall is generally sufficient to wash off the contaminants, and may be separately collected as the first flush.
(c) Water collected from a roof below a tree hanging gets heavily contaminated.
(d) Metallic roofs possibly get hot enough to sterilise the dust particles.
(e) Bacterial count is more at the bottom if the water is allowed to stand for some time before drawing.
(f) Rain water was stored in plastic and cement tanks for 18 months. There was a decline in bacterial counts and no significant increase in TDS, was seen.

Household water security

Using multiple sources of water is one feasible way communities have adopted to circumvent the situation of water scarcity at certain times of the year. Communities in different areas of Sri Lanka have been surveyed to find out how households use rainwater in combination with other sources to meet the entire household water requirement throughout the year. Best practices are being identified of water use in combination with rainwater harvesting.

RUNOFF AND LAND DEGRADATION IN RELATION WITH LAND USE CHANGES IN MOROCCO

Abdellah LAOUINA, Miloud CHAKER & Rachida NAFAA
Unesco-Gas Natural Chair, Mohamed V University, Rabat

The plant covering defacement takes many forms : a rapid physionomic change of the vegetal cover in relation to the over-exploitation through excessive wood cuttings and by overgrazing and an effective receding of the forest thanks to the encroachment of the cultivating lands on the forest domain.

The runoff goes from 0 to 300 mm per year (Streaming coefficient between 0% in the driest years and 25-30% in the most humid ones). However, and most often, it remains inferior to 10%. The soil loss varies in even greater proportions, since it can be insignificant in many cases, to reach a record figure (more than 50 t/ha/year), practically comparable to that of the gullies and the badlands.

In accordance to the plant covering and to the use of the soil, the bare or tilled soil undergoes a stronger erosion than the permanently covered sites. The cork-oak forests in the central Rif, represent the most stable milieu with a streaming of less than 5% and a loss of insignificant rate. The watersheds covered by wheat cultures, with remains of matorral, are also the less eroded ones (<0,9 t/ha). As soon as we go to slopes of wheat monoculture, the specific degradation grows and can reach an average of more than 20 t/ha/year.
The rains of low intensity allow certain water permeation and reduce the runoff on the slopes. On the other hand, episodes of high intensity entail a more important runoff.

The evolved soils having a closed plant cover and dense cultivated plots, record an important permeation. On the other hand, the bare or covered soils with secondary degraded cover undergo a direct superficial streaming.

But water turbidity does not comply with the same factors as the streaming. It is the unceasing rains, responsible for the saturation of the superficial horizon of the soil, that account for the highest turbidity values. Besides, the heavy and brief rains allow moderate turbidity. The coming out of saturation phenomena in the located sites is responsible for the formation of scars that sweep mud materials, in some particular plots. The constitution of rills entails a rapid rise, during a first period and then the tubidity becomes slower after the stabilisation of the rills..

The amount of soil loss is more correlated with the amount of the runoff than with turbidity. That is why it is not always the fields, holding located erosion forms (scars and rills), that represent cases of the most important erosion. Cases of moderate soil loss, despite a strong turbidity correspond to situations of important permeation, with a high impregnation of the superficial horizon. The functioning of the muddy flow process - to the limit of solifluxion - accounts for the strong turbidity, yet the swept mass remains moderate. Still, in cases where a high streaming and a strong turbidity intertwine, we come to rates of specific degradation, that are as important as those recorded in the big gullies. In those cases, erosion becomes disastrous. The load reaches then maximal values.

Hortimed- Sustainable Water management for Horticultural crops

N. Sigrimis (AUA-GR), C. Stangellini (IMAG-NL), M. Fuchs (ARO-IL), J. Papadopoulos (ARI-CY), F. Tognoni (UNIPI-IT), P. Lorenzo (CIFA-ES), Abou-Hadid (CLAC-EG), J. Wady (AAUG-PA)

Abstract

The objective of this project is to develop a context sensitive strategy for managing irrigation and nutrient supply of protected crops with constraints on the quantity and quality of water supply. The **economical** (quality and quantity of crop yield) and the **ecological** (contamination risks of water table, nature conservation) factors affecting the strategic decisions will also be considered. Moreover the research of this project will advance our knowledge about plant response to **salinity** and water stress. These new findings will be combined with **new management techniques** into developing a Decision Support System for farmers.

Goals	Method	Specific Objectives and Approaches
Increase fresh water use efficiency of protected cultivation	**Minimise fresh water use**	• To ***determine environmental impact*** for selected protected-horticulture crops, for different root media and salt content of available water. • To ***develop irrigation/fertigation recipes*** for main vegetables under protected conditions based on soil fertility, growth stage and yield-quality targets.
	Increase utility of low-quality water	• To ***compile/determine yield response to salinity*** of the major crops. • To ***determine a strategy for climate management*** with high salinity of irrigation (CO_2 injection, shading, humidification), in order to mitigate salinity damage and exploit the potential for better quality with salty root environment. • To ***determine a strategy to minimise salt accumulation rate*** in a closed-loop irrigation system, in dependence of water and nutrients uptake and of root medium characteristics.
Decrease their reliance on good quality water	**Strategies to maximise use of lower quality water**	• To ***determine cost-benefit*** of possible farm level investments (rain harvesting, drain water recycling, use of wastewater, reverse-osmosis, disposal of residuals), depending on available water resources and type of crops. • To ***determine a strategy for management*** of water sources of varying quality, under given constraint of input of fresh water and/or of release of residuals. • To ***determine feasibility of cascade combinations of crops of increasing salt-tolerance.***
	Ensure application of new management	• ***A Decision support system*** that aims to maximise return under given constraints in water, water quality and release of chemicals. • ***To develop a farmers guide and "rules of thumb"*** translated to all participating languages. • ***Dissemination and short courses*** for extension specialists.

Preliminary first year results on Salinity tolerance, recirculated water management and water use efficiency are presented._

PROTECTED HORTICULTURE IN-BETWEEN POLLUTION AND SAVING OF WATER RESOURCES

Tognoni F., Serra G., Pardossi A.

[1] *Dipartimento di Biologia delle Piante Agrarie, Università degli Studi di Pisa, Pisa, Italy*

[2] *Scuola Superiore di Studi Universitari e Perfezionamento Sant'Anna, Pisa, Italy*

[3] *Dipartimento di Produzione Vegetale, Università degli Studi di Milano, 20133 Milano, Italy*

Abstract

The problem of quantity and quality of water is becoming more and more worring. Mankind activities - civil and industrial settlements, agriculture - are continuously depleting the fraction of freshwater in favour of waste one.

The increasing use of water in many activities (civils as well as agricultural) reduces its availability.

Water in the next future, in some Countries even today, would become a constraint to all human activities.

At the moment agriculture is the largest consumer of water, more than 50% and in some cases even 70% is used for irrigation. Its large use and misuse due to over-watering in order to improve plant productivity may cause at the least two main problems: a) salinization of water table due to sea-water infiltration called by too many wells; b) ground-water pollution from fertilizer and pesticides leached.

From now on one can expect that one of the grower main targets become to reach the most water use efficiency.

One cannot deny that protected cultivations in the last few year are becoming a popular technique in the mild climate areas. This cultivation system allow the production regardeless esternal climate but at the same time, a more efficient use of resources and among these water is the most important. In fact, it is well known that greenhouse may reduce water up to 50% with respect to outside production.

Through the analysis of greenhouse crops in Italy and in other European countries, the paper introduces some issues relative to protected horticulture, such as the socio-economical aspects, the environmental impact and the technologies to reduce it (irrigation and fertilization scheduling of irrigation and fertigation, closed-loop soilless system, integrated pest management).

It is proposed that protected horticulture may contribute substantially to the development of many regions all over the world and reduce the use and the pollution of water resources, provided suitable technologies are employed.

HYDROMED: PROGRAM OF RESEARCH ON HILL RESERVOIRS IN THE SEMI-ARID ZONE OF THE MEDITERRANEAN PERIPHERY

Mr Jean Albergel
Milieu et Environnement
IRD - Institut de Recherche pour le Développement

HYDROMED is a program of research on hill reservoirs in the semi-arid zone of the Mediterranean periphery. It is sustained by the European Commission in the framework of the INCO-DC program. It begun in November 1996. Its main objectives are as follows :

- To study an optimal management of each type of hill reservoirs. The use of the supplement of water resource by users raises both technical and social questions such as, what is the duration of life of a reservoir (siltation) ? or what are the possible social organization of the users ?
- To define an optimal land use planning upstream and downstream the artificial lake. To protect the reservoir, soil conservation works have to be planed on the slopes of the watershed. The development of lands close to the lake downstream (gravity irrigation) or on slopes (pumping requires adequate management. Fish breeding is a possibility to valorize the new water resource, just as the tourist exploitation of some sites.
- To assess the impact of one or several lakes on the environment. The hill reservoir is considered as an artificial structure of little size with very few impacts on the environment. This postulate has often occulted researches on real impacts and on ecosystems modifications.

Hydromed contains four work packages, a training program and coordination activities. The four work package are :

- Existent works synthesis in each country. This work package aims to establish the state of the art. It includes a bibliographical review, the analysis and synthesis of realizations and projects, the identification of constraints and the choice of pilot sites for relevant experimentation.
- Water - soil - environment. This work package includes the study of process on pilot sites and the researching of indicators on the functioning of watersheds and hill reservoirs.
- Agricultural economy - social management of the water and the erosion. The following activities are developed : analysis of the new economic practices introduced in traditional productions systems ; role of the different economic actors in designing, realizing and managing hill reservoirs and watershed works.
- Sustainability of the hill reservoir and its integration in the durable development of marginal regions. This work package will use data and models crossing from the three preceding packages. Interactive models will be developed : physical resources - human resources - impacts on the environment.

The work carried out in this project should provide guidance for small and medium hydraulic works in soil and water conservation in semi-arid hill areas. It should identify natural and human constraints to the development of hill reservoirs and provide tools for assistance to decision makers at regional and national levels. It should also highlight the importance of small catchment areas in water resources mobilization particularly during dry periods.

The Hydromed Model and its Application to Semi-Arid Mediterranean Catchments with Hill Reservoirs

***R. RAGAB*[1]**
Centre for Ecology & Hydrology, Wallingford, OX10 8BB, UK
E-mail: Rag@ceh.ac.uk

ABSTRACT

The semi-arid region of the Mediterranean basin has climatic conditions characterised by a very erratic pattern of rainfall with respect to time, duration, intensity and amount. Subsequently, the hydrology of semi-arid regions is different from that of humid and sub-humid regions. As a result, one would expect that models developed for humid regions are not necessarily applicable to the semi-arid Mediterranean region. Mediterranean countries could increase their water resources by constructing small hill reservoirs. Gaining more understanding of the dominant hydrological processes operating in such an environment will help in the design as well as in sustainable water use of these reservoirs. Field measurements and modelling studies can achieve these goals. After being validated, models can be used as a management tool. The HYDROMED model has been developed for semi-arid regions in general and for Mediterranean conditions in particular. The model has two sub-models, the Rainfall-Runoff and The Reservoir Storage Capacity and Probability of Failure. The HYDROMED model is menu driven, easy and friendly to use. The model uses the Genetic Algorithm for optimization and has default parameter values that can be selected in the absence of measured ones. There are different options to calculate the flows, options for the time steps ranging from less than one hour to one month and there is the facility to import text data files and import data directly from data loggers and to output results into data files and graphs. The model successfully showed its ability to simulate Rainfall-Runoff events on a number of catchments in the Mediterranean region . In the HYDROMED model, the probability of failure is calculated on a monthly basis using a modified Gould probability matrix method. The model has been applied to the El-Gouazine catchment in Tunisia. The model results showed that there is no high risk of El-Gouazine being unable to meet its requirements at a capacity of 233,000 m^3. Subsequently the benefit, in terms of probability of failure, by increasing the reservoir volume of EL-Gouazine to greater than the 250,000 m^3 is not high. However, the analysis is based on the existing water abstraction policy, absence of siltation rate data and on the assumption that the present climate will prevail during the lifetime of the reservoir. Should these conditions change, a new analysis should be carried out.

[1] Dr. R. Ragab
Principal Research Scientist
Chairman of the Work Team on the Use of poor quality waters for Irrigation, International Commission on Irrigation & Drainage, ICID
Chairman of the Work Group on the Sustainable use of natural resources for crop production, International Commission on Irrigation & Drainage, ICID

Irrigation Management Information System Project In The Jordan Valley

Mohammed A. Jitan

NCARTT, Water & Environment Program, Jordan

Abstract:

Agricultural sector consumes about 70% of Jordan's water resources. Efficient irrigation water use is a major national concern. This requires further development of irrigation water management.

Jordan Valley is one of the main irrigated agricultural areas in the country. In 1991, the irrigated area was about 32,300 ha with annual growth rate of 3.2%. Due to limited water resources; Jordan Valley Authority (JVA) had established a pressurized system for the conveyance of irrigation water. This system allows farmers to convert from conventional irrigation methods to modern drip and sprinkler systems. The pressurized system will also enables the JVA to keep the irrigation water in the network for 24 hours (continuous flow). Recently, most of the water that is delivered to farm gate is conveyed through pressurized pipelines. A total of 29,000 ha are equipped to receive water from the irrigation distribution network. Irrigation water scheduling is totally controlled by JVA through the existing irrigation water distribution system. Allocation by JVA do not take into consideration all of the factors which determines irrigation scheduling and crop water requirements on farm level such as: Soil type, Soil depth, Crop type, Stage of growth, Climatic zone, Water quality and Irrigation method. In fact, water is distributed according to allocation by JVA where special treatment is given to fruit trees growers according to a license given by JVA. This license enables farmers to get extra amounts of water than vegetable farms. Irrigation management efficiencies for CJV is reported to vary from 34% to 90%. Conventional surface irrigation systems were found to have an average irrigation management efficiency of 70%.

According to previous studies, the main factor contributing to low irrigation management efficiencies was attributed to lack of knowledge by farmers concerning crop water requirements and scheduling of irrigation water. Distribution uniformity of trickle system caused by emitters clogging problem as a result of unsuitable filtration system, and poor hydraulic design of the irrigation network.

Irrigation management efficiency could be significantly increased by improving technical background of farmers especially in the area of crop water requirements, and irrigation scheduling. This contribute to water saving, help expansion of irrigated areas, and enhance quality of environment.

For the above mentioned, NCARTT had established Irrigation Management Information project (IMIS) to over come these problems, and improve irrigation water management for saving water and improving agriculture production and quality, and minimize environmental hazardous.

The Irrigation Management Information System project can provide irrigation personnel (farmers) with real time estimates of irrigation requirements and scheduling. This will help to initiate and sustain a technology transfer program concerning the issues of when to irrigate and how much irrigation water on-farm level to maximize water use efficiency. *The Beneficiaries of this project are* Planners, Water Sector, Agriculture Sector, Farmers, National Economy, and Environment.

IRRISPLIT: Partial Root Drying: A sustainable Irrigation System for Efficient Water Use Without Reducing Fruit Yield

Marc Bacon

Biological Sciences

Lancaster University

Bailrigg, LA1 4YQ Lancaster, UK

This project plans to improve the efficiency of water use for Mediterranean agriculture through sustainable approaches via an investigation of the effects of partial root drying on the vegetative and reproductive growth of a range of fruit crops. Irrigation down one side of a row of plants allows soil drying around roots on the other side. If the wetting zone is alternated from one side of the row to the other then some roots of the plant are always in contact with drying soil. This technique is being employed to control vegetative vigour, save irrigation water and reduce fertiliser use without influencing fruit yield and quality. In the first year of this project, partners from Portugal, Cyprus, Turkey, Morocco and the United Kingdom have made significant progress in trialing this technique in a wide range of crops with potentially significant consequences for Mediterranean and global agriculture.

MED-POL: Innovative decentralised energy and water management policies can encourage the creation of a market economy and help rural development

Dr. Francesco Aleo
Conphoebus S.p.A Enel Group
Passo Martino Zona Industriale
95121 Catania, Italy

The concerted action "Med-Pol"started on December 1998 and will be completed on April 2002. The co-ordinator is Conphoebus S.p.A (I) a company of ENEL group and the other participants are Ciemat (ES), Universidade Nova de Lisboa (PT), Universidad de Las Palmas de Gran Canaria (ES), Higher Technical Institute (CYPRUS), JRC – Institute for Prospective Technological Studies (UE), University of Malta (MALTA), ANER-National Agency for Renewable energy (TUNISIA), CDER (MOROCCO), NREA New and Renewable Energy Authority (EGYPT) and the National Energy Research Center (JORDAN).
Med-Pol project wants to promote new models for a sustainable rural development in non-electrified small-medium villages of the Third Mediterranean Countries (TMC) by means of the creation of local organisation like SMEs, Co-operative and NGO acting in the field of water and energy supply and management. The schemes for a sustainable development will be based on the application of soft and new technologies developed in RTD EU programmes and using as far as possible the Renewable Energies (R.E.).
The methodology of the project is based mainly on thematic meetings with specific topics logically connected but also on seminars for the training of local experts and on the creation of a WEB site for the dissemination of the results.
The main expected outcomes of the project are :

- the launch of national programmes for water/energy sustainable supply and management in isolated rural areas of TMC;
- the creation of a stable network among partners and other interested private and public subjects;
- the involvement of EU economic operators in joint venture with TMC companies for production, installation, distribution, financing of initiatives.

So far four project meetings have been organised in Italy at Conphoebus premises, in Tunisia at the ANER centre, in Spain at the University of Las Palmas and in Morocco at CDER centre.
The main barriers which obstacle the diffusion of new sustainable technologies in TMC have been identified and the local experiences of the partners in the definition of policies and programmes aimed at overcoming the financial barriers have been analysed.
The contribution of external invited experts coming from European Energy Institution and Utilities allowed to identify some financing models for energy technologies in TMC and permitted to focus successful experiences of decentralised water and energy supply schemes in the rural areas.
In order to favour the exchange of information among all the interested subjects a WEB site of the project (www.medpol.org) has been already created. The next meeting will be held in Cairo on end of May 2001 at NREA's premises and the specific topic will be the role of institutions and utilities in the identification of policy packages to promote projects on energy and water management.

A Hybrid Decision Support System for Water Management

H. Kazeli [1], T. Christofides [2] and E. Keravnou [1]
1. Department of Computer Science and 2. Department of Mathematics and Statistics
University of Cyprus P.O. Box 20537 CY 1678 Nicosia Cyprus

email: {hariklea, tasos, elpida}@ucy.ac.cy

Abstract

During the last twenty-five years the scarcity of water resources is exponentially growing worldwide. As a result, there has been a serious and growing concern about the water shortage problem, resulting in substantial progress in different aspects of water resource development and management in different parts of the world. The problem of the scarcity of water is especially severe in the semi-arid countries and in particular, in the coastal and island communities of the Mediterranean region, where the satisfaction of water demand is not possible. Cyprus situated in the north east part of the Mediterranean region is among the countries facing a severe water shortage problem and focusing in finding efficient and systematic ways for effective water management.

This paper describes an interdisciplinary, intelligent and flexible decision support system addressing the highly complex problem of the management of water resources in the regions along the South Conveyor Project (SCP), the largest water development project in Cyprus. The proposed decision support system is based on a heterogeneous, hybrid architecture integrating together a variety of technologies and targets the development of an integrated, holistic approach to manage water and replace use-based management. Such a scientific approach allows information management, knowledge elicitation, prediction of the future, exploration of alternatives but mainly systematic decision making on the operational activities involved, providing methods for handling the interdisciplinary nature of water management and the measurement of the effectiveness of the decisions taken.

The proposed decision support system embodies deep knowledge in the form of causal loop modeling and uses systems dynamics and simulation modeling for case-base reasoning that performs inferencing at a high level. It also involves relational databases for data storage, analysis and representation, and employs data pre-processing and standard statistical techniques for intelligent data analysis and forecasting. Its components can evolve on the basis of input data and expert knowledge. All these disciplines equip the system with intelligence and allow it to reason under uncertainty, increasing in that way efficiency and accuracy in the management of water. The system's interactions is achieved through complicated and well-designed GUIs, which utilize a number of communication and integrating techniques.

This system is developed in the context of the INCO-DC project MEDWATER whose overall target is the management of water resources in the Mediterranean region. The duration of this project was three years (Nov 1997 – Oct 2000) and its overall financial support from the EU was 0.5M Euro. The system to be presented is mainly the result of a close collaboration between the University of Cyprus and the Water Development Department (WDD) in Cyprus. Given the nature of the problem, an interdisciplinary consulting team, consisting of water engineers, hydrologists, computer scientists and statisticians was necessary for addressing all aspects of the problem.

The resulting decision support system will be installed at the WDD. Experimental results on real data will be presented, analyzed and used for further reasoning and decision making. The benefits accruing from the use of the system are expected to be highly significant.

Keywords: Water Management, Decision Support Systems, Hybrid Architectures, Causal Loops, Systems Dynamics, Simulation and Regression Models.

Maîtrise des ressources en eau au Liban

Wajdi NAJEM
Centre régional de l'eau et de l'environnement
Université Saint Joseph
Beyrouth- LIBAN

La maîtrise des ressources en eau au Liban suppose comme pré-requis la connaissance de ces ressources. Le Liban est un des premiers pays de la région à avoir développé un réseau de mesures réparti sur tout le territoire, ce qui a permis d'élaborer plusieurs plans d'aménagement hydrauliques.

Malheureusement la guerre a bloqué durant plus de quinze ans tous les réseaux de mesure dans le pays, et par suite tout plan de développement et d'exploitation des ressources.

Depuis quelques années, on assiste de nouveau à la remise en place et à la modernisation de ces réseaux et à leur utilisation pour une évaluation plus approfondie des ressources et de la demande dans le pays.

Le Centre Régional de l'Eau et de l'Environnement participe de façon active, et à travers différentes actions, à la connaissance de la ressource en eau au Liban.

Par ailleurs, à travers plusieurs programmes de recherche nationaux, bilatéraux, régionaux et européens, il fournit un apport considérable dans l'évaluation et l'élaboration d'outils de gestion efficaces de ces ressources.

POSTER

FOS_EN: The Fiber Optic Sensors European Network

Coordinated by ProtoDel International Ltd.
Vulcan House, Restmor Way, Hackbridge, Surrey SM6 7AH, UK
Website: http://www.fos-en.net

About FOS-EN

Formed in 1999 by ProtoDel International Ltd and supported from the European Union Growth Programme, FOS_EN continues to expand and attract new members. Currently with over 70 members throughout the EU and representatives from Switzerland, FOS_EN's core of expertise encompasses all of the key technological areas relevant to optical fiber sensing.
FOS_EN has been structured around the three core themes:

- Safety, Integrity and Maintenance (SIM)
- Medical and Environmental Sensors (MES)
- Sensors for Process Control (SPC)

The Objectives of the Network

Through regular technical discussions, theme meetings and group discussions on the FOS_EN interactive Website, FOS_EN provides a forum which:

- Encourages practical collaboration between technologists and researchers to produce innovative and competitive sensor products
- Promotes co-operation between users, technologists and manufacturers increasing the pull through of enabling measurement technology into commercial application
- Enables companies with complementary skills to co-operate to produce competitive and higher specification products
- Gives manufacturers direct access to state of the art technology and ideas
- Acts as a focal point for end-users to access technology relevant to their own requirements.

Optical Fiber Sensors for Environmental Monitoring

Environmental surveillance with optical instrumentation entails two types of measurements, remote and on-site. On-site measurements mainly involve sampling of elements and subsequent analysis via variour types of spectrophotometers. Fiber optic sensors (FOS) offer several advantages over conventional instrumentation for on-site measurements:

- On-line, real-time, localised measurements are possible
- Sensor miniaturisation
- Materials used in fiber construction aloow FOS to be permanently positioned in hard-to-access-areas, including underground sites
- The electro-optic power supply and control units can be located remotely from the measuring area.

The poster will show the fiber optic instrumentation, relative to environmental monitoring, which has been implemented by the research groups and by companies belonging to FOS_EN.

POSTER

Optical Fiber Spectroscopy for Environmental Monitoring

*A.G. Mignani *, D.A. Jackson, M. Tur, C. Christofides, D. Halot, T. Kuzniz, A. Romolini,*
K. Kalli, A. Othonos

* IROE-CNR, Via Panciatichi 64, I-50127 Firenze, Italy, email: mignani@iroe.fi.cnr.it

The results of the joint research Programme INCO-DC 'RAMFLAB' are presented, consisting of a new instrumentation capable of detecting multi-component pollutant mixtures. On-line measurements are possible, either as separate instruments supporting fluorescence or absorption spectroscopy with the potential of a single instrument supporting both fluorescence or spectroscopy. The instrumentation can be operated remotely using conventional optics or fiber optic links and probes. A neural network software allows to obtain accurate information on multi-component water sample composition.

Target pollutants which have been investigated were Chromium mixtures and polycyclic aromatic hydrocarbons, the BTEX and crude oil.

Integrated Systems for Decentralized Wastewater Management and Recycling for Unsewered Communities in the East Mediterranean Countries

Dr. Mohammed Saidam
The Royal Scientific Society
Environment Research Centre
E-mail: m.saidam@rss.gov.jo

ABSTRACT

The paper presents a regional project designed to facilitate accelerated expansion of robust, and cost effective decentralized wastewater management and recycling services to the unsewerd communities in the East Mediterranean Region (EMR). The project will bring together a network of partners from Jordan, Morocco, Tunisia, UK, Netherlands, Cyprus, Palestine, Lebanon and Syria facilitated by WHO Regional Centre for Environmental Health Activities (CEHA). The project idea emerged from the "Technical Expert consultation on Appropriate and Innovative Wastewater Management in Small Communities in EMR Countries" convened by WHO/CEHA in November 2000 with participation of water and wastewater management experts from EMR, Europe, Latin America, and some Arab and international organizations.

With increasing demand on the already stressed water resources in the EMR, the need for rational utilization of these resources and protecting their quality is becoming more urgent than ever. The provision of appropriate wastewater management and recycling services to as many communities as possible is central to satisfy this need, enhance public health protection and the environment at large. The present wastewater management practices in EMR, of relying mainly on centralized systems comprising a sewer network and central treatment works, are most likely to decelerate the extension of the service due to the high costs entailed. Even in most advanced countries, it is increasingly realized that achieving 100% sewerage is impossible. Additionally, the centralized concept has some serious drawbacks in that the "scarce" freshwater is utilized to transport waste and huge concentrated environmental risks are presented when centralized treatment works fail or become overloaded as commonly experienced.

The ultimate objective of the project is the protection of public health, the environment and augmentation of water resources through facilitating and accelerating the expansion of cost-effective, efficient and environmentally responsible wastewater management services to unsewered communities in countries of the EMR. Specifically, the project aims at the introduction and promotion of the decentralized concept of wastewater management through the provision of viable, cost-effective, appropriate and efficient solutions of flow modification and reduction, greywater reuse for non-potable purposes, improved on-site wastewater management for pollution control and recycling, and modular integrated community wastewater systems utilizing settled sewers.

The methodology for achieving these objectives includes assessment of existing wastewater management practices, systems demonstration, education and training and networking and information exchange. It is perceived that several cases of wastewater management systems will be broadly analyzed for appropriateness from the various aspects. Demonstration schemes will be built and researched as advocacy and educational models. Design and operation manuals on decentralized wastewater management alternatives will be developed. Educational and research programs on decentralized wastewater management systems will be established in three universities in EMR. Training sessions will be conducted. Research results and policy recommendations will be disseminated through workshops, printed media and the web.

The proposed duration for the project is three years.

Development and Implementation of an Integrated and Automated Dam Monitoring System for Jordan Valley Authority

Abdallah I. Husein Malkawi, Ph.D.
Associate Prof. of Geotechnical Engineering and
Consultant to Ministry of Water and Irrigation, Jordan Valley Authority - Civil Engineering Department
Jordan University of Science and Technology, Irbid 22110 – JORDAN
E-mail: mhusein@just.edu.jo

Jordan Valley Authority is the primary governing agency in charge of the construction, maintenance, and operation of the entire infrastructure in the Jordan Valley. As part of the water resource development and management scheme, a large number of earth dams have been constructed; three dams are now under construction and many more are planned for near future construction. These large number of built or planned dams constitute a significant amount of capital investment by the government, and maintaining these dams' operational conditions and their healthy performance functions are especially critical to the well beings of the Valley as well as the nation. Each as-built earth dam in Jordan Valley has various types of instrumentations installed, which in turn provide tools for monitoring the operational conditions of the dams during the service life of the structure.

However, the JVA engineers who typically lack adequate training for such a task have performed the maintenance and reading of these instrumentations. Furthermore, the reading of these instrumentations has been done manually, which is time consuming and labour intensive. The drawbacks of manual reading of these monitoring data include:

(1) Error in transcribing the data,
(2) Lack of automated mechanisms for data entry and query,
(3) Lack of efficient user graphic interface,
(4) Lack of effective means for interpreting the monitored data to make timely engineering judgment,
(5) Lack of automated warning system in case of emergency situations arise at the dam site, and
(6) Lack of efficient data management capabilities.

Because of these drawbacks of current data monitoring system, the full potential of dam instrumentation has not been fully realized. With a small amount of investment in upgrading current dam monitoring reporting system through the proposed project outlined herein, it is believed that a modern and state-of-the-art health monitoring system will be in place to help JVA manage/maintain/operate the vast number of earth and concrete dams in the valley.

Drinking Water Quality Management in Distribution Networks

Dr. Hani Abu Qdais, Civil Engineering Department, Jordan University of Science & Technology, e mail

hqdais@just.edu.jo

Dr. Muna Hendeyeh, Environmental Sciences Department, Jordan University of Science & Technology

The distribution of drinking water in networks is a technological challenge both in quantitative and qualitative terms. It is essential that each point of the distribution network be supplied without interruption with an invariable flow of water complying with all the qualitative parameters of drinking water standards in force. This is essential in order to ensure the security, public health and general cleanliness of communities. There is currently an increasing concern regarding potential water quality problems in drinking water distribution systems. Of principal concern is the problem of water quality variability within the distribution system. It is clear that the distribution system itself may adversely affect the quality of treated water. In spite of water treatment, finished water may be subjected for substantial changes in quality while being transmitted through the distribution system before reaching the end consumers.

Quality changes in the distribution system may be associated with complex physical, chemical and biological processes that take place during transport. These processes can occur either in the bulk water column, the hydraulic infrastructure, or both. The potential of water quality problems usually increased with the age of water distribution networks. The problem is further complicated when the water is supplied on an intermittent basis (time supply), which is the case in many water scarce countries, such as Jordan.

For all these reasons the quality of water within the distribution system may vary with both space and time. In order to understand water quality variations in a distribution system, one must also understand hydraulic behavior as well as the kinetics of chemical formation and destruction.

The progress so far achieved in recent decades in drinking water production has focused mainly on treatment processes, enabling the production in each particular situation of water of ever higher quality, meeting the new standards and recommendations laid down. Increasing level of pollution, consumer expectations, the development of new analytical techniques and the growing degree of regulation have led R&D teams to amplify the studies made of evolutive parameters relating to distribution networks, and to consider drinking water treatment technologies as a homogeneous system including the quality of the resource, the stage of treatment in plants, and distribution conditions. In fact, many qualitative parameters can vary in pipes, such as turbidity, color, flavors, residual chlorine and circulating bacteria counts.

The overall purpose of the proposed project is to develop an improved understanding of the water quality variations within the water distribution networks of Jordan, which will assist the Water Authority in attaining their mission to deliver safe and potable water to the end consumers, so as to meet the water quality standards. This will be achieved through a very well designed water quality monitoring program which will cover distribution networks in different cities and towns of the country. It is also essential that utility personnel, regulatory personnel, and consultants have the proper training and guidance in the application of water quality management techniques and models. Therefor, a parallel purpose for this project is to develop an on site training for the operation and maintenance staff of the water utilities to prepare and test procedures for conducting water quality investigations, which are essential in developing the data necessary for successful application of water quality management programs. In addition, operational manuals will be prepared to guide the system operators in applying the best available techniques to prevent water quality deterioration within the distribution system.

Achieving the objectives of the proposed project, a number of benefits will be offered to the water industry, such as, potential water quality deterioration within the distribution systems, and evaluating the water quality aspects of distribution networks and storage reservoir improvements. Furthermore, management programs can be used to evaluate the effectiveness of proposed network improvements to be undertaken to ensure the maintenance of acceptable water quality throughout the distribution system before construction, thereby avoiding possible costly mistakes.

Enhancement GIS use in Agriculture in Jordan

Munther Kharraz, Dept. of Land & Irrigation , Amman, Jordan

1- Background and Rationale :

During recent years the importance of Remote sensing RS. Has increased greatly because of its manifold application possibilities. It become one of the most important techniques that provides detailed information about an area, phenomena or an object through analyzing and interpreting the spatial or spectral data gathered through these techniques.

In agriculture, it allows to follow the development of some problems or phenomena such as soil erosion, desertification processes, changes in land use, water resources, soil and water pollution…etc.

The sorting of ground information in a good (GIS) system can provide decision makers with essential , reliable and up-to-date information's and imposes a uniformity of format as well as standard information concerning different agricultural themes. The experience of MOA in the field of GIS applications started in 1989 where Jordan Soil and Climate Information System is established through the execution of national soil map and land use project which becomes now aunit in the survey and GIS division of land and irrigation department. At present, efficient and adequate information services system concerning different agricultural issues is not fully available in Jordan , therefore developing a strategy for promoting efficient Agricultural Information System including conduct of potential water and soil pollution maps is essential.

2- Objectives :

The main objectives to be achieved with the project are:

- Promotion reliable, effective, and up-to-data . Agricultural Information System concerning forests, orchards, major field crops " wheat and barley" inventory, desertification and land use.
- Producing soil and water potential pollution maps and soil salinity and fertility maps in the irrigated area in Jordan Valley.
- Update land use maps through :
  - One- Upgrade the existing Jordan Soil and Climate Information System.
  - Two- Replacement of hardware and software packages.
  - Three- Transfer of data into newer software packages.
- Training and capacity building-up on RS and GIS applications in the field of agriculture.

1- Project Management.

The Project will be managed by MOA through the survey and Information System Division in the land and Irrigation Department.

2- Impacts.

- Promotion of Agricultural Information System
- Availability of reliable and up-to-data informations essential for Agriculture.

3- Budget .

The proposed budget is in order of (707850) U$ over three years.

Control of Bacterial Regrowth in Water Distribution Systems

Project IC18CT97-0136 (INCO-DC)

Dr Sam James
Civil Engineering, University of Newcastle, Claremont Rd.
Newcastle upon Tyne NE1 7RU, UK
e-mail: Sjames3014@aol.com

This project aimed to identify situations in continuous and intermittent water supplies in which regrowth of bacteria occurred, and to develop predictive models of these systems to evaluate various control scenarios to limit the regrowth problem. Continuous distribution systems in the UK and Portugal, and intermittent systems in Jordan, Lebanon and Palestine have been intensively sampled for physical, chemical, bacteriological and hydraulic parameters over a period of 1-2 years. The selected systems have been simulated using the public-domain Epanet model, and the output files have been interfaced with a new event-driven model (Enhanced Performance Q), developed by our Portuguese partners, which incorporates prediction of bacterial growth and death, in suspension or as biofilm.

The coefficients of growth and death of distribution system isolates and other organisms known to be present in distribution, have been determined during the project, and the kinetics of chlorine decay, both in the bulk water and due to wall (biofilm) effects have been evaluated so that appropriate values can be used in the bacterial model.

Biofilm development has been studied in actual distribution systems and in experimental rigs, where biofilm interactions with chlorine and effects of drying and/or velocity on bacterial detachment have been measured.

The continuous distribution system in the temperate UK climate was shown to suffer bacterial regrowth problems especially where river-derived supplies were subject to long retention times (long mains, service reservoirs), low chlorine concentrations and relatively warm (above 15^{o}C) summer temperatures.

The intermittent water supplies of the Mediterranean countries demonstrated several scenarios which led to poor bacterial water quality. Household water storage tanks are an essential component of systems subject to intermittent supplies, and our studies showed that the bacterial quality of the water deteriorates, with increases of up to 5 orders of magnitude of bacteria, when water is stored for up to seven days at temperatures of 20^{o}C and above.

A second potentially serious situation has been identified when water pumping restarts after a period of no flow in an intermittent supply. When the pipes are in an unpressurised state, infiltration of contaminated water is possible; partially-dried biofilm has also been shown to detach as water velocities increase. Both events lead to poor bacterial water quality in the first flush, as water pumping starts.

Throughout these studies bacterial isolates have been made, organisms identified using a variety of techniques, and these results will be presented.

In addition to Enhanced Performance Q, a simple plug flow model has been developed to simulate bacterial growth, death and detachment, chlorine decay and other chemical changes in water quality, and this has been validated both for the distribution system data and for the household storage tank data. Both models are being used to predict regrowth in a variety of situations and to evaluate alternative control scenarios, e.g. most appropriate locations in the systems for rechlorination, and what chorine concentrations will be effective.

Comparison of the two models indicates that the plug flow models work well both in continuous and intermittent supplies, but that Enhanced Performance Q is most useful in the continuous supply situation.

Use of Saline Water for Agricultural Purposes

Dr. Mohammad A. Al- Dabbas
National Center for Agricultural Research and Technology Transfer
E-mail : mdabbas98@ yahoo.com.

Shortage of water resources in Jordan is a very severe problem due to the dominance of arid and semi-arid climate over about 90% of its area. Water recourses originate mainly from rainfall. Water Budget in Jordan for the past few years indicate that, the agricultural sector consumes about 70% of available water resources. Available surface water resources are almost exhausted and ground water abstraction has already exceeded the safe yield. It is estimated that, within two decades, the proportion of marginal water (saline and treated wastewater) will be more than 30% of the total available water resources for irrigation. Saline water will be highly valuable source of water for irrigation.
The Main objectives of the project are the following:

- Conserve available water resources by optimum use and management of saline water for irrigation.
- Increase agricultural production through widening the irrigated areas using saline water and decrease the dependence on good water quality in agriculture in Jordan.
- Study the effect of using saline water on yield components and soil properties.

Two experiments were carried out at Al- Khaldiah Research Station in 1995/96 and 1996/97 seasons using Tomato and Sudangrass. For the first experiment, the main treatments were four levels of irrigation water amounts 50, 75, 100, 125% from evaporation class E-pan readings. Three levels of water quality treatments as sub-main treatments were used: Fresh water (0.7 dS/m), Saline water (5.4 dS/m), and Alternate irrigation with fresh water followed by saline water (1:1 ratio of the total amount of water applied). For the second experiment, four saline irrigation amounts (5.4 dS/m) were used (100%, 115%, and 130% of E-pan reading) as main treatments. Four N-fertilizations were used as sub-main treatments (0, 14, 20, 26 Kg N/du) in four replicates using basin irrigation system.
Tomato experiment results showed an increase in total production by increasing irrigation water amount for the three sub-main treatments. Total and marketable production increased significantly for the Fresh treatment (34.67 ton/ha) and Alternate treatment (31.96 ton/ha) over the Saline treatment (22.99 ton/ha) at the 125% irrigation level. Percentage of Total Soluble Solids (TSS) increased significantly for the Saline treatment (6.8%) over the Fresh (5.2%) and Alternate treatments (5.57%). Total Soluble Solids percentage decreased by increasing the amount of irrigation water. The highest TSS value (7.24%) was obtained under the Saline treatment at 50% irrigation level. Alternate water treatment was the lowest in decreasing fruit weight. Salinity development in soil profile was related to the amount of applied irrigation water. It has been found that salinity of the surface layers decreased under the 50% and 75% irrigation levels, while the decrease in salinity for the other depths was related to the higher levels of applied water (100% and 125%).
In the second experiment, the 1995/96 season results showed that biological yield of Sudangrass decreased with increasing the irrigation amount and the applied N-fertilizer. Biological yield increased significantly for all irrigation levels and reaches 101.9 ton/ha when 14 kg N/du was applied in comparison with 55.12 ton/ha production when 26 kg N/du was added. On the contrary, 94.75 ton/ha was gained in the second season 96/97 when 20 kg N/du was added and it under the 115% irrigation level. Percentage of dry matter weight increased throughout the season. The highest amount was achieved in the third cutting at the 130% irrigation level in both seasons 95/96 and 96/97 and reached 29.5% and 31.03% respectively. Protein percentage decreased throughout the growing season but increased when N-fertilization increased for all irrigation treatments. The highest protein percentage in both seasons was in the first cutting at 130% irrigation treatment and when 26 kg N/du was added. The amount in both seasons 95/96 and 96/97 reached 20.05% and 20.65% respectively. Salinity development depends on the applied amount of irrigation water. In both seasons, the effect of 100% irrigation level restricted in decreasing the salinity of the first layer (0-15 cm). While, decreasing the salinity of the deeper layers depended mainly on the higher irrigation levels, which are 115% and 130%.

A Holistic Generic Integrated Approach for Irrigation, Crop and Field Management: The SALTMED Model

R. RAGAB[2]
Centre for Ecology & Hydrology, Wallingford, OX10 8BB, UK
E-mail: Rag@ceh.ac.uk

ABSTRACT

A successful water management scheme for irrigated crops requires an integrated approach that accounts for water, crop, soil and field management. Most existing models are designed for a specific irrigation system, specific process such as water and solute movement, infiltration, leaching or water uptake by plant roots or a combination of them. There is a serious gap in the knowledge related to models of a generic nature, models that can be used for a variety of irrigation systems, soil types, soil stratifications, crops and trees, water application strategies (blending or cyclic), leaching requirements and water qualities. SALTMED model has been developed to fill this gap. The model employs established water and solute transport, evapotranspiration and crop water uptake equations. Due to the scarcity of data sets that are suitable for model testing over the complete growing season, where different processes are acting simultaneously, different subroutines were separately tested. The model was able to reproduce the soil moisture, salinity and relative concentration profiles of Gilat Loam under infiltration using trickle line source, soil moisture profiles of sand under trickle line source and soil moisture profile of Lakeland Sand (3 layers) under infiltration from trickle point source. In this paper, the model has been run with five examples of applications for one growing season using data from the literature. The model successfully illustrated the effect of the irrigation system, the soil type, the irrigation salinity level on soil moisture and salinity distribution, leaching requirements, and crop yield in all cases.

[2] Dr. R. Ragab
Principal Research Scientist
Chairman of the Work Team on the Use of poor quality waters for Irrigation, International Commission on Irrigation & Drainage, ICID
Chairman of the Work Group on the Sustainable use of natural resources for crop production, International Commission on Irrigation & Drainage, ICID

Hydropower harvesting from wastewater treatment plants in Jordan

Dr. Sulieman Tarawneh
Civil Engineering Department
Mu'tah University
Jordan

Hydropower harvesting is analogous to water harvesting in utilising the resource in its location. Also it resembles water harvesting in being utilised in several forms and several techniques. On the other hand, hydropower harvesting needs an elevation difference in the topography on the intended location.
This elevation difference is one of the most important factors that makes hydropower harvesting successful in any form using any technique.

Fortunately, many wastewater treatment plants in Jordan discharge their effluent in valleys several hundred meters below the plant)e.g. Tafilah, Karak, Salt, Ajlon and Irbid). This elevation difference, besides the continuity and the volume of the discharge make the hydropower harvesting of this growing sector very promising.

The extracted hydropower could be used in operating the plant itself. Also it could provide the close villages or farms with electricity or could be connected to the national or local grid. This promising hydropower harvesting needs several precautions. First, the treated wastewater should be prepared properly for the process. Secondly, the turbines should be selected top resist corrosion.

This promising technique could be utilised in many countries in the world where the elevation difference is remarkable and the discharge reasonable.

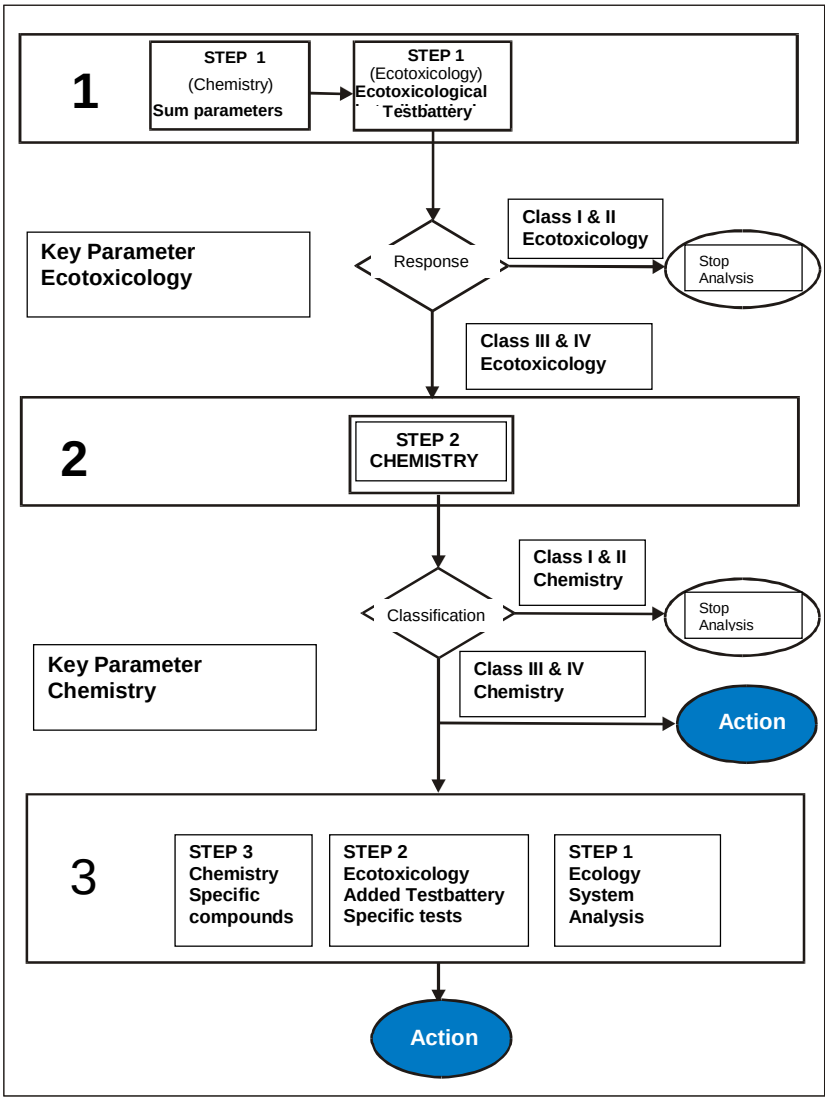
Guideline for assessing the quality of sediments and dredged material

H. Neumann-Hensel *(Technical University-Hamburg-Harburg; Labor Dr. FINTELMANN and Dr. MEYER)*
M. Ricking *(FU-Berlin, FB Geoscience)*
H. Hollert *(University of Heidelberg; Zoology I)*
W. Ahlf *(Technical University-Hamburg-Harburg)*
J-P. Lay *(DBU Deutsche Bundesstiftung Umwelt)*
K. Terytze *(UBA Federal Environmental Protection Agency; Free University of Berlin, Dept. Geoscience)*

The recommendations presented in this approach use an integrated stepwise approach which unites ecotoxicological, chemical and ecological analysis methods to assess and screen the quality of sediments. For this reason biological methods in combination with the tools of chemical analysis are given priority when examining the quality of the sediment and dredged material to establish adverse effects, to prognosticate the effects of introduced dredged material and potential remediation activities and to document effects on aquatic ecosystems.
The examination patterns that make up the basis for the assessement are set irrespective of the location.

Based on different sediment collection approaches, stepwise analysis of inorganic (trace metals like Hg, Pb, Cd, etc.) and organic compounds (PAH, OCP, PCB) in different phases and toxicological test on multiple trophic stages is recommended.
An integrated package for assessing the ecosystem quality is the final stage.

All analytical and toxicological methods are based on international norms, the quality criteria are exemplified on a national basis, but can be transferred to other countries.



Water Resources Management under Drought Conditions: Criteria and Tools for Conjunctive Use of Conventional and Marginal Waters in Mediterranean Regions.

Giuseppe Rossi and Federico Vagliasindi[3]

Water resources management in arid and semiarid region is a complex, multifaceted task due to the many hydrological, environmental, and management factors that need to be integrated in order to provide to all users from different sectors sufficient supplies of adequate quality while ensuring the necessary level of environmental protection.

Specifically, scarcity of conventional water resources in arid and semi-arid regions promotes the search for additional sources (i.e., unconventional or marginal waters) such as deep groundwater, treated wastewater, saline or brackish water, and for practices, such as advanced irrigation technologies and water harvesting, for reducing demands and satisfying water requirements. Furthermore, drought events, that often occur in Mediterranean countries, amplify water management problems and require long-term measures to reduce the water systems vulnerability, and short-term measures to mitigate drought impacts.

This paper presents the main objectives and the preliminary results obtained during the first year of the WAM-ME project, which is carried out by seven partners from six Mediterranean countries with the overall goal of increasing the scientific background and developing technological tools for improving water resources management and environmental control in drought-prone Mediterranean regions, addressing the exigency of integrated water management and environmental protection, as already highlighted in the European Commission water policies and directives.

Particular attention will be devoted to the definition of criteria for an efficient use of marginal water resources (in particular the reuse of treated waste water for irrigation and the withdrawal of deep groundwater considered as emergency resource) and the development of modeling tools and Decision Support System (DSS). These criteria and tools could support the choice of the preferable mix of long-term and short-term measures for water management under normal and drought emergency conditions.

The specific objectives of the project are as follows:

1. Identify the most significant problems occurred in the countries participating to the project during recent drought events and the institutional, legal, and technical features of the water management systems in operation;
2. Develop adequate recommendations for the most efficient water application methods, diminishing risks for environment and human health while utilization low qualities waters, by using the results of specific field experiments with waste water treated effluent and with different kinds of modern application technologies;
3. Define potential applications and limits of the use under drought conditions of water resources marginal for quality (waste water, saline and brackish water) or marginal for exploitation costs (deep groundwater), taking into account the minimum water quality requisites, the level of treatment and the hygienic constraints as a function of the final uses and utilization schemes, and to provide recommendations for treated wastewater disposal and reuse incorporating criteria developed by various countries and international authorities.
4. Develop a set of strategies identifying the role of groundwater in mitigating drought impacts in complex water systems which include the conjunctive use of surface and groundwater;
5. Develop an optimization model for the conjunctive use of conventional and marginal waters incorporating significant water quality indices;
6. Develop a Decision Support System (DSS) for the management of integrated water resources systems focused to drought prevention and mitigation which could help the decision makers to face drought risk in the Mediterranean regions;
7. Verify the usefulness of the developed optimization model and DSS tools to identify, in selected Mediterranean regions, the preferable mix of long-term and short-term measures for drought impacts mitigation.

[3] Respectively: Project Co-ordinator and Contact Person for INCO-MED Research Contract no. ICA3-1999-10035 (WAM-ME), Department of Civil and Environmental Engineering, University of Catania, Viale A. Doria 6, 95125 Catania, Italy. Tel. 0039 095 738 2704; fax: 0039 095 738 2748; e-mail: fvaglias@dica.unict.it.

Use of Constructed Reed Beds for Dewatering and Humification of Liquid Sludge Obtained in Small Wastewater Treatment Plant",

Dr.-Ing. George Zahr
Damaskus University, Faculty of Civil Engineering
Department of Environmental Engineering
E-mail drgz@usa.net
Damascus, Syria

The humification of waste water sludge in constructed reed beds is a nature closed process for dewatering and advanced mineralisation. Because of big requested surfaced area, this process will be applicated in rural regions.
The properties of reed shall be of use as pertinent evaporation, favorable influence of soil structure through root system in the drying beds, which are planted with reed
The root network system penetrates the whole sludge body, breaks it up, takes care of aerobic states, and accelerates the soil formation.
The seepage water infiltrates through the soil layer and will be pumped back to the treatment plant.
Despite their technically undemanding nature, constructed reed beds need to be observed and tended carefully both.
The surface overflow rate in the aride regions can be based on 200-300 kg TS/(m^2.yr) for liquid sludge of aerobic treatment of wastewater That means, a specific load of drying beds is not to exceed 0,20 m^2/p.and only 100 kg TS/(m^2.yr) for liquid sludge of anaerobic treatment of wastewater.

The Desalination Commission in Syria

S. AlAyoubi, Z. Salhani, A.H. Zein, M. Azmeh

Scientific National Commission for Water Desalination
Higher Institute of Applied Science and Technology
P.O. Box: 31983, Damascus – SYRIA
Tel: 963-11-5124639, Fax: 963-11-2237710, e-mail: soufa@scs-net.org

Desalination of sea and brackish water has become a necessity in many arid and semi-arid regions in Syria. Natural fresh water resources in Syria are being depleted rapidly as a result of population growth and socio-economical development. It is apparent that water demand in Syria will grow more rapidly within the next twenty years: forecasts expect that the Syrian population will increase from 18 million in 2001 to more than 28 million in 2020. This increasing demand for water puts enormous strain on the underground aquifer, which results in lowering water levels and increasing salt concentration.

As stated above, it is clear that any solution that allows an increase in water resources will be of great advantage to the country. Many solutions were undertaken by the government of Syria to solve the problem by building dams and creating multipurpose reservoirs. Water that becomes available by catchment is used in power generation and in irrigation. The development of non-conventional water resources including water desalination technologies will constitute an important source of water that augments the national water budget. Desalination technologies will permit Syria to invest the seawater and its brackish water in the eastern regions in order to obtain industrial and fresh drinking water.

As a result of the Syrian government interest in desalination technology and because of the importance of enhancing technical expertise in this field, the Ministry of State for the Transfer and Development of Technology decided on 28/11/2000 to form a Scientific National Commission including the following bodies:

- University of Damascus
- Higher Institute of Applied Science and Technology
- Atomic Energy Commission in Syria
- Ministry of Irrigation
- Ministry of Housing and Utilities

The mission of this commission is to:

1- Evaluate the Syrian needs for water desalination technology.
2- Perform a technical feasibility study in order to identify the most adequate technologies of water desalination for the Syrian needs.
3- Suggest an integrated program enabling Syria to optimize its investments in brackish and seawater desalination.

This commission must provide the ministry with a detailed plan of action including the executive measures to be taken in order to establish a national industry for water desalination.

The need for comprehensive project planning is extremely important. In developing a good plan, one must first assess surface and groundwater resources, available energy, water distribution system, local desalination industry and quality of water required. These activities are already started in collaboration between the National Commission for water desalination, Ministry of Irrigation and Ministry of Housing and Utilities.

This proposal focuses on elaborating an RTD program of water desalination in Syria. The main objective of this proposal is the advancement of the desalination knowledge and experience in Syria through execution of an integrated research and technical program. Ultimately, this will be manifested through development of applied desalination research laboratory in Syria that may be hosted in the Higher Institute of Applied Science and Technology. The objectives of this laboratory will include:

1- Developing the necessary human resources and expertise through an adapted training and capacity building program.
2- Promoting of desalination technology transfer through conducting design, construction and operation of demonstration plants in specific remote areas.
3- Enhancing the public awareness about desalination technologies and helping decision-makers in choosing the most suitable desalination technologies for Syrian needs.
4- Developing sustainable regional and international scientific and technical relationships that help Syria in elaborating its long term national plan in water desalination development.

Development of Drinking Water Quality Standards in Jordan

Dr. Muna Hindieyh,

Environmental Science Department, Faculty of Sciences and Arts.

University of Jordan for Science and Technology.

Dr. Hani Abu-Kudais,

Environmental Engineering Department,

University of Jordan for Science and Technology.

In order to be used as a healthful fluid for human consumption, water must be free from organisms that are capable to cause diseases and from minerals and organic substances that could produce adverse physiological effects. Drinking water should also aesthetically acceptable, it should be free from apparent turbidity, color and odor and from any objectionable taste. The provision of a safe and aesthetically acceptable drinking water is secured now in most countries by a series of obligatory or advisory standards. Although the scientific approach in setting drinking standards is basically similar, there are differences in both the mechanism producing standards, and the philosophy of application. For example, there are international guidelines set by WHO, national standards set for individual states such as USEPA standards or local standards set by a certain local authority.

WHO guidelines for drinking water quality were, evolved in lieu of WHO standards for use by countries as a basis for the development of their own national standarrds, which if properly implemented, will ensure the safety of drinking water supply. However, it should be emphasized that the level of contaminants recommended in WHO Drinking Water Quality Guidelines, are not standards, instead they will serve as guiding values for states to set their own standards based on the prevailng environmental, social, economic, political and cultural characteristics and constraints.
As the case in many countries of the world, Jordan used the WHO guidelines as a basis to derive the national drinking water standards. These standards have been subjected to several modification, since their setting for the first time in 1982. The preliminary objective of this paper is to review the history of drinking water standard development in Jordan and the methodology followed in their development. The next step is the review of constraints facing the compliance with the drinking water standards in Jordan and recommended actions that should be taken to comply with.

In addition, a comparison between Jordanian Drinking water standards and natural mineral water standards was carried out which revealed many contradictions.

An Autonomous Solar Distillation System of Brackish or Seawater for Remote Areas*

G. Papadakis[1], D. Georgakis[1], E. Maliderou[1], J. Markopulos[2]

[1]Agricultural University of Athens, Engineering Department,
[2]Austro Control Ltd., Austria

Abstract

The lack of fresh water is a phenomenon often met in many islands and coastal areas through out the world. This fact inhibits social and economic development and this results in many cases, the people to leave their place and seek for a better life in the nearest city. Locally available renewable energy sources can in most of the times, supply the necessary energy for the operation of desalination systems and produce fresh water from sea or brackish water.

Existing technologies such as multi-stage-flash-evaporation (MSF), multi-effect evaporation (ME) and vapour compression (VC) distillation are the most characteristic and are generally cost-effective in large scale since the unit cost of product water is lower. They are mainly used to supply municipal drinking water and are relatively commercial. Other thermal processes such as freezing, membrane distillation and solar humidification usually have a lower quality energy requirement. Low-grade thermal energy can be used from sources as solar collectors or industrial waste heat. These processes are cost effective in medium- to small-scale systems. They are principally used to supply community or household drinking water supplies.
Such technologies require high infrastructure for securing electricity supply and system maintenance. Thus there is a need for an autonomous desalination system operating away from the electricity network and exploiting local renewable energy sources.

The present paper regards the development and application of a solar distillation system completely autonomous suitable for remote areas. Solar collectors supply the necessary heat energy for evaporating brackish or seawater. The salty water evaporation takes place under pressure lower than the atmospheric one (about 0.5 bar) thus lowering the boiling temperature and increasing the rate of evaporation. All auxiliary systems such as pumps, circulators, control system are energised by photovoltaics.

A prototype system was installed within the EC CRAFT programme in Greece. The system comprises of solar collectors of heat pipe type, having a surface of 90 m^2, photovoltaics of about 5.5 kWp with battery bank of 600 Ah (48 V) and a DC/AC inverter 48/240 V. During the first system operation under low solar radiation conditions the fresh water production was between 0.5 to 0.7 m^3 per day.

* Project supported by the European Commission

Projection of Irrigation Demand in Jordan: Introduction to GIS-based Model for the projection and Management of Irrigation Demand

Suzan Taha [1] and Hazim El-Naser [2]

[1]Water Sector Planning Support Project Coordinator
[2] Secretary General
Ministry of Water & Irrigation
P.O.Box 922014
Amman-Jordan
E-Mail[1]: Suzan_Taha@mwi.gov.jo
E-Mail[2]: Hazim_El-Naser@mwi.gov.jo

Studies of projected water demand and supply in Jordan have shown that the water deficit is increasing with time. Demands upon finite quantity of good quality water are ever increasing. With agriculture constituting about 70% of the overall demand, it became necessary to create a tool for the projection and management of irrigation demand in the country given available water quantity and quality.

The model is one single component of a constellation of digital tools developed in order to enable the Ministry of Water and Irrigation to carry out nation wide water balances based on the most recent data and various development scenarios. The irrigation model consists of several modules for the pre-processing of climatic data, calculation of Et_o, crops net irrigation requirements, and the estimation of present and future irrigation demand for the whole country or a selected planning/development region. The model is GIS-based and is linked to a Relational Database Management System under ORACLE thus allowing for the updating of data and visual presentation of the results.

The input parameters for the irrigation model include:

- Reference Year Irrigation Areas
- Reference Year Distribution of Irrigation Methods
- Reference Year Conveyance Efficiency
- Projected Increase or Decrease in Irrigated Areas in Relation to the Reference Year.
- Projected Distribution of Irrigation Methods
- Projected gains in conveyance and application efficiency
- Water Salinity Class

Based on the above parameters, irrigation demand for different planning horizons is calculated and can be used as one demand component in the national water balance as a basis for water sector planning and decision making. Various scenarios reflecting different water strategies can be examined with variations in the input parameters.

Irrigation demand projections can then be reviewed in the light of the National water balance results, and hence allowing for easy modification of water sector strategies, including changes in irrigation areas and/or cropping pattern, improved irrigation technologies and rehabilitation of existing conveyance systems. Furthermore, the GIS-based application of the model allows the examination of the irrigation demand situation with regards to water allocation for any spatial unit or development region.
The model can be adapted to specific situations of different countries since the users can be familiarized with the internal procedures of the system. Permanent enhancement of the digital model is also possible as new algorithms can be integrated into the tool.