

Water Perspectives in Emerging Countries

Water Use in MENA Countries 2017

Souad El Hajjaji, Abdelmalek Dahchour, Norbert Dichtl (Eds.)

November 03-08, 2017 - Marrakech, Morocco



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Water is an indispensable element for human life. However, clean water supply is a worldwide issue nowadays. This is because of pollution due to anthropogenic activities that are related to the increase of human population. The man-induced inputs as important sources of pollution contribute to the contamination of water quality in rivers and reservoirs. These pollutants include domestic organic wastes, industrial wastes, heavy metals, oil and grease, polycyclic aromatic hydrocarbons, endocrine disrupting chemicals, persistent organic pollutants, etc., which can deteriorate the natural chemistry of water. Monitoring the pollutant levels in water bodies is an important issue, since their elevated levels could be hazardous to biota that live in the water body and the sedimentary compartment of the aquatic ecosystems, partly or mostly being the natural resources in the food chain up to human being.

Therefore, water pollution will always remain *a never-ending story*, today's society will be faced with. To conclude, the aim of this workshop was to update the knowledge on water related issues and to discuss practical solutions to reduce (if even not to stop) water pollution while integrating experts from technological, environmental and social-economic fields.

Editors

Prof. Dr. Souad El Hajjaji, Prof. Dr. Abdelmalek Dahchour, Prof. Dr.-Ing. Norbert Dichtl



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PREFACE

MENA Region represents a geographical space including Turkey, Jordan, Egypt, Tunisia and Morocco. These countries share similarities in terms of aridity and scarcity of water, and suffer from climate change that has induced periodic severe drought periods in some countries like Morocco. The increasing demand on water due to economic development, abusive usage of resources and anthropogenic pollution generated by domestic, industrial and agricultural activities tend to be alarming for certain countries with low potential of water. To tackle the problem in its entirety, management strategies based on real investigation and best fitting models are required in terms of saving, protecting and managing the clean water.

The EXCEED Swindon project aims to highlight this issue in order to tackle it through exchange of experiences and joint research projects involving experts and researchers from the respective countries.

After the workshop held in Cairo, April 2017 under the title “*Solutions to Water Challenges*”, this workshop held in Marrakech November 3-8, 2017 aimed to pursue this under the title “*Water Use in MENA Countries*”. The choice of Marrakech was appropriate, since this city is located in an arid region of Morocco and relies on water drawn from hundred kilometers away, and from aquifers loaded through melting snow from the Atlas Mountains nearby and drawn through an ancient and ingenious system of connected wells “*Khattarat*”.

The workshop was attended by 51 participants from all associated countries. It was inaugurated by the welcome speech given by Prof. Dahchour on behalf of the organizing committee, and the words pronounced by Prof. Dichtl and Prof. Haarstrick on behalf of this DAAD project.

The first day was dedicated to three sessions on **water and wastewater management** and one session on **groundwater**. In the second day, sessions dealt with **water and wastewater treatment, water quality models and irrigation issues**. The third day was dedicated to the evaluation of the workshop, distribution of greeting certificates for the three major works and presentations, followed by the distribution of certificates to participants. The fourth day was reserved for field visit of the wastewater treatment plant and an excursion to the Berber villages of *Eurica and Sete Fatma* for appreciation of the natural sceneries of High Atlas Mountains and of the local and endemic products.

In conclusion, the workshop covered the management of water issues from different viewpoints and experiences from several countries in the MENA Region. It was an opportunity to bring together researchers from the entire MENA Region, to whom the gratitude of the workshop chair people is warmly delivered.

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THE CHALLENGE OF MANAGEMENT OF WATER IN MOROCCAN CITIES

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Keywords: Morocco, water scarcity, water management, wastewater, drinking water

Abstract

Water resources in Morocco are under serious threat due to climate change, abusive use and increase of pollution potential of water resources, including surface and groundwater resources. Northern part of the country is well fed (up to 1,500 mm precipitation per year) compared with the south (100 mm). However, Morocco is self-sufficient in water resources and their management. The impact of the constraining factors tends to shift the situation to critical limits of 550 m³ by 2020 instead of 1000 m³ few years ago. This situation has pushed the authorities to work out new strategies aiming to increase the availability of water, to improve its quality and to protect it from pollution. Different governmental authorities are involved to supervise production, quality control and distribution to consumers in the framework of new law of water that considers water as public domain and precious commodity. Access to drinking water tends to reach 100% as well as sewerage network in rural and urban zones. Private sector is involved in the main cities, and the prices practiced are calculated according to economic social level of life of the population and to give up with the free access to this commodity.

REVITALIZATION OF HISTORICAL BEYKOZ-ONÇEŞMELER WATER SYSTEM IN ISTANBUL, TURKEY

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Keywords: Water heritage, historic constructions, Onçeşmeler Fountain, Istanbul

Abstract

Beykoz-Onçeşmeler is one of the best historical water fountains of Istanbul that was built during the Ottoman era of Turkey in 1746. This historical water system and its masterpiece water fountain survived until today. The fountain was built on a spring that actually discharges water collected from precipitations of Beykoz-Forestry region. The fountain structure is very important in terms of architecture and in historical perspective. People of Beykoz District in Istanbul have raised public awareness for protection and sustainability of this historical water system, therefore, Istanbul Great Metropolitan Municipality supported this research to investigate the hydrological properties of the water system to revitalize it according to its historical conditions. In the last couple of years, flow rates of the Onçeşmeler reduced significantly. A wastewater collection tunnel passed thorough Beykoz District along the Istanbul Straight at the depth of -5 m elevation below sea level. The tunnel was blamed to drain the groundwater that supplies water of the Onçeşmeler along the tunnel's outer face. In this study, it was aimed to investigate the hydrological and hydrogeological properties of this historical water system in order to understand the relationship of the climate conditions, land use changes, and the wastewater tunnel passing underneath the water system with water of the Onçeşmeler fountain. At the end of the study, it was found out that the tunnel construction caused to increase hydraulic conductivity of the formation around the tunnel perimeter. Groundwater started flowing along the tunnel to follow this newly formed higher hydraulic conductivity zone along the tunnel instead of flowing towards the Onçeşmeler as it was used to flow formerly. This is especially true in dry and average seasons, however, in wet seasons, since groundwater levels are high, water is abundant to flow towards the Onçeşmeler as well as along the tunnel. Therefore, the effect of the tunnel is seen only in dry and partially in average seasons but not in wet seasons. The change of the precipitations, land use change, and other hydrological factors are not very effective in reducing the Onçeşmeler fountain.

WASTEWATER MANAGEMENT ROADMAP TOAWARDS 2050 EGYPT

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Keywords: Wastewater, Reuse, Treatment, Water Quality, Monitoring

Abstract

The emerging increase of population at the Delta and around the Nile River banks leads to water stress, and increases the gap between needs and available resources. In addition, it exerts more pressure to the infrastructure due to the correspondingly increasing wastewater amount and pollution. In the same time, Egypt is subjected to droughts and their environmental and economic damages due to global climate change that is decreasing the conventional water resources. In addition to the new threat, the downstream countries Egypt and Sudan are facing a decrease of their historical water budget from the Nile River due to the new mega projects planned and under construction at the upstream Nilotic countries. Although wastewater reuse projects have been initiated for more than two decades, the magnitude and complexity of the Egyptian wastewater networks minimize their efficiency. The low coverage of wastewater treatment plants in most rural areas is threatening these areas by waste disposal without treatment at agricultural banks causing pollution of agricultural lands. This is due to the absence of a comprehensive vision and sectorial coordination to manage the non-traditional water reuse system. The different types of wastewater in Egypt as industrial, domestic and agricultural are considered in this study in order to present a non-conventional water resource that can help filling the shortage in water needs. The roadmap for wastewater management aims mainly to analyze all data related to the current situation, then to study the social, economic, environmental and legislative challenges facing the development of water reuse, and to end by proposing a future vision for the role that different institutions can contribute towards developing short, medium and long term plans for optimal water reuse.

MANAGING WATER LOSSES IN URBAN WATER DISTRIBUTION SYSTEMS

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Keywords: Apparent losses, non-revenue water, water balance, water losses, water efficiency

Abstract

Managing water losses in urban water distribution systems helps improving efficiency of urban water distribution systems. Water is lost in water distribution systems due to leakage in pipes, overflows at storage tanks, illegal consumption and water meter accuracies. Reducing water losses helps reducing costs and energy demand of water supply services. Furthermore, reducing water losses helps improving services of water utilities, increasing resilience and providing better financial performance. Management of water losses requires a common understanding and terminology. Therefore, a standard water balance and 170 performance indicators were developed by IWA for assessing water supply services. Furthermore, four basic intervention tools for physical and apparent losses were developed, as well. The levels of water losses in many countries are relatively high. In Turkey, country average non-revenue water that represents excessive water losses is 43.6% of system input volume. Aging infrastructure, poor assets management and poor evaluation of water distribution systems due to insufficient data are the main challenges for water loss reduction program. This study provides brief information on standard water balance, performance indicators of water supply services, and intervention tools for water loss management, non-revenue water and water loss levels for some countries and for some municipalities of Turkey.

DEVELOPING A RISK MANAGEMENT MODEL TO PROTECT WATER SOURCES

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Keywords: Protecting water resources, water resources management, risks of contaminants, environmental risks, risk management

Abstract

Water pollution is a global problem and could have negative impacts on ecosystems, food production, health, and economic activities. The pollutants may have severe impacts on the usefulness and value of water resources. Presence of hazardous substances, poor monitoring and control, improper handling and treatment of wastes as well as misuse of water could be considered as the main causes for pollution of water resources. Furthermore, climate change, increasing of human population, and the unprecedented urbanization and industrialization of the developing countries will make the situation worse in terms of pollution and consequently shortage of freshwater sources. Due to the abovementioned problem, protection of water resources should be a global attempt. In this study, a model has been developed, by which the risk of water pollution could be identified and minimized. A case has been selected to see how the model works. It was found that the model accompanied by the procedure of cause effect analysis and weighting risk factors is capable of ranking the existing risks regarding the contaminated wastes in an area. Furthermore, it was found that reducing risk levels could be achieved as the model considers the most important problems related to the environment.

INTEGRATED MANAGEMENT OF WATER RESOURCES IN TRANSBOUNDARY EUPHRATES-TIGRIS (ET) BASIN

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Keywords: Agricultural water demand, Euphrates, Tigris, ET Basin, water footprint

Abstract

Water in Euphrates-Tigris (ET) basin is essential to meet multiple demands such as consumption, sanitation, agriculture, and energy in the three riparian states Turkey, Syria and Iraq. It is a fact that the water potential of the ET basin is unable to meet the increasing demands of the three riparian countries. Agriculture is currently the largest user of water at basin level, accounting for at least 70% of total withdrawal. All countries in the region have to cope with a water deficit, while they strive to achieve a self-sustaining agriculture at the same time. Water, energy and food are inextricably linked. Water is an input for producing agricultural goods in the fields and along the entire agro-food supply chain. Energy is required, to produce and distribute water and food: to pump water from groundwater or surface water sources, to power irrigation machinery, and to process and to transport agricultural goods. In addition, hydropower potential of the Turkish part of the ET basin constitutes to almost 15 % of the total energy production of the country. In this study, the effectiveness of agricultural water use will be evaluated by means of virtual water and water footprint methodology. As water, energy and food security are to be simultaneously achieved in ET basin, a management proposal which will satisfy these demands will be presented.

TYPOLOGY OF WATER PRODUCED AND DISTRIBUTED BY ONEE - WATER BRANCH IN THE REGION CENTER - KHOURIBGA

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Keywords: Physicochemical parameters, temporal-spatial assessment, water quality

Abstract

Sustainable development of human activities is based, in particular on integrated, effective and sustainable water management, which aims to secure sufficient supply for human demands in terms of drinking water, and for industrial and irrigation purposes. In this context, this study aimed at assessing surface and ground waters qualities using physicochemical water data collected during 2003–2013 in the Khouribga region (DR3).The research evaluates the physicochemical quality in a suitable technical and regulatory context for the protection and preservation of water resources.

Investigation related to surface waters show that the hydrochemistry of 80% of dams in the study area are characterized by SO₄-Cl-Ca-Mg facies and 20% by mixed facies. The classification according to Moroccan quality standards showed that the water quality of 60% of dams is excellent to good, the other 40% of a moderate quality. For ground waters, the majority of boreholes are characterized mainly by SO₄-Cl-Ca-Mg chemical facies. The classification according to Moroccan quality standards showed that 75% of groundwater boreholes were of good to medium quality, compared to 25% of degraded quality.

FLASH FLOODS AT EL-ARISH CITY - A CRITICAL REVIEW OF FLOOD RISK MANAGEMENT

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Keywords: Arid Region, El-Arish City, Flash Floods, Flood Mitigation, Sinai

Abstract

The world is heading into an international crisis due to water resources being gradually depleted as well as the populace increasing on a daily basis. Integrated water resources management (IWRM) has never been more urgent. One organization with this kind of mind-set is the International Water Association (IWA), which established 17 principles in 2017 in order to help world leaders to ensure that residents have access to drinking water and sewage networks. One key principle is to “*prepare for extreme events*”, such as storms and heavy rains, by managing flow regimes in rivers, maintaining adequate vegetation in the basin to minimise flash floods as well as investing in coastal dikes and flood warning systems. The study case is concerned with the city of El-Arish in Egypt. Flood resilience constitutes great importance in these parts of the country and, therefore, will become the focus of this paper. Intense rainfall events devastated the entire city in 2010. The study aimed to investigate the efficiency of existing mitigation measures/strategies undertaken by the local government as well as the preparedness and awareness of local residents (if any), and defines the main aspects that must be addressed in further studies.

ADVANTAGES OF DECISION SUPPORT SYSTEMS FOR COMPREHENSIVE WATERSHED MANAGEMENT

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Keywords: Web Based Decision Support System, Water Resources Management, Information System, Ergene Watershed, Turkey

Abstract

Decision Support Systems (DSS) are commonly used in business management and organizational areas to take serious and comprehensive decisions ever since it emerged in 1960s. These kinds of systems become quite helpful tools for decision makers in various studies and business areas. Therefore, it can be said that the DSSs are very capable to comprehend sophisticated structures. As a natural resource, water resources and watersheds are precious resources for life, but at the same time the management of these resources is a tall order. As known, watershed management is a complex issue due to its inherited sophisticated structure. At this point, DSSs come into prominence to express all the related data to the decision makers in a simplistic way. DSSs were started to use in watershed management first at the beginning of 1990s. The web-based Decision Support Systems, which is a step beyond, was started to be applied on different watershed in the last decade. Web-based DSSs have more advantages compared with stand-alone systems such as giving basic information about the watershed, as they act as a digital library for the watershed and allow collaborative researches. This paper intends to explain the advantages of web-based Decision Support Systems by giving examples from the scientific literature. The preliminary activities of the DSS application for Ergene Watershed will also be introduced.

PROBLEMS CAUSED BY IMPROPER WATER AND LAND MANAGEMENT AND GLOBAL CLIMATE CHANGE EFFECTS IN KARAPINAR BASIN (KONYA, TURKEY)

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Keywords: Global warming, improper land use, Karapınar, water management

Abstract

Karapınar basin (Konya, Turkey), also known as the Konya-Çumra-Karapınar basin, has a semi-arid climate with an area of approximately 8,822 km² in the Konya Closed Basin. In recent years, decreasing rainfall and global warming have caused water stress in the basin due to the increasing temperatures proving the unsustainability of the basin. Having a deficit in the water budget, the underground water level drops by 1 m every year, and the ground water reserves are depleted. Subsequently, owing to the falls of the water level, a large number of sinkholes are formed in the region threatening the safety of life and the property of the people in the region. In consideration of the constrictions in the agricultural production, life in the region will become dangerous, the existing desertification symptoms will increase, and the basin will become desert eventually. As a solution, it is necessary to apply the water management plan strictly in order to ensure the sustainability of the basin, thereby taking into consideration the global warming and water shortage situation. In addition, it is necessary to cultivate less water consuming species rather than high water requiring plants. In this study, the problems caused by over use of irrigation water, and wrong agricultural types and technics in Karapınar basin were evaluated. Problems caused by improper water management in the basin are pointed out.

LOSS AND LEAKAGE OPERATION AS A PART OF ISKI SMART GRIDS

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Keywords: DMA (District Metered Areas), Flow meter, Smart Network Management, Water Leak, Water Saving

Abstract

In this study, investigation and results are presented within the scope of ISKI Loss and Leakage project in order to reduce the unbilled drinking water, in other words loss-leakage, by coordinated study of different units. An integrated study was carried out with teams of Plan and Project Department, Water Conduction and Distribution Department, Information Technologies Department, GIS Directorate, and Subscriber Affairs Department and their stakeholders, and the Loss-Leakage Management System was developed. A hierarchical system structure has been created with the flowmeters and DMA devices, and the flexibility of communicating with different types of communication devices is ensured. With the network communication system, created in the ISKI organization, any intervention or threat from the outside is minimized, and the data are converted into meaningful data and introduced into the ISKI database. A total of 319 flowmeters, integrated in the SCADA system, were monitored, analyzed, reported, and live monitoring of the network was provided by a system approach. All data of the network, collected through 70 DMA devices in Sultanbeyli and Sancaktepe pilot areas were displayed. The Loss-Leakage Management System provides the data sets necessary to detect and to reduce water losses and leaks. In selected pilot districts, isolated areas were identified, and a total of 70 DMA devices started to serve for the purpose. With these devices, hourly, daily, and monthly pressure and flow information are compared with each other, time intervals of consumption increase or decrease are determined, pressure is made in line with each other, and observations are made by comparing between requested dates. Signal levels and number of connections were reported and monitored. In addition, the data consistency between the flowmeter and the DMA (District Metered Areas) devices connected to this flowmeter are controlled and the total daily consumption is compared. As a result of loss-leakage works in Istanbul, it was found that the loss-leakage water ratio was 36% in 2003, then decreased by 12% and reached 24% in 2017. In pilot districts, this ratio has been reduced to 13% between 2015 and 2017. Fault detection was accelerated by monitoring the flow and pressure values of the isolated regions, and it was ensured that they were intervened more quickly. In addition to reducing loss and leakage, it is also aimed to provide efficient use of clean water resources that have been saved from labor power and economy.

MULTI CRITERIA ANALYSIS OF SEDIMENTATION IN VERTICAL DRAINAGE WELLS, CASE STUDY: EL-OBOUR CITY, EGYPT

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Keywords: Clayey layers, drainage wells, groundwater rise, sedimentation, water logging

Abstract

Last two decades, Egypt has followed a new strategy in constructing new cities not so close to the Nile River as usual, instead on the eastern and western deserts. When initiating new communities or a major agriculture project in a desert area, the great challenge is to maintain sustainable water resources and wastewater management programs. El Obour new city, considered in this study, is located on the eastern Nile Delta fringes, 25 km north east to Cairo. A problem of water logging was appeared in the 6th and 7th districts in the new city. These two districts, covering an area of 16 km², were taken as the study area. The water logging problem happened due to many reasons like the variations in topography, as these districts are located in a lower area with respect to the surrounding districts, which caused consequently a groundwater rise. The second reason was the distribution of the clayey layers, which coincide with the areas facing water logging problems. Many vertical drainage wells were designed for dewatering strategies. After couple of years, these implemented drainage wells started facing a proficiency problem due to sedimentation by fine sand particles, and their efficiency decreased. It was found that the sedimentation rates are different from one well to another. In order to study the sedimentation process and intensity, many parameters related to the wells characteristics and the districts hydrogeological parameters have been studied. The study came up with the most influencing parameters and suggested many solutions to reduce the sedimentation process.

GROUNDWATER MANAGEMENT OF SKHIRA AQUIFER (CENTER EAST OF TUNISIA): FLOW MODELING

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Keywords: GIS, modflow, modeling, mathematical model, Skhira aquifer, Tunisia

Abstract

High pumping rates from Skhira aquifer during the previous years lead to a major decline of water levels and degradation of the groundwater quality by seawater intrusion. To avoid these major problems affecting groundwater quality and quantity of this aquifer, sustainable water resource management is necessary and a priority to select an appropriate exploitation scheme. For this purpose, Geographic Information Systems (GIS) and Modflow [1] have been applied to estimate current and future water budgets; hydrodynamic modeling of Skhira groundwater was investigated by using Modflow code to understand the hydrodynamics and the geometry of the aquifer system. The calibration of the mathematical model in steady state (1973) helped to refine the spatial distribution of transmissivity, to restore the groundwater level at each point, and to establish the stock of the groundwater, in spite of the lack of data and information concerning the geometry and the hydrodynamic parameters in some places. The assessment of the reliability of the model was conducted by comparing the simulated and observed values of the hydraulic head for the observed wells. It is noticed that there is a satisfactory concordance between these levels especially in areas, where there is sufficient information about the hydrodynamic properties (transmissivity and piezometry). The results from steady state were used to calibrate the transient model, to refine the spatial distribution of recharge and storage coefficient, and to determine the drawdowns at all points capturing Skhira aquifer during the period (1973-2014). Using the calibrated model, different scenarios were considered in order to predict the aquifer response under different exploitation conditions and stresses.

**ASSESSMENT OF THE GROUNDWATER SALINITY USED FOR IRRIGATION AND
RISKS OF SOIL DEGRADATION:
EXAMPLE OF OUED EL MALEH, REGION OF MOHAMMEDIA (MOROCCO)**

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Keywords: groundwater, irrigation, Oued El Maleh, salinization, soil

Abstract

Morocco has an arid and semiarid climate. Irrigation is imperative for agriculture. Oued El Maleh region is considered as a very important agricultural area, known nationally for its high potential for market gardening. This intensification has been accompanied by an excessive use of agrochemicals, and a poor control of irrigation and drainage. Consequently, salinization phenomena and deterioration of soil structure as well as water quality are about to create an alarming situation. Therefore, the objective of this research work was to assess the quality of irrigation water and the risk of soil degradation. The study site is located in a coastal area and dedicated to intensive land use for growing vegetables in a peri-urban agricultural zone. A field survey was conducted to assess soil and water quality in the region focusing on physicochemical parameters and analyzing their spatial dependency on a regional scale. Monitoring physicochemical parameters of water and soil were carried out in 78 wells and 78 soil sample in order to assess the state of salinity of water and soil in the region. The obtained results from sample wells show relatively higher values of nitrate and electrical conductivity exceeding Moroccan national standards, revealing that the water quality of the Oued El Maleh is deteriorating with an alarming rate. Therefore, this water is considered not suitable for human consumption and can induce a degradation of soil. The results of the studied soil show that pH of these soils is weakly to moderately basic; they are usually non-saline with moderately organic matter content. Moreover, very high concentrations of nutrients (potassium, phosphorus and nitrogen) were recorded, highlighting the mismanagement of fertilization of vegetable crops in the region of Oued El Maleh.

CONTRIBUTION OF REMOTE SENSING AND GEOCHEMISTRY TO IDENTIFY HYDROGEOLOGICAL INTERCONNECTIONS BETWEEN THE TWO AQUIFERS OF SMINJA - OUED RMEL (NORTH-EASTERN TUNISIA)

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Keywords: GIS, geochemistry, hydrogeological interconnections, remote sensing, Landsat ETM+, Sminja Oued Rmel aquifers

Abstract

The Sminja Oued Rmel aquifers, located in the Zaghouan region, are exploited for irrigation and meeting the drinking water demands of agglomerations. In order to identify the lateral communications between the Sminja and Oued Rmel aquifers, two important approaches were applied: Geochemistry and Remote Sensing. GIS combined with geochemistry software can provide real-time information on the quality and quantity of the water resources of the Sminja-Oued Rmel aquifer, in order to understand the chemistry of the waters and then to identify the mixing phenomenon of the two aquifers. To identify the waters of boreholes of Oued Rmel aquifer, which are most influenced by the water inputs of Sminja aquifer, their positions were compared with respect to the theoretical mixing straight line calculated by the Phreeq C software. The chemical analyses of waters of the two aquifers show the predominance of sodium and calcium for the cations and of chloride and bicarbonate for the anions with an enrichment of sodium and chloride from upstream to downstream of each aquifer. If the chloride-sodium facies is the same in the downstream parts, it is not the same in the upstream parts: Na-Ca-Cl-SO₄ for the Sminja aquifer and Na-Ca-Cl-HCO₃ for the Oued Rmel aquifer were found. This difference would be in favor of a mixture of waters on both sides of the boundary between the two aquifers. The water points located at the west of the Oued Rmel aquifer show water with a chemical composition similar to that of the waters of the Sminja aquifer, which proves the importance of the contribution of the waters of the Sminja to the Oued Rmel aquifer. On the other hand, the waters of the boreholes, located at the east and south of this aquifer, have different chemical compositions from the Sminja aquifer. The application of Landsat ETM+ satellite image processing techniques (Color Composition, Principal Component Analysis and Filtering) contributed to the development of a map of lineaments showing a total of 13 fractures that provide hydraulic communication between Sminja and Oued Rmel aquifers [1]. The statistical analysis of these lineaments using directional rosettes and the linea density map showed a predominance of ESE-WNW faults. The superposition of the various boreholes capturing Oued Rmel and Sminja aquifer with the plot of the lineaments determined by remote sensing made it possible to deduce that the communication between the two layers is essentially ensured by the faults.

A SMALL SOLAR DISTILLATION PLANT FOR THE PRODUCTION OF LABORATORY PURE WATER IN NORTH JORDAN

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Keywords: Concentrated parabolic trough, solar energy, treatment, water distillation

Abstract

This paper deals with the applicability of solar thermal energy to produce distilled water for laboratory use under Jordan climate conditions. This solar distillation system is installed on the rooftop of a public building with the aim to generate a balanced answer to the energy demanded by the buildings: electricity, heat and cold, as well as other energy driven services like the supply of distilled water. Within the framework of the STS-Med Project, funded by European Commission under the ENPI CBCMED program, four solar poly-generative plants have been designed to be connected with public buildings. The Jordan plant is installed on the rooftop of Al-Khwarizmi building at Al-Husson University College. The plant introduced a steam circuit that feed a steam turbine manufactured at a very small scale. Raw water is driven to the soft water tank. The water hardness is reduced to 50 ppm. The steam generator produces saturated steam of 18kg/h at 6 bar. In order to recover the steam energy before condensation, steam is superheated to a temperature of 200 °C and fed to the steam turbine. Project outcomes are drawn and documented about the potential impact of solar distillation in the Mediterranean solar belt and the future development of the involved technologies.

MANAGEMENT AND REUSE OF TEXTILE WASTEWATER AFTER ELECTROCOAGULATION / NANOFILTRATION TREATMENT

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Keywords: Electrocoagulation, nanofiltration, optimization, textile wastewater.

Abstract

Textile effluents are usually highly colored and contain a considerable amount of contaminants and pollutants. Stringent environmental regulation for the control of textile effluents is enforced in several countries. Both nanofiltration (NF) and reverse osmosis (RO) are good alternatives for textile wastewater treatment since high reductions in the aforementioned parameters (conductivity, COD and color) can be reached. Nevertheless, untreated textile effluents cannot be used directly as influent to nanofiltration or reverse osmosis membranes due to high solids concentrations. Thus, it is necessary to carry out a very exhaustive pre-treatment in order to avoid fouling and membrane deterioration. The purpose of this work was to optimize the electrocoagulation (EC) process using aluminium electrodes as a pre-treatment of NF process of untreated textile effluent sample supplied from a Tunisian factory. The EC process was studied under several conditions such as various current densities and effect of experimental tense. Efficiencies of COD and turbidity reductions and color removal were studied for each experiment. The EC treatment was intended primarily to remove color and COD of wastewater, while nanofiltration was used to further improve the removal efficiency of the color, COD, conductivity, alkalinity and total dissolved solids (TDS). The experimental results throughout the present study indicated that EC treatment followed by nanofiltration processes were very effective and capable of elevating quality of the treated textile wastewater effluent, which could be reused within the textile coloring process.

ANALYSIS AND OPTIMIZATION OF SURFACE WATER DEMINERALIZATION PLANT PERFORMANCES

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Keywords: Fouling, Filtration, Membrane, Pretreatment, Plant Design, Reverse Osmosis

Abstract

The aim of this work was to analyse and to optimize the technical performances of the reverse osmosis plant, which treats the surface water of the river "Oum Er Rbiaa" in Khenifra-Morocco. Results of the study showed that the chloride content varies over time without exceeding the threshold of 866 mg/L, which represents the design reference of the demineralization plant. This situation led the operator to reduce the operation of this plant the third, which consists of three reverse osmosis trains functioning every two days alternatively. Moreover, monitoring the plant technical indicators revealed the absence of membranes fouling, and this is due to the trains frequent rinsing at their stops. For this reason, the hydraulic performance of the treatment plant has not been evaluated under contractual conditions. The questioning of the design of the demineralization plant initiated to make simulations with ROSA Dow software and AVISTA on a new basis, which is the current water quality of the river water, characterized by a chloride content of 295 mg/L. This new simulation of the current quality showed a better result in terms of recovery rate compared with what was initially expected: 88% for this new quality versus 78% for the quality taken into account for the demineralization plant design. This is also reflected in the energy consumptions that decreased by 0.09 kWh/m³.

REMOVAL OF METHYLENE BLUE BY RAW AND ROASTED DATE SEEDS OPTIMIZATION USING RESPONSE SURFACE METHODOLOGY, KINETIC MODELLING AND ADSORPTION ISOTHERMS

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Keywords: Methylene blue (MB), Raw date seeds (RDS), Response surface methodology (RSM), Sorption, Roasted date seeds (RoDS)

Abstract

The present study concerns the sorption of the cationic dye methylene blue (MB) in aqueous solution on raw date seeds powder (RDS), roasted date seeds (RoDS), and carbonized date seeds (CDS); commercial activated carbon (CAC) is taken as a reference. Infrared spectroscopy has been used to characterize the afore-mentioned adsorbents. Sorption tests were carried out by varying the mass of the adsorbent, initial concentration of the adsorbate, and pH of the solution. The optimum conditions for these three parameters have been determined using the surface response methodology. The studied response designed for modeling is the retention rate. Selected optimum conditions were 75 mg of sorbent dose and 5 mg/L of dye solution with a pH 5. Retention of MB by RoDS was comparable to that of the CAC. MB sorption on RoDS is higher than on RDS, the latter is higher on CDS. The infrared analysis reveals that functional groups are involved in the sorption on RDS and RoDS, but not on CDS. MB is adsorbed in multilayers on heterogeneous surfaces. The sorption process of MB on the examined adsorbents is controlled by chemisorption.

EVALUATION OF HEAVY METALS IN SEWAGE WATER USING BIOFILM AS AN INDICATOR AT AL-ALBAYT UNIVERSITY – MAFRAQ, JORDAN

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Keywords: Heavy metals, Jordan, Biofilm, wastewater

Abstract

A study was done to monitor level and source of six heavy metals (Zn, Mn, Cd, Cr, Pb and Cu) in the sewage system of Al-Albait University campus in north Jordan using two monitoring methods: grab sampling and biofilm. Twelve sampling sites were selected at the sewage outlet of twelve buildings representing different activities. Results showed that activities within each selected building were reflected in the heavy metals concentration at the building sewage outlets. For Cu and Cr, the highest concentration was found at Institute of Earth and Environmental Sciences and the lowest at the cafeteria and the hotel. For Mn, Cd, Pb and Zn, the highest concentration was found at the Faculty of Architecture, Water and Environment Research Center, automobile repair and Institute of Earth and Environmental Sciences, respectively, while the highest concentrations were detected at the Engineering Center Reforms, automobile repair, Faculty of Science, and Engineering Center Reforms, respectively. The concentration of heavy metals using biofilm sampling method showed similar trends as wastewater from the different activities but at higher concentrations, since the biofilm samples represent wastewater pollution accumulated for six weeks, while wastewater samples represent time of sampling in addition to the slightly alkaline wastewater enhancing the precipitation of heavy metals. Zinc was an exceptional case, as it showed higher concentration at the outlet of the Institute of Earth and Environmental Sciences, which is related to research activity at the laboratories using high amount of Zn in their chemical experiments in the six weeks period of sampling of biofilm. Biofilm sampling was an effective method in monitoring sewage system in the arid environment.

STUDY OF A UV DISINFECTION PILOT TREATMENT PLANT FOR PURIFIED WASTEWATER

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Keywords: *E. coli*, *Enterococcus*, UV radiation, wastewater, water quality

Abstract

The present paper concerns the evaluation of performance of a UV disinfection system at Bouregreg complex wastewater treatment plant WWTP in order to reuse treated water in irrigation. Indeed, wastewater treatment plant aims to eliminate suspended solids, organic matter, and sometimes some mineral compounds, nitrogen compounds, phosphates, etc. The concentration of micro-organisms (especially pathogenic ones) can also be reduced to a significant extent, but this is still insufficient for reuse of the treated wastewater especially in irrigation because of microbial content in their rejections after treatment. Therefore, the aim of this study was to evaluate the purification performance of the WWTP and to test a complementary treatment of disinfection by UV radiation to the currently applied system of purification that has been revealed to be insufficient in eliminating the pathogenic bacteria source of waterborne diseases. Disinfection with the UV rays shows consequent abatement rate of the bacteria indicator (*E. coli* and *Enterococcus sp.*) and thus satisfies the Moroccan standards of water quality intended for irrigation (rate of fecal coliforms ≤ 1000 bacteria / 100 mL).

EVOLUTION OF THE HISTORY OF WATER QUALITY COMPLAINTS IN CASA-ANFA DURING THE PERIOD 2013-2015

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Keywords: AEP, bad taste, complaints, concordance rate, red waters

Abstract

The quality of water distributed through the network and delivered to the consumer tap is one of the aspects of the diet, to which customers are sensitive and must be one of the major priorities of the drinking water and health authorities. The processes used to make water safe also aim to rid any taste or odor. But between the treatment plant and consumer's tap, water can get an unusual taste or unpleasant odor. The main objective of this work was the study of the evolution of history of water quality (bad taste & red color) complaints in Casa-Anfa during the period 2013-2015. These complaints, even if there were numerous, but not all of them presented a real problem of water quality, that is, why based on the analysis of the satisfaction surveys, developed by the LYDEC laboratory (LABELMA), a rate of concordance of the complaints was deduced about bad taste and red water problems in order to remedy the situation and to improve the quality of water in Casa-Anfa.

CONTROLLING THE IMPACT OF THE MOHAMMEDIA CITY LANDFILL ON GROUNDWATER AND SURFACE WATER RESOURCES

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Keywords: Groundwater, surface water, leachate, pollution, organic load

Abstract

The installation of landfills in unassigned or undeveloped sites increases the risk of contamination of surface and groundwater and, therefore, the risk to human health. Following a physicochemical and biological evolution of this waste disposed of and the action of the rains, a juice called "leachate" is generated. This juice is a pollution source of the environment and groundwater. In addition to the odor that produces, this juice causes an alteration of the groundwater quality due to its very high pollution load (COD, BOD₅, metals, viruses, and algae). More generally, the problem of waste management (liquid and solid) is global and daily. However, the current situation is alarming in developing countries like Morocco. This work involves the analysis of the quality of wells and river water located nearby of controlled landfills (south-north). The results obtained show very high COD contents in landfill leachate of 69,120 mg/L, and BOD₅ values are also important (mean 40,500 mg/L). The analytical results of water of the nearby wells and the surface water show that the content of the parameters screened met Moroccan standards for drinking water. These results prove that the controlled discharge of landfill leachates is the best choice for protecting the groundwater and surface water.

SAFE REUSE OF TREATED WASTEWATER FOR AGRICULTURE IN EGYPT

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Keywords: Treated wastewater, drainage water, reuse, agriculture, Egypt

Abstract

Water scarcity in Egypt is one of the most serious problems that could limit the economic development. Limited water resources in Egypt are the main factor driving the exploration of unconventional sources that can fulfil the water demand of the increasing population. Egypt's water resources are limited and population growth increases the gap between the demand and the available resources. Reuse of treated wastewater TWW and of drainage water DW in agriculture is considered one of the most sustainable alternatives to cope with water scarcity in Egypt. Reuse of treated wastewater and of drainage water in agriculture could be an effective method to reduce the gap between water demand and supply, to save freshwater in addition to enhance the physiochemical properties of light-textured soil. However, the bioaccumulation of pathogens and toxic chemicals are the main problems of TWW reuse in agriculture. This study aims to discuss Egypt's current situation of water supply and uses, to analyze the quantities of generated wastewater and TWW, to highlight the main problems related to the use of wastewater in Egypt, furthermore, the safe reuse of TWW for agriculture and related laws and regulations, and approaches to control pollution in agricultural drains. Finally, opportunities and challenges of using TWW & DW in agriculture in Egypt are presented.

POLLUTION SOURCES TO ZARQA RIVER: THEIR IMPACT ON THE RIVER WATER QUALITY AS A SOURCE OF IRRIGATION WATER

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Keywords: Industrial pollution, irrigation water, pollution sources, wastewater reuse, Zarqa River

Abstract

Over the last forty years, Zarqa River water quality has deteriorated seriously as it receives pollutants from several sources along its course. In addition, its flow has diminished, which reflected negatively on its quality. In this study, pollutants released to the river were identified, quantified and linked to their sources, based on field observations, existing quality data by monitoring agencies, and literature. It was found that the main sources of pollution to the river are wastewater treatment plants in the basin, overflow of wastewater pumping stations located close to the river course, sewer lines, and manholes that pass through the river bed, in addition to industrial, commercial, domestic and agricultural activities along the river course. Main pollutants released to the river from these sources are organics, nutrients, heavy metals, and solid waste. The results showed that the river water is suitable for restricted irrigation downstream of As Samra WWTP and upstream of KTD, although the concentration of some heavy metals have occasionally exceeded the maximum limits allowed by Jordanian standards for reuse in irrigation.

MANAGEMENT WATER RESOURCES CAN DEFICIT IRRIGATION ADAPT WATER SCARCITY IN MENA?

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Keywords: Water Scarcity, Deficit irrigation, Water use efficiency, Soil salinity, Soil nutrients

Abstract

Management of water resources in agricultural zones allows water saving and maintaining relevant levels of production in semi-arid regions. With water scarcity, national policies encourage the reuse of agricultural drainage water for irrigation. Due to this reason, the solute concentration of the irrigation changes within seasons. Improving irrigation management can help adapting to water scarcity in the Mediterranean Region. Field experiments to assess the effects of different irrigation water amounts on yield and soil nutrients were carried out during two successive winter seasons 2012/13 and 2013/14, respectively, on high saline soils at Sahl El-Tina, North Sinai, Egypt. Three irrigation treatments with 3,600 m³/ha (W1), 6,000 m³/ha (W2), and 7,200 m³/ha (W3, normal irrigation) from El-Salam canal were applied in a complete randomized block design, using faba beans (*Saka-3*, *Vicia faba L.*) as test crop. Soil salinity decreased with increasing water supply regimes by an average of 33%, 37%, and 48% for W1, W2, and W3, respectively, compared with the initial soil salinity. Soil nutrients showed a descending order with increasing water stress. Nevertheless, the water use efficiency (WUE) showed another effect. Water regime W1 saved 50% of the supplied water and resulted in a WUE of 2.36 kg/m³ compared with W2 and W3 with 1.75 kg/m³ and 1.39 kg/m³, respectively. This expressed the great potential of deficit irrigation to save water, while producing stable yields and reducing soil salinization.

ASSESSMENT OF WASTEWATER QUALITY OF SOME DRAINS IN EGYPT FOR IRRIGATION PURPOSES

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Keywords: Drains, Irrigation, Wastewater, Water Quality

Abstract

Samples of agricultural drainage water were collected monthly from the drains of Bahr El-Baqar, Bilbies and El-Qalyubia, East Delta, Egypt for one year during October 2013 to September 2014 in order to evaluate water quality and suitability for irrigation. According to the USDA, water was classified as class C3 S1 (high salinity, low sodicity), which cannot be used on soils with restricted drainage. With adequate drainage and special management for salinity control as well as for plants with good tolerance to salinity, the water could be used for irrigation. According to Gupta classification, water of Bahr El-Baqar drain is classified as with low salinity and no sodicity (C2S0), while water of Bilbies and El-Qalyubia drains is classified as normal water being non-sodic (C1S0) and can be used for irrigation for most crops on most soils. Water of the three drains are suitable for most crops except for salinity sensitive ones, and can be used to irrigate all soils except very heavy textured one with impeded drainage. These waters do not cause any problem regarding sodicity.

STUDY OF THE REMEDIATION OF MOROCCAN SALTY-SOILS BY APPLICATION OF GYPSUM AND COMPOST

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Keywords: Salt-affected soil, gypsum, compost, reclamation, Central Bahira, Morocco

Abstract

In Morocco, most of lands are under severe climate conditions, with 93% of the total area driven by aridity. The use of irrigation in these areas is necessary to obtain good and sustainable agricultural production. The Bahira Plain represents a typical example of groundwater reservoir in central Morocco under high evaporation regime. Concomitantly, the excessive use of water for irrigation in the region is accompanied by a reduced drainage control and poor appropriate management system. This causes rapid soils salinization and alkalization. Hence, high salinity levels affect plant growth, leading to reduced plant yield. In order to overcome this situation as well as to ensure the sustainable preservation of soil resources, the remediation of salt-affected soil in the region becomes necessary. There are several effective approaches for improving salt-affected lands, such as water leaching, chemical and organic remediation, and phytoremediation. The aim of this study is to investigate the effects of two rates of gypsum and different composts on soil salinity and on plant growth. The experiments were conducted under controlled conditions using ryegrass as crop. Five soil remediation treatments were tested: gypsum with two rates (G1 = 3.8 g/kg of soil and G2 = 7.6 g/kg of soil), two different composts (C1 and C2) both at 5 g/kg of soil, and a control. Varying soil salinity levels was taken as S1 (non-saline soil) = 0.79 mS/cm, S2 = 9.94 mS/cm, and S3 = 25.3 mS/cm. A split plot trial was conducted. Results of soil and plant analyses showed that there are positive effects of incorporation of compost and gypsum on soil electrical conductivity for the salinity level S2 and on dry matter yield. Moreover, compost and gypsum application were highly efficient as a treatment method for changing the chemical parameters of the soil, especially of pH.