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Proceedings of the Regional Workshop Solutions to Water Challenges in MENA Region

Editors: Zeinab Abou-Elnaga, Mehmet Emin Aydin

April 25-30, 2017 - Cairo, Egypt



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MENA region is the most water scarce region in the world. The region is home to about 6.3% of world's population, but has access to measly 1.4% of the world's renewable freshwater. The region faces a dramatic increase in water demands due to rapid population growth, urbanization tendency, higher living standards, and an agricultural policy, which emphasizes expanding production in order to feed the growing population. Continued water scarcities will affect the social and economic potential of the region, increase the land vulnerability to salinization and desertification, and raise the risk of political conflicts around the limited water available and increasing demand. Groundwater is a hidden problem, since many countries extract more than it is being recharged. Water quality degradation through pollution and salinization are important factors affecting water availability in the region. In recent years, flash floods occurred by extreme weather events, their occurrence was highly random, and the associated problems are expected to increase in the near future due to climate change.

Finding solutions to these challenging problems requires close collaboration between scientists – established as well as young ones - practitioners, and stakeholders from governmental and public organizations.

The workshop will focus on multidisciplinary approaches to water challenges and their solutions with special interest on functions and limitations under various land-use systems and climatic conditions, remote sensing applications in water sciences, and latest technological developments for use and management of water in terms of sustainable water management.

Editors

Assoc. Prof. Dr. Zeinab Abou-Elnaga, Prof. Dr. Mehmet Emin Aydin

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Solutions to Water Challenges in MENA Region**

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CONTENT

Preface	1
Proposals for good governance of water resources In Mediterranean Sea Basin - Response of the scientific world (<i>H. Şahin, B. Topkaya</i>)	2
Pasture land in a desert area at Al-Karak Province/Jordan (<i>A. Jiries, F. Al-Nasir, T. El-Hasan</i>)	10
Integrated sustainable coastal development program in the MENA Region: Egypt's experience (<i>A. N. El-Bahrawy</i>)	18
Water loss and control in drinking water networks in Turkey (<i>M.E. Aydin, S. Aydin, F. Bedük</i>)	28
Can land-use changes affect water soil content at semi-arid region? (<i>M.S.D. Abu-hashim, A.A. Belal, S., Mohamed</i>)	38
Sustainable water management training and demonstration center in TUBITAK Marmara Research Center (<i>E.A. Aytis, A. Baban, S. Murat, K. Günes, S. Ayaz</i>)	47
Overview of brackish water desalination in the Jordan Valley (<i>A. Alsarayreh</i>)	56
Maximizing the utilization of water and soils for agricultural land use in the deltaic Nile alluvium (<i>A.A. Afify, S.M. Arafat, G.F.O. El Shiekh, N.M. Afify</i>)	62
A case study on evaluation of household water security in MENA countries (<i>I.E. Karadirek</i>)	72
Boron removal from seawater using adsorption and ion exchange techniques (<i>A.M. Abdullah</i>)	83
Qualitative assessment of irrigation water in the central Bahira plains – El Kalâa, Morocco (<i>A. Zouahri, S. EL Hasini, H. Dakak, O. Iben Halima, H. Iaaich, A. Ghanimi, A. Dahchour, S. El Hajjaji</i>)	94
Evaluation of groundwater quality and its suitability for drinking and irrigation use in semi-arid region using GIS: case study: Skhira coastal aquifer, center east Tunisia (<i>F. Hamzaoui-Azaza, R. Trabelsi, R. Bouhlila, H. Khanfir</i>)	104
Assessment of drinking water quality in Oued Rmel aquifer in Zaghoun in north- eastern Tunisia, through geographic information system and water quality index (<i>M. Ameer, F. Hamzaoui-Azaza, M. Gueddari</i>)	113
Evaluation of groundwater quality in two coastal regions of Morocco (Oued El Maleh & Gharb) (<i>K. Belhsaien, A. Zouahri, H. Dakak, H. Iaaich, A. Douaik, A. Dahchour, S. El Hajjaji</i>)	122

Salt tolerant agriculture in some areas of Morocco (<i>A. Dahchour, A. Zouahri, S. EL Hajjaji, K. Belhsaien, M. El Khadir, A. El Allam</i>)	134
Binary adsorption of copper and nickel metal ions on nano zero valent iron supported on activated carbon (AC-NZVI) (<i>E. Debik, K. Altuntas, I.I. Yoruk, D. Kozal</i>)	146
Sustainable solutions for water quality management: A focus review on natural bio-sorbents/adsorbents (<i>Z.S. Abou-Elnaga</i>)	153
Application of a new methodology (TRAD) to control seawater intrusion in the Nile Delta aquifer, Egypt (<i>H.F. Abd-Elhamid, Ismail Abdelaty</i>)	168
Hydrological and water quality modeling of Ergene River basin of Turkey by SWAT (<i>A. Doğan, M. Pacal, M.M. Vanolya</i>)	178
Bioaccumulation and physio-biochemical parameters of in vitro regenerated <i>Pogostemon erectus</i> (Dalzell) Kuntze to Cd - A study for phytoremediation (<i>M. Doğan, M. Karataş, M. Aasim</i>)	192
Removal of vanadium from Jajarm bauxite processing plant effluents (<i>M. Moshtagh, A.K. Darban, M.J. Koleini, H. Arabyarmohammadi, M.E. Aydin, M. Shahriari</i>)	202
Rehabilitation of the wastewater treatment plant (WWTP) of a Tunisian tannery: optimization of coagulation-flocculation process and integration of tertiary treatment step (<i>C. Fersj, M. Chaouch, C. Gorgi, A. Irmani</i>)	213
Sustainable wastewater management in Konya Province (<i>M.E. Aydin, E. Uslu, A. Demir, S. Koyuncu</i>)	223
The methodology of pollution load calculations (<i>S. Ayaz, E. Aytis, S. Aynur, B.H. Haksevenler, B. Kiran, E.M. Dereli, M. Dilaver, N. Erdogan, M. Besiktas, C. Kinaci</i>)	231
Temporal distribution of heavy storms in the Gulf of Suez Region (<i>A.M. Elmoustafa, A.A. Saleh</i>)	242
Solar energy for wastewater treatment (<i>K. Al-zboon, R. Damsah, M. al-Harahsheh</i>)	251

PREFACE

Middle East and North Africa Region (MENA) is a part of Exceed-Swindon project. The partner countries in the region are Turkey, Jordan, Egypt, Tunisia, and Morocco, which are located at eastern and the southern part of Mediterranean Sea. The countries in the region have some general characteristics: Water scarcity, high population growth rates, food importing dependence, and the potentially high impact of climate change. A fast-growing population, in interaction with the low water availability and unsustainable water use, particularly in the agriculture, leads in many places to an average amount of water per capita that is far below the scarcity level.

Finding solutions to water challenges in the MENA Region, such as water shortage/scarcity, which is potentially affected by climate change and unsustainable water management strategies, water quality degradation and pollution due to high population and economic growth demands in the region, requires close collaboration between scientists, engineers, NGOs, and stakeholders from governmental and public organizations.

The most parts of the MENA region is characterized by hot climate and fresh water shortage, and some countries have very little access to renewable freshwater. They rely primarily on groundwater and desalination. This may consider as a good way/idea the use of solar power to purify and to manage the available sea water resources. On the other hand, science should deal in a sustainable ways with the impacts of this practice on marine life.

Other countries, like Egypt, Iraq and Jordan, get most of their water from rivers that they share with neighboring countries. Industrial discharge is a major environmental and health concern due to the variety, high concentrations, and potentially adverse effects of industrial water pollutants on receiving water bodies. Sustainable and cost effective solutions should be implemented to these countries' strategies. One of the most wonderful strategies is to use CO₂ cleaning technology instead of water cleaning method in industrial practice. CO₂ coolant/cleaning involve the use of carbon dioxide in solid form, highly propelled dry ice particles out of a nozzle to cool/clean a variety of different surfaces.

This workshop, organized in Cairo, the highest population density city in MENA and the most water stressed one, provided the fertile land for our ideas for discussing the "*Solutions to Water Challenges*". 32 participants from all partner institutions participated at this Regional Expert Workshop, presented their knowledges and experiences in the field of sustainable water management, sustainability of groundwater resources, management and restoration, water quality management and control, among others. Moreover, Exceed Swindon invited especially a well known water conservationist, who won the Stockholm Water Prize, an award known as the "Nobel Prize for Water" in 2015. Dr. Rajendra Singh, also known as the "Waterman of India" for combining his ideas with social practices, enriched the discussions during the workshop.

This proceedings book brings 26 papers selected out of 31 presented ones in the workshop. We are confident that the readers will gain benefit and knowledge from reading these papers.

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PROPOSALS FOR GOOD GOVERNANCE OF WATER RESOURCES IN MEDITERRANEAN SEA BASIN - RESPONSE OF THE SCIENTIFIC WORLD

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Keywords: Agriculture, Mediterranean Sea, virtual water, water footprint, water scarcity

Abstract

Water resources in Mediterranean Sea Basin are under strain from rapid urbanization and industrialization. The situation is made worse by water-related disasters, climate change and poor governance. Countries especially in the southern-rim are experiencing the urban scenario of water stress. Traditional systems to share water are increasingly unable to cope with growing demand and competition between users. In this study, the water resources management in Mediterranean Sea Basin is evaluated using water footprint methodology and proposals for sustainable management are introduced. In addition, through bibliometric analysis the responses of the scientific world to water related problems in the selected Med Sea Basin countries are introduced.

PASTURE LAND IN A DESERT AREA AT AL-KARAK PROVINCE/ JORDAN

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Keywords: Desert plants, Fodder, Pasture land, Jordan

Abstract

Evaluation of irrigation with treated wastewater at the initial stage of germination on biomass production for five desert plant species (*Stroled halimus*, *Achillea*, *Salsola vermiculite*, *Medical sativa* and *Sednaniasesban*) was done in a semiarid area at Karak, Jordan. Revegetation was done by using two methods; seeding and out planting nursery grown seeding and different irrigation schedule. The investigated season was a wet year with 309 mm of rain which was much higher than average long term amount of 227 mm. Therefore, the results of this work are applicable to wet years only. The biomass yield varied with plant species and irrigation program. The biomass for sites irrigated once every week ranged from 1.000 g/m², 1,050 g/m², 150 g/m² and 50 g/m² for sites without irrigation to 4,500 g/m², 2600 g/ m², 1,200 g/m² and 1,200 g/ m². In general, biomass increased with increasing frequency of irrigation. For out planting, the biomass at the end of the experiment was 325 g, 1,200 g, 1,500g, 1,250 g per each plant for *Achillea*, *Artemisia annua*, *Salsola vermiculite* and *gataf*, respectively. Irrigation at the initial stage of seeds germination increased the biomass production rather than using plantation.

INTEGRATED SUSTAINABLE COASTAL DEVELOPMENT PROGRAM IN THE MENA REGION: EGYPT'S EXPERIENCE

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Keywords: capacity building, coastal management, MENA region, networking, Sida

Abstract

For the last five years, Egypt was involved in a coastal development program funded by the Swedish government that includes four other MENA countries besides Egypt. The countries involved are: Tunisia, Lebanon, Jordan and Palestine. The author was the national coordinator of the Egyptian team. The paper presents a description of the program with its five phases, four batches from 2014 to 2015, its target group and an overview of the participants in Egypt representing several organizations dealing with coastal management. Such organizations include universities, research bodies, and government agencies responsible for shore protection, urban planning and tourism. The paper also reviews program outputs at different levels and shows how it affected the stakeholders, decision makers and the participants themselves. It also gives examples of outstanding Change Projects of selected participants. In addition to two national seminars, which took place in Egypt, a final program seminar was conducted and well attended by key persons of the organizations involved. Such seminar consolidated the efforts throughout the program years and strengthened the network between decision makers and professionals responsible for coastal management in Egypt. The networking among MENA region is also demonstrated as one of the sustainable outputs of the program.

WATER LOSS AND CONTROL IN DRINKING WATER NETWORKS IN TURKEY

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Keywords: Leakage, water demand, water distribution network, water loss.

Abstract

Water scarcity is an increasing problem in some regions in Turkey, as a result of urban population growth, low precipitation and agricultural activities. Turkey is categorized as “water scarce country” with water potential lower than 2000 m³ annual water per capita, and projected to be “water-poor country” in 20 years time. For a sustainable water supply, it is now more critical to preserve water in drinking water distribution networks. Water loss ratio up to 45% was reported for some urban networks in Turkey. According to IWA reports, while water loss is between 8-24% in developed countries, it goes up to 24-45% in developing countries. 10% water loss is acceptable for IWA. Physical loss in network includes leakages from broken or cracked pipes, leakages from branch connection points and weir losses in storages. Total water budget not only includes physical losses but also illegal consumptions, that is not invoiced. For instance, Istanbul Municipality accomplished to decrease water loss from 38% in 2002 to 27% in 2013 with effective measures. In this study, it is aimed to give the dimension of existing water loss problems in Turkey and to present improvement works of municipalities. Necessary strategies to overcome the problem will also be reviewed.

CAN LAND-USE CHANGES AFFECT WATER SOIL CONTENT AT SEMI-ARID REGION?

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Keywords: Curve number model, Land-use, Potential water retention, Spatio-temporal variation

Abstract

Changes of land-use and land cover (LULC) have extreme impacts on soil degradation through their effects on water soil storage capacity. Investigations were carried out in Tanta catchment in the middle Nile Delta, Egypt (30° 45' N, 30° 55' E), where collecting soil samples covered different hydrological soil groups and land-uses. Based on the natural resource conservation service, curve number model (NRCS-CN), CN approach was used to investigate the effect of spatio-temporal variations of different land-uses on soil water retention. Potential soil water retention from 1990 to 2015 was reduced by 118 m³ per hectare with decreasing cropland area. Urbanization encroachment from 1990 to 2015 was increased by 2.13% by decreasing cropland with 15.3% (5,300 ha in 2015). This resulted in losing the potential soil water retention by 625,968 m³ water for the whole catchment area. The (S) value of the NRCS-CN model coupled with GIS technique provides useful measure to identify land-use changes of potential water storage capacity at catchment scale.

SUSTAINABLE WATER MANAGEMENT TRAINING AND DEMONSTRATION CENTER IN TUBITAK MARMARA RESEARCH CENTER

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Keywords: Black water, grey water, membrane biological reactor (MBR), rotating biological contactor (RBC), sequencing bed reactor (SBR)

Abstract

A Training and Demonstration Center (TDC) for sustainable water management (SWM) was built in Marmara Research Center (MRC) in the scope of Zero-M Project. The TDC designed consisted of integrated concepts for different applications of decentralized wastewater treatment and reuse applications. The term decentralized here refers to tourist facilities, rural areas (small municipalities) and suburban residential areas that are not connected to central wastewater treatment plants. The TDC covers a variety of measures as wide as possible, ranging from water saving equipment to wastewater recycling. Different treatment technologies are applied to grey and black water treatment. For grey water treatment, four different technologies are assessed as membrane bioreactor, sequencing batch reactor, rotating biological contactor and constructed wetlands. For the treatment of black water, first alternative is to combine constructed wetlands with two-stage anaerobic reactors as a primary treatment stage. The second alternative is the membrane bioreactor. It is expected that the TDC will serve as a base for the training of decision makers and technicians to help the dissemination of activities between national and international institutions and to mitigate the water scarcity problem by creating non-conventional water resources for sustainable development.

OVERVIEW OF BRACKISH WATER DESALINATION IN THE JORDAN VALLEY

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Keywords: Brackish water, Desalination, Reversed osmosis, Water scarcity, Jordan Valley

Abstract

Jordan is one of the ten most water scarce countries in the world. In 214, the share of water per capita per year in Jordan was 120 m^3 , while the water deficit is estimated to be 160 Million Cubic Meter (MCM) in 2015. This deficit is projected to grow up to 490 MCM by 2025. This study investigated the potential of brackish water desalination in Jordan Valley (JV) to minimize the water deficit in Jordan. Field visits and interview with the different stakeholders were conducted in order to identify the current situation of the brackish water desalination availability in the Jordan Valley. The study shows that the estimated surface brackish water in the JV is 141MCM/yr, with an average salinity of 1,000-3,000 ppm, while the ground brackish water estimated to be more than 78 MCM/yr, with an average salinity of 1,300 – 8,028 ppm. The study shows also there are about 40 brackish water desalination plants with a capacity range from 10 to 40 m^3/h in the South Shouneh Area. Most of these plants are used for banana irrigation.

MAXIMIZING THE UTILIZATION OF WATER AND SOILS FOR AGRICULTURAL LAND USE IN THE DELTAIC NILE ALLUVIUM

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Keywords: Land suitability, Nile Delta, remote sensing, saving water

Abstract

The study area was situated to cover the River Nile Delta in North Egypt aiming at maximizing the output of utilized water and land resources to safe amounts of water resources as well as getting more yield production. This approach based on fitting the requirements of irrigation types and cropping pattern to specific soil attributes. Remote sensing data acquired in January 2017 by OLI of TM8 were used for defining the landscape features in the study area, by physiographic analysis and automated classification. Nile Alluvium was divided to delta apex (612,732 ha) includes soils that will be highly suitable if utilized under drip irrigation for growing cabbage, citrus, cotton, date palm, green pepper, guava, maize, mango, and potato. Pro-delta (1,198,368 ha) includes soils that are highly suitable when utilized under surface irrigation for growing date palm, guava, rice, soya, and wheat, while are moderately suitable for alfalfa, cabbage, citrus, cotton, green pepper, maize, mango, potato, and tomato. This adaptation is setting up a better spatial distribution that face the problem of water scarcity in a region of arid climate and also reducing the hazard of sea water intrusion that is facing the pro-delta.

A CASE STUDY ON EVALUATION OF HOUSEHOLD WATER SECURITY IN MENA COUNTRIES

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Keywords: Household water security, sustainability, water management, water resources, water security.

Abstract

Water resources are under pressure due to climate change and increasing water demand resulting from urbanization, industrialization and increase of population. Therefore, sustainable management of water resources has become more crucial and securing water resources has attracted a worldwide attention over the past years. Water is unevenly distributed across the Earth's surface. Therefore, some countries have been facing absolute water scarcity. In addition to water scarcity, some countries have also problems with water security issues. Water security plays a key role for building resilience in water resources management. Increasing demand, overexploitation, climate change and poor management of water resources are the major factors of water security concerns. Providing adequate quantity and quality of water for basic needs is defined as water security. Water security has different aspects, of which one is the household water security, measuring water security at domestic level. The aim of this paper is to provide an evaluation of household water security in some MENA (Middle East and North Africa) countries (Algeria, Egypt, Jordan, Lebanon, Morocco, Tunisia, Turkey and Yemen). Measuring water security at domestic level is defined as household water security that consists of piped water access, sanitation access and hygiene. For this purpose, the methodology presented by AWDO (Asian Water Development Outlook) was used to calculate household water security in some MENA countries. Vulnerability to water scarcity of these countries was also evaluated. Proportion of total renewable water resources withdrawn was used as an indicator for evaluation of those countries' vulnerability to water scarcity. Findings on those countries' vulnerability to water scarcity and household water security are concluded in this study.

BORON REMOVAL FROM SEAWATER USING ADSORPTION AND ION EXCHANGE TECHNIQUES

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Keywords: boron, seawater, removal, adsorption and ion exchange techniques.

Abstract

Boron is readily found in the environment at fairly low concentrations mainly as boric acid or borate salts. Boron is a micronutrient required for most plants and animals; however, the range between deficiency and excess is narrow. In an industrial setting, the removal of boron from process streams, such as in the treatment of magnesium brines or in the production of ultrapure water (UPW) for the semiconductor industry, is essential. In other industrial applications, a boron selective resin can be applied to reduce and to eliminate boron from discharge streams. Boron occurrence in most natural fresh waters is at less than 1.0 mg/L and in seawater at 5.0 mg/L range. There are some areas in the Southwestern US, with unique geology, that also yield higher boron levels. Levels in the 7 mg/L boron have been reported. Higher concentrations are often cited as an indicator of pollution from sources like laundry detergents, boiler blow down water, or mining operations, which may require treatment prior to discharge or before applying for agricultural uses. In the present study, adsorption and ion exchange using adsorbents like fly ash, natural zeolite and demineralized lignite and also Boron selective resin (BSR) (Dow's XUS-43594.00) were investigated for the purpose of removal of boron from water. Boron in water was removed with fly ash, zeolite, demineralized lignite and BSR with different capacities. 92.6% boron was removed using fly ash and 89.6% boron removed using BSR. Batch experiments were conducted to test removal capacity, to obtain adsorption isotherms, thermodynamic and kinetic parameters. Boron removal by all adsorbents was affected by pH of solution; maximum adsorption was achieved at pH 11.

QUALITATIVE ASSESSMENT OF IRRIGATION WATER IN THE CENTRAL BAHIRA PLAINS – EI KALĀA-MOROCCO

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Keywords: Cartography, Central Bahira, groundwater, hydrodynamic state, physicochemical quality

Abstract

In Morocco, climate aridity due to the succession of drought periods leads to water scarcity. Hence, the use of irrigation is an obligation for the development of agricultural lands to cope with this scarcity. However, agricultural intensification was accompanied by a lack of irrigation control. This causes problems of degradation of water and soil quality in terms of salinity problems and thus constitutes a serious danger to the sustainability of the production systems. In order to overcome this situation as well as to ensure the sustainable preservation of these resources, their monitoring and analysis becomes necessary. This work falls within this framework. It aims to study the physicochemical and piezometric quality of the water table of the perimeter of the central Bahira region in Morocco. An approach was followed involving a monitoring of the groundwater at the scale of the area, using a network of 40 water points. The measurements were carried out in situ (EC, pH, piezometric level) and in the laboratory (major and secondary elements). The piezometric results indicated that the water table increases from the center to the periphery, varying from 19 to 70 m. The physicochemical analysis of water showed that the majority of the wells have a slightly basic pH, the salinity level oscillate between 1.2 and 14.6 mS/cm, increasing from the edges towards the center. Moreover, the maps of the groundwater quality parameters were established under GIS allowing to delineate the areas affected by the problems of degradation of this resource, constituting a source of information and management for a better future monitoring of the qualitative state of the water table.

**EVALUATION OF GROUNDWATER QUALITY AND ITS SUITABILITY FOR DRINKING
AND IRRIGATION USE IN SEMI ARID REGION USING GIS:
CASE STUDY: SKHIRA COASTAL AQUIFER, CENTER EAST TUNISIA**

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Keywords: Skhira aquifer, irrigation, suitability, major ions, World Health Organization

Abstract

Skhira coastal aquifer is located in the center east of Tunisia. It is already affected by the intrusion of saline water phenomena. The main objective of this study is the assessment of suitability of groundwater uses. The geochemical study was undertaken using the existing data on chemical and physical parameters during 2000-2010 from 31 wells. The salinity increases in the direction of flow and exceeds 10 g/Lin the northeast region. Groundwater mineralization is controlled primarily by the concentrations of sodium, chlorides and sulphates. The majority of the groundwater samples fall at the unsuitable zone for drinking purpose, according to Tunisian Standard NT. 09.14 and the World Health Organization. The results of Sodium Adsorption Ratio (SAR) and sodium percentage show that the majority of groundwater samples are unsuitable for agricultural purposes.

ASSESSMENT OF DRINKING WATER QUALITY IN OUED RMEL AQUIFER IN ZAGHOUAN IN NORTHEASTERN TUNISIA, THROUGH GEOGRAPHIC INFORMATION SYSTEM AND WATER QUALITY INDEX

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Keywords: GIS, human consumption, Oued Rmel aquifer, Tunisia, Water Quality Index (WQI)

Abstract

The present work aims to highlight the natural and anthropogenic factors affecting water quality of Oued Rmel aquifer in northeast region of Zaghouan in Tunisia. To achieve the main objectives of the study, we collected 46 water samples in January and August 2013 across the study area. Several geochemical analyses were conducted in situ as well as the laboratory. Nine parameters related to salinity, Na^+ , Ca^{2+} , Mg^{2+} , K^+ , Cl^- , SO_4^{2-} , HCO_3^- and NO_3^- were generated to assess the water quality (Water Quality Index) and aptitudes for human consumptions across the region. A geospatial visualization tool GIS was built in order to monitor in near real time the water quality across the Oued Rmel aquifer. This tool also allows users to investigate spatially the relationship between water quality, land use/land cover change, geological structure, population distribution, and the aquifer characteristics. The results provide additional insights into this isolated and vulnerable region. The assessment approach used in this study may be adapted for application in other regions in Tunisia where groundwater monitoring systems are spatially and temporally limited. The results showed a high seasonal and spatial variability, with values ranging from 120 to 265 in the winter season and from 113 to 280 in the summer season. The Water Quality Index (WQI) results confirmed that 70% of the water qualities of Oued Rmel aquifer are of poor quality, with WQI values between 100 and 200, whereas 30% presented very poor quality with WQI varying between 200 and 300.

EVALUATION OF GROUNDWATER QUALITY IN TWO COASTAL REGIONS OF MOROCCO (OUED EL MALEH & GHARB)

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Keywords: Oued El Maleh, Gharb, Groundwater Quality, Salinity, Piper.

Abstract

Morocco has arid and semiarid climates. Irrigation is an imperative for agriculture. The two regions Oued El Maleh and Gharb are known for the production of vegetables, and are considered very important agricultural areas, known nationally for their high potential for market gardening. This intensification has been accompanied by an excessive use of agrochemical inputs and poor control of irrigation and drainage. Consequently, salinization phenomena and deterioration of soil structure as well as water are about to create an alarming situation. Therefore, the objective of this research work was the assessment of the quality of irrigation water of the two regions. The study sites are located in a coastal area and dedicated to intensive land use for growing vegetables in a peri-urban agricultural zone. A field survey conducted in 2014-2015 to assess water quality in the two regions focuses on the physicochemical parameters and analyses of their spatial dependency on a regional scale. Monitoring of physicochemical parameters of water was carried out in 79 wells in Oued El Maleh and 22 wells in Gharb. The obtained results from groundwater in the two regions show relatively high values of nitrate and conductivity, exceeding Moroccan national standards and revealing net degradation of water quality. Therefore, water from there can be considered not suitable for human consumption and can induce a degradation of soil.

SALT TOLERANT AGRICULTURE IN SOME AREAS OF MOROCCO

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Keywords: Morocco, salt tolerant plants, soil, sustainability

Abstract

The prevailing climate changes and aridity had led to scarcity of water and an increase of salinity in some areas of Morocco. This situation raises concern among scientific community and decision makers in Morocco to overcome the difficulties and constraints faced by growers in terms of irrigation potentialities and delivery of drinking water. Attempts to remedy to this situation would be welcome to enhance productivity and sustainability of the ecosystems. Sed El Mesjoun, Oued el Maleh, and Gharb area are three representative sites with different ecosystems affected by sanitization and pollution by different agricultural applications. There, different geographical locations confer them specific particularities that provide different natural edaphical and phenological situations in terms of response to the stress generated by the salinization. Sedmesjoun is an internal location far from the coast and experiences severe situation of drought. Oued el Maleh is close to the coast, while Gharb area is on the coast and is dominated by clayey and sandy soils. The available data on salinity from these different regions reveal variations in different parameters that could be optimized to reach appropriate conditions for agricultural activities. Diversity of crops would represent a strong potential for an added value products for animal and human consumption. On the other hand, these natural resources will definitely contribute to reduction of salinity and an increase of sequestered carbon. Tests with some local plants have proved to be efficient to overcome the stress generated by salinity. Results of performance of the tested plants could be recommended for remediation in the affected areas.

BINARY ADSORPTION OF COPPER AND NICKEL METAL IONS ON NANO ZERO VALENT IRON SUPPORTED ON ACTIVATED CARBON (AC-NZVI)

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Keywords: Activated Carbon, Adsorption, Copper Removal, Nano-Zero Valent Iron (nZVI), Nickel Removal

Abstract

Copper and nickel ions in water and wastewater can be treated with several methods such as adsorption and membrane filtration. In this study, the use of sorbent synthesized by nano zero valent iron (nZVI) on activated carbon for the removal of copper and nickel has been investigated in a binary system. Adsorption studies were carried out by expressing removal efficiencies and adsorption capacities while considering the initial concentrations of both metal ions. Effect of activated carbon is also studied. It is attained that the removal of copper with AC-nZVI was more satisfactory than of nickel. While the removal of copper was 97% in the absence of nickel, it was decreased to 84% for 50 mg/L copper and nickel concentrations each. In a similar manner, 97% removal rate of nickel ions in absence of copper was decreased to 59% with 50 mg/L nickel and copper ions concentration. It was also observed that adsorption capacity of copper in the binary system was higher than of nickel. For highest total metal ions concentrations (300 mg/L) adsorption capacities were obtained as 1,100 mg/g and 1,217 mg/g for nickel and copper adsorption in the binary system, respectively.

SUSTAINABLE SOLUTIONS FOR WATER QUALITY MANAGEMENT: A FOCUS REVIEW ON NATURAL BIO-SORBENTS/ADSORBENTS

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Keywords: Water pollution, heavy metals, pesticides, green chemistry, bio-sorption, groundwater, wastewater

Abstract

Most of experts in the world on water related fields agree that water will be very soon the coming subject for environmental stress. It is easy to recognize the reason of water crisis, but it is too difficult to address it, while water resources are limited and scarce in most countries of the MENA region. Virtually, population growth and increase of water demand is another important issue. The global climate change has severe impact on the water availability and quality. Today, among the water challenges the world is facing particularly in the MENA region, water pollution is one of the most pressing issues. Water quality has ties to the natural resources and ecological systems, in which all life on the earth are pendent. However, green chemistry offers set of solutions scientifically based, sustainable, and cost-effective for water quality protection and management. An effective way to manage the water pollution challenge in the MENA region is to use the least risky ways to disallow contamination. To achieve these attainable goals, the chemistry principles of separation and chromatography offers a wide range of encouraging and beneficial methods. The remediation of groundwater contamination is very important for the agricultural activities and population growth in the region. A range of novel methods has been recorded for remediation and treatment of water contamination. This paper mainly focusses on and highlights the effective sustainable examples of natural bio-sorbents and other adsorbent materials for water pollution control and quality management.

APPLICATION OF A NEW METHODOLOGY (TRAD) TO CONTROL SEAWATER INTRUSION IN THE NILE DELTA AQUIFER, EGYPT

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Keywords: Saltwater intrusion, control, Nile Delta aquifer, SEAWAT, TRAD.

Abstract

Groundwater contamination affects water availability in Egypt. Saltwater intrusion is a special category of groundwater contamination that threatens coastal aquifers. Increasing pumping, reducing recharge, climate change and sea level rise have increased saltwater intrusion. The control of saltwater intrusion became crucial to protect groundwater resources. The Nile Delta aquifer contains large quantity of freshwater (400 BCM) and is subject to sever saltwater intrusion. In this paper, SEAWAT code is used to simulate saltwater intrusion in the Nile Delta aquifer with focuses on the control of saltwater intrusion. Different scenarios are implemented to control saltwater intrusion including recharge of freshwater, abstraction of brackish water, and a new methodology (TRAD) is applied to control saltwater intrusion in this aquifer. TRAD includes Treatment of wastewater and Recharge to the aquifer, Abstraction of brackish water and Desalination. Comparison between the two traditional methods and the new methodology TRAD is presented. The results showed that all three scenarios could be effective in controlling saltwater intrusion, but using TRAD resulted in the maximum movement of freshwater/saline water interface towards the sea. TRAD is an effective tool to control saltwater intrusion, is economical, has less environmental impacts, and can be used for sustainable development of water resources in coastal areas.

HYDROLOGICAL AND WATER QUALITY MODELING OF ERGENE RIVER BASIN OF TURKEY BY SWAT

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Keywords: Surface Water, Modeling, Ergene River, SWAT

Abstract

Hydrologic and water quality modeling of the Ergene River Basin has been developed by using Soil Water Assessment Tool (SWAT). The purpose of this study is to model distributed surface flow and contaminant transport to evaluate the management of the Ergene River Basin. SWAT model is one of the few hydrologic models with water quality coupling capability that is convenient for this purpose. Most of the industrial activities, causing the water pollution in the watershed, take place in the upper part of the Ergene River Basin. Therefore, only this part with about 2780 km² was modeled. Continuous daily climate data for 8 years, land use, soil properties, and contaminant point source data set compatible with the structure of SWAT are used in the model as input data. The river basin was divided into 38 sub basins and 2631 Hydrologic Response Units (HRU). The model was calibrated by considering 11 parameters of hydrology and 3 parameters of nutrient transport for five years, and it was validated for a three years period. The model results for monthly stream flow is good with $R^2 = 0.75$, however, for daily stream flow ($R^2 = 0.40$) and nutrient ($R^2 = 0.35$) that is fair to weak. Water quality modeling study of the basin is continuing to improve the calibration before applying the model to evaluate the watershed management scenarios towards improving water quality.

**BIOACCUMULATION AND PHYSIO-BIOCHEMICAL PARAMETERS OF *IN VITRO*
REGENERATED *Pogostemon erectus* (DALZELL) KUNTZE TO Cd
A STUDY FOR PHYTOREMEDIATION**

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Keywords: Accumulation, Aquatic plants, Cadmium, Phytoremediation, *Pogostemon erectus*

Abstract

In vitro regenerated shoots of the aquatic plant *Pogostemon erectus* (Dalzell) Kuntze were exposed to different cadmium (Cd) concentrations (0.2 - 1.6 mg/L) for 1, 3 and 5 days. Various physio-biochemical parameters including metal content, bioconcentration factor (BCF), fresh and dry weight, chlorophyll, protein contents, and lipid peroxidation (Malondialdehyde-MDA contents) were investigated. Cadmium accumulation increased with increasing exposure time and metal concentrations in the solution, with the highest metal accumulation obtained after 5 d at 1.6 mg/L Cd. The maximum bioconcentration factor of 1,687 was recorded when exposing plant to 0.8 mg Cd/L for 5 d. The fresh weights of the plant increased depending on the increase of the exposure times, whereas dry weights decreased. Cd exposed plants demonstrated significant decreases in their photosynthetic pigments with increasing Cd concentrations and durations. In comparison to control, the maximum decrease rates for chlorophyll *a*, *b*, total chlorophyll and carotenoid contents were determined at 1.6 mg Cd/L after 5 d were 69.1%, 74.4%, 70.2%, and 62.7%, respectively. It was noted that the interactions between exposure time and Cd concentration significantly affected both the protein and lipid peroxidation contents of *P. erectus*. The protein contents decreased with increasing Cd concentrations and exposure times, and the lowest protein content was recorded at 1.6 mg/L after 5 d (7.31 mg/g fresh weight). On the other hand, MDA contents increased with increasing concentrations of Cd and reached the maximum at 1.6 mg/L after 5 d (26.1 nmol/mg fresh weight). This study may be useful for utilizing *P. erectus* in phytoremediation applications.

REMOVAL OF VANADIUM FROM JAJARM BAUXITE PROCESSING PLANT EFFLUENTS

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Keywords: Activated Carbon, Adsorption, Ferric Sulfate, Removal, Vanadium.

Abstract

In mineral processing industry, the tailings dams constitute the major environmental problems with heavy metals playing a major role in destruction and degradation of natural habitats. In this study, activated carbon and ferric sulfate were applied for the removal of vanadium from effluent of tailing dam in case of Jajarm Bauxite processing plant. Design of experiments was performed using DX7 software (CCD method), and the best-fit model was chosen accordingly. Finally, the optimum conditions for the adsorption of vanadium by activated carbon and ferric sulfate from the synthetic aqueous solution were evaluated. Sequential extraction experiments showed that the highest amount of vanadium had been involved in the exchangeable phase. Vanadium sorption tests by ferric sulfate revealed that the maximum amount of vanadium removal is achieved at pH 10.7, 4 h 49 min of contact time, and 49.6 mg/L concentration of ferric sulfate. The maximum amount of vanadium adsorption by activated carbon was obtained at pH 9, 5 h of contact time, and 0.5 g/L carbon dosage.

REHABILITATION OF THE WASTEWATER TREATMENT PLANT (WWTP) OF A TUNISIAN TANNERY: OPTIMIZATION OF COAGULATION-FLOCCULATION PROCESS AND INTEGRATION OF TERTIARY TREATMENT STEP

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Keywords: coagulation-floculation, nano-filtration, optimisation, tannery wastewater

Abstract

The leather and shoes industries sector has 286 units in Tunisia, the vast majority (215 units or 75%) produced totally for export. It is an activity, which showed for several years its dynamism, active participation in investment, export, and job creation. However, tannery effluents are complex and highly contaminated with organic and mineral matter, especially salts. They exhibit variable characteristics over time and are not readily biodegradable. This work deals with the optimization of the existing physical-chemical treatment using coagulation/flocculation and the assessment of the pollution generated by the tannery wastewater using the nanofiltration as a tertiary treatment. The laboratory experiments showed that on one hand, this process made it possible to eliminate the microbial load of the treated effluents and to reduce considerably their salinity. On the other hand, the quality of the treated wastewater after nanofiltration process allows its reuse in industrial processes. Monitoring of the WWTP using the coagulation/flocculation process as pretreatment showed that it significantly reduces suspended solids (R = 95%), biochemical oxygen demand (R = 92%), and the regularization of the pH (pH = 8.5 at the exit of the WWTP).

SUSTAINABLE WASTEWATER MANAGEMENT IN KONYA PROVINCE

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Keywords: KOSKI, sustainable wastewater management, purple network, heavy metals, Octopus passive sampler

Abstract

Water consumption and the produced wastewater quantity of the humankind are increasing due to the recent living standards. As a result, the collection, disposal, and reuse of domestic and industrial wastewater are gaining importance from the point of view of human and environmental health. In Turkey, the responsibility field of the greater city municipalities includes all areas within their borders. Due to this fact, the service area of KOSKI (Konya Greater City Municipality, Water and Wastewater Authority) increased from 5,983 km² to 41,001 km². KOSKI general management, having the greatest province area, almost greater than of 60 countries in the world, is doing the sustainable water and wastewater management applications. Depending on geographic location, receiving environment, population, and other properties, the domestic wastewater is collected by means of sewerage network, septic tanks, sucking machines, and pumping stations. The collected wastewater is transported to independent or common wastewater treatment plants, depending on the feasibility analysis, that are constructed and operated by KOSKI. The wastewater is treated according to the standards in force until it can be used as irrigation water. Industrial plants operated in the province of Konya are forced to build pre-treatment and/or treatment plants according to the regulations in force, and periodical operational supervision is done by KOSKI. A passive sampling system named as the *Octopus System* has been in operation since 2012 in order to monitor the heavy metal pollution in the sewerage originating from industries, and to prevent illegal discharges. In this report, applications of KOSKI in general in the province of Konya sustainable water and wastewater management are presented and costs of the measures are analyzed.

THE METHODOLOGY OF POLLUTION LOAD CALCULATIONS

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Keywords: Pollution load calculation, point source pollution, diffuse source pollution, river basin

Abstract

The sources of pollution that put pressure on water resources are divided into two groups: Point Source Pollution and Diffuse Source Pollution. If pollution is discharged from a controllable and measurable point, such sources are expressed as point sources, and if the pollution is spread into the environment as a diffused way, the source of the pollution is defined as the diffuse source of the pollution. Point and diffuse total pollution loads are calculated by using the methods used within the scope of Watershed Protection Action Plan Preparation Project. The database of the Project is used for urban and industrial pollution load calculations and updated with the data obtained from other recent projects. Diffuse pollutants emitted are analyzed under the following headings and the pollution load estimations given to the basin from these sources are calculated: Land cover, agricultural activities, animal livestock activities, solid waste irregular storage, and septic tank exit waters. The methodology for these calculations is explained.

TEMPORAL DISTRIBUTION OF HEAVY STORMS IN THE GULF OF SUEZ REGION

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Keywords: Arid regions, Design hyetograph, Flash floods, Surface hydrology, Wadi hydrology

Abstract

The temporal distribution of storm precipitation controls the generated flood characteristics. The common lack of detailed measurements in many places makes hydrologists rely on synthetic temporal distributions. In this study, a hydrological simulation of a selected watershed is used to simulate 25, 50 and 100 years return periods design storm, each with four different distributions (two synthetic, and two historical storms). They were compared based on the generated peak discharge to determine which is able to generate the worst-case scenario. For 100-year storm, the historically based temporal disruption generated a peak 14% more than the synthetic based disruption. On the other hand, generated flood peaks were almost similar among all temporal distribution for 25-years and 50-years return period storms. Results recommend, depending on real historical storms, designing structures with a long return period. On the other hand, applying synthetic storm is accepted for designing protection structures according to short recurrence intervals.

SOLAR ENERGY FOR WASTEWATER TREATMENT

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Keywords: Drying Sludge, Concentrated Parabolic, Solar energy, Treatment, Wastewater

Abstract

In the present study, the applicability of solar energy to enhance the drying of municipal sludge was investigated. Such solar drying systems could be applied in MENA region due to the high solar radiation intensity. In the field, about 20 m² of solar collector panels were assembled to concentrate the sun energy. This energy was used to heat water that was passed through galvanized pipes at the bottom of modified sand drying bed to enhance evaporation and to accelerate sludge dewatering. The modified filed drying bed has resulted in a 20% weight reduction in the drying period, when compared to the conventional drying bed. At lab scale, solar energy was collected and concentrated in two parabolic tough collectors (PTC-1) connected in series. The concentrated solar radiation heated the transfer fluid (HTF), thermal oil, to a temperature of 240 °C. The heated oil was utilized for steam generation; the generated steam from the plant was used to accelerate sludge drying processes in a conventional basin. Three basins (N1, N2, and N3) made of galvanized steel with dimensions of 1 x 0.5 x 0.3 m were used to contain the sludge. Networks pipes were installed at the bottom of basin N2, N3 and connected to the source of hot steam from the solar system, while basin N1 had no any modification. The solar system produced a steam, which flowed through the network of pipes under the sludge layer. Preliminary results indicated that the solar drying system resulted in a high evaporation rate and significant reduction in the drying period up to 50%.