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Water Perspectives in Emerging Countries

Water – Energy – Food NEXUS in MENA Region

Mohamed Abu-Hashim, Mehmet Emin Aydin (Eds.)

November 11-17, 2018 – Aswan, Egypt



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Water-energy-food NEXUS is central to sustainable development in MENA Region. Demand for these domains is increasing, driven with a rising global population, changing diets, rapid urbanization and economic growth. Agriculture is considered to be the largest consumer of the world's freshwater resources, and more than one-quarter of the energy consumed globally is spent on food production and supply. The linkages between these essential domains require an appropriately integrated approach to ensuring water and food security, sustainable agriculture, and energy production worldwide.

Water is a finite resource having to serve exponentially more people and usages, and so ensuring that everyone has access to a reliable supply and sustainable progress. As water resources become more stretched, the energy and food sectors' dependence on water means that decision-makers are now increasingly focusing on water resources management, ecosystem protection, and water supply and sanitation as part of their policy and practice for sustainable developments goals. In addition, there will need development of less water-intensive renewable energy, such as hydropower and wind power, before it makes a significant impact on water demand.

As agriculture set to remain the biggest user of water into the middle of this century, efficiency measures along the entire agrifood technologies can help saving water and energy, such as precision irrigation based on information supplied by water providers, which can motivate farmers to invest in their systems ensuring the best returns from their water investments.

The expert workshop held in Aswan, Egypt aimed to exchange knowledge and to share information on water-energy-food challenges and solutions, and to establish a sustainable network of water experts in the MENA Region.

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Prof. Dr. Mehmet Emin Aydin – Necmettin Erbakan University, Turkey

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ROLE OF DAMS IN WATER-ENERGY-FOOD NEXUS

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Keywords: Climate Change, Dam Construction, Hydro-Electrical Power Plants, HEPP, Irrigation, Water Supply

Abstract

Water is essential for life and sustainable socio-economic development. It is an essential element for the eradication of poverty and hunger. Population growth, industrialization, urbanization and rising affluence in the 20th Century resulted in a substantial increase in water consumption. While the world's population grew three fold, water use increased six fold during the same period. The demand on water resources will continue to increase. Contrary to the general perception, Turkey is among the countries that is or will be under water stress. In recent decades, Turkey has made a lot of works in development of water resources for irrigation, hydropower generation, flood control, and other purposes. The building of dams and reservoirs has enabled to save the water from its brief seasons of rainfall to use throughout the year for irrigation, energy, drinking water and sanitation. Water storage facilities are needed to benefit from existing water resources. By the year 2018, 596 dams are under operation and 83 dams under construction in Turkey. Irrigation areas are also planned to increase from 5.6 million hectare to 8.5 million hectare in 2040. In this study, water resources of Turkey and regulation studies of surface water are discussed. The usage of dams for generating energy and as irrigation facilities are given in detail.

WATER-ENERGY-FOOD STRATEGY FOR SUSTAINABLE DEVELOPMENT IN MOROCCO

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Keywords: Food, water, solar energy, management

Abstract

Moroccan economy relies mainly on agriculture and some limited industrial sectors as food and textile industry that represent fairly 15% of GNP. During the last two decades, Morocco has launched new economic strategy aiming at diversifying and boosting the industrial sector through an industrial emergency plan. Management of water has been dealt with through a national strategy for storage of surface water started in the 1960ies to irrigate 1 million ha, followed by the improvement of access to drinking water and the national plan of liquid sanitation. In the energy issue, Morocco has to face the regular increase of demand that has exceeded 105 tons of oil equivalent (toe). The adoption in 2009 of an ambitious strategy enables Morocco to shift towards other sources of energy, mainly solar and wind sources. The construction of four solar energy plants (Noor 1, 2, 3, 4) tends to achieve a ratio of self-generation of energy of 42% by 2020 and of 52% by 2030.

IMPACTS OF GRAND ETHIOPIAN RENAISSANCE DAM ON WATER, AGRICULTURE AND ENERGY SECTORS IN EGYPT

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Keywords: Agriculture, Energy, Egypt, Grand Ethiopian Renaissance Dam, Water Scarcity

Abstract

Egypt has a high rate of population growth. At the same time, it suffers from a severe water scarcity. In addition to the fact that its main source of fresh water is being threatened by the construction and probably the expected improper operation of the Grand Ethiopian Renaissance Dam (GERD) on the Blue Nile at about 20 km from Sudan border. Any reduction of Egypt's Nile water share will affect all associated water activities particularly energy generation from the Aswan High Dam (AHD) and the food security, which depends mainly on agricultural activities. This paper aims to summarize the results of various own and other authors' studies, which focus mainly on the impacts of GERD on the reduction of the surface water resources and the expected adverse impacts on the associated activities particularly in agriculture and energy generation. The results indicated that the reduction of the incoming water to the Aswan High Dam will depend on filling period and the assumed incoming flow in addition to other factors. The period of 10 years is recommended to minimize the negative environmental impacts on the Egyptian Society. After filling the GERD reservoir, the investigated operation scenarios reveals that to mitigate the adverse environmental impacts on Egypt conservative storage of at least 20 BCM (billion cubic meters) should be maintained to cover the expected shortage due to the adopting improper operation scenario to generate hydropower. The paper also presents how the reduction of the incoming water affects both the hydropower generation at AHD and the crop production in the agriculture and consequently the resulting food insecurity.

IMPACTS OF CLIMATE CHANGE ON WATER AND FOOD SECURITY IN TURKEY

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Keywords: Antalya Basin, climate change, food security, Konya Basin, water security

Abstract

The Mediterranean Basin is one of the regions, which will be affected by climate change more than other parts of the world. It is identified by the fourth IPCC report as one of the most vulnerable regions to future climate change. The major concern for this region is the basin-wide reduction of precipitation, which is expected to aggravate the situation on the already scarce water resources. Turkey is one of the countries in the basin that could be profoundly affected by this change. The climates of Turkey are suitable to grow a wide variety of crops, vegetables, and fruits. Most of the crops including wheat, barley, and rye are grown in the central plains (e.g., Konya). Most vegetables and fruits are produced in the coastal cities of Turkey (e.g., Antalya). The hotspot cities for some of the top crops and fruits of Turkey overlap with the areas where the projections show decreases in rainfall. Thus, it could be stated that climate change will increasingly threaten water and food security in Turkey in the 21st century.

REMOVAL OF ARSENIC POLLUTION FROM GROUNDWATER IN SMALL VILLAGES, ASSESSMENT OF LOW COST TECHNOLOGIES IN KONYA, TURKEY

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Keywords: Arsenic, Konya, Turkey, water quality, water treatment

Abstract

Arsenic (As) contaminated drinking water is a water related security problem in some towns in Konya, Turkey. Aquifer sediment is the source of As contamination in small villages. Since As has a high toxicity, there is a requirement for enforcement of stringent maximum allowable concentration (MAC) for drinking water. The regulated MAC level for As in Turkey is 10 µg/L, but the maximum reported concentration in a village in Konya is 473 µg/L, among 100 other villages exceeding the MAC. These water sources also contain Boron (B) and Nitrate (NO₃) pollution in mean concentrations of 2,358 mg/L and 70 mg/L, respectively. The flow rates in these water sources vary between 3-43 L/sec. These water sources require treatment methods likely of low technology with a minimum need for the operation of the plants at rural areas. The aim of this study was to propose alternative technologies to remove As from water sources in small villages in Konya District, Turkey.

CONSTRUCTED WETLANDS AS SMART COMBINATIONS OF WATER TREATMENT AND ENERGY GENERATION

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Keywords: Biogas production, constructed wetlands, microbial fuel cell, direct combustion, harvesting

Abstract

Constructed wetlands are developed into a secure wastewater treatment technology for domestic, agricultural and industrial wastewater as well as for runoff waters. Microorganisms play the main role in pollutant and nutrient removal. Microbial activity and abundance is supported by plants due to provision of habitats, oxygen and carbon sources. As the storage of nutrients within plant tissue is not permanent, the aboveground plant biomass needs to be harvested to ensure that nutrients stored within plant tissue are removed from the system. Harvested plants can directly be re-used as compost or animal fodder. Alternatively, the biomass can be utilized for energy generation both through direct combustion and biogas production. Direct combustion has low infrastructure costs and a low level of experience necessary to operate and maintain the system. While biogas production the harvested biomass is converted to methane in an anaerobic reactor. The biogas production requires more coordination and complexity and has a higher need of infrastructure, training, operation and maintenance. Energy generation is also possible with the installation of microbial fuel cells (MFC) within constructed wetlands. COD removal efficiency could be improved by including the MFC component in constructed wetlands. On the other hand, power generation with MFC could be improved by constructed wetland plants. So far, the current power generated by MFC systems in constructed wetlands is not competitive in terms of cost-effective energy generation. Most of the reported constructed wetland-MFC systems have been designed and operated at laboratory scale, and their implementation as a suitable real-scale system is still in development. In order to forecast the effects of harvesting securely, further research needs to be done with variation in plant species, harvesting times and harvesting intervals.

ASSESSING THE POTENTIAL OF USING SOLAR PHOTOVOLTAIC PUMPING IN IRRIGATION: CASE OF THE TADLA REGION IN MOROCCO

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Keywords: Solar Pumping, Potential Assessment, Financial Analysis, Tadla Region

Abstract

The purpose of this work is to develop a methodology of quantitatively assessing the potential of using solar pumps in agricultural irrigation in a given region. The approach includes an evaluation of the environmental impacts of using solar pumping in terms of the reduction in CO₂ emissions and the increase of the water consumption. A financial analysis is also carried out in order to determine the important savings in terms of public energy subsidies resulting from the use of solar energy instead of diesel, butane or electricity generated from fossil fuels. The application of this methodology to the agriculture in the Tadla Region in Morocco shows that more than 35,000 solar pumps with power ratings range from 0.341 to 80 kW can be installed. The financial analysis shows that public subsidy of solar pumping instead of butane is very profitable to the country as the pay-back period varies between three to five years. In addition, the amount of CO₂ emission avoided is 0.5 megatons. The much-feared impact of an overexploitation of the water resources was found to be limited due to the high initial cost of oversized solar systems and by the tendency to combine water saving drip irrigation with solar pumping.

INTEGRATION OF SOLAR ENERGY, DESALINATION AND AGRICULTURAL GREENHOUSES

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Keywords: Solar energy, agricultural greenhouses, desalination

Abstract

Egypt's natural water resources are limited and the annual per-capita is around 550 m³ as compared with the UN standard average of 1000 m³. The water shortage will be worsened after Ethiopian Dam is constructed on the Blue Nile (that provides 85% of Egypt's Nile water). Additionally, agriculture is the most water consuming activity in Egypt (70-80%) as well as in the world. Moreover, most of Egypt's area (94%) is desert, where saline brackish water is only found. Desalination of saline water is, therefore, considered as a strategic alternative water resources and technology to be adopted in Egypt. On the other hand, open field agriculture in such conditions is not economical particularly with high ambient temperature and solar intensity. Agricultural Greenhouses (GHs) present a suitable alternative for different plants growth for Egypt's desert. With the available high solar energy, integration of solar-GHs-desalination presents a real challenge and is the field of this paper. This paper outlines the integration of solar energy, agricultural GHs and suitable desalination processes. It summarizes the author's different R&D projects targeting the development, manufacturing and pilot testing of a novel stand-alone solar energy driven agricultural GHs-desalination system in Egypt. The new integrated system should be (1) standalone and grow its energy and irrigation water demand, i.e., be self-sufficient of energy and irrigating water, (2) have suitable micro climatic conditions for different plants in order to be a provider of the basic food needs for small community living in remote areas, and (3) a mean of creating jobs and business opportunities. All these aspects will be presented.

KINETIC STUDY FOR NITRATE REMOVAL BY NANO ZERO-VALENT IRON

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Keywords: Adsorption, Nanoparticle, Nitrate pollution, nZVI, Pseudo kinetic modeling

Abstract

In recent years, nitrate pollution has increased due to the contamination of water resources with untreated wastewater and the unconscious overuse of nitrogenous fertilizers in agriculture. High amounts of nitrate in drinking water lead to serious health problems especially in pregnancies and infants through the blue baby syndrome. In order to remove nitrate, physicochemical processes are mostly applied with high efficiency. In this study, nano-zero valent iron (nZVI) was synthesized for nitrate removal by investigating the application of well-studied adsorption kinetics. The effect of initial nitrate concentration, nZVI concentration, pH and reaction time were investigated. Removal efficiency was found higher than 85%, when 200 mg/L nZVI was applied for water samples containing 100 mg/L nitrate after 30 min reaction time. In cases, where the initial nitrate concentration is lower, the reduction rate was higher than 95%. Kinetic model showed that the reduction fits the pseudo second order, and this resulted not only from adsorption but also from oxidation mechanism in the removal.

IMPACTS OF UNOFFICIAL WATER REUSE IN EDKO DRAIN CATCHMENT WESTERN NILE DELTA

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Keywords: Edko Drain, SIWARE, Water Scarcity, Western Nile Delta, Water management.

Abstract

Water resources management in arid regions such as Egypt is a continuous process for achievement of rational use of the scarce water resources for the benefit of the national economy. Water scarcity in Egypt is a major challenge, which is annually increasing due to the high water demand of different sectors, while the share of Egypt from Nile is fixed at 55.5 billion cubic meter (BCM). Non-conventional water resources, such as drainage water reuse, are essential alternatives to improve the water use efficiency. In Nile Delta, a considerable number of reuse pump stations (RPSs) are distributed along the drains network already decades ago. But farmers are unofficially using small pumps to divert drainage water directly to their fields. The major concern in the reuse of agricultural drainage water is the build-up of salts. This research aims to assess the impacts of the unofficial water reuse on the drainage catchment level for the evapotranspiration, soil salinity and crop yield. The study area of Zarqun and Shubrakhit is a part of the drainage catchment of Edko Drain, Western Nile Delta. The water allocation of the study area were simulated by SIWARE Model to assess the current water uses and soil conditions, while the results are visualized using Geographical Information System (GIS) as an essential tool for decision support system. The simulation results indicated that the study area suffers from a water stress by about 0.8 (water use index WUI = 0.8) that forces the farmers to unofficially reuse the drainage water. Electrical Conductivity (EC) of the unofficially reused water ranges between (2 and 3.5 ds/m) that gives restrictions on the crop pattern, causes hygienic risks, and increases the pollution in the shallow aquifer.

STUDY OF PHYSICOCHEMICAL PARAMETERS OF GROUNDWATER IN MOHAMMEDIA REGION, MOROCCO, FOR USE IN AGRICULTURE

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Keywords: Irrigation, discharge, groundwater quality, physicochemical parameters

Abstract

Water resources are threatened today by pollution that comes from domestic, industrial and agricultural discharges without prior treatment. This pollution causes deterioration of water quality. The superficial pollutants can infiltrate through ground towards the aquifers. The goal of this investigation was to evaluate and to control the physicochemical quality of groundwater to protect human health and environment. The quality of 12 groundwater wells in Chaâba El Hamra region of Mohammedia, Morocco was evaluated by analyzing the physicochemical parameters in the laboratory in Rabat. These parameters were pH, T, O₂, EC, Ca²⁺, Mg²⁺, Na⁺, K⁺, Cl⁻, NO₃⁻, NO₂⁻, CO₃²⁻ and HCO₃⁻. Obtained results were compared with irrigation standards of Morocco and WHO. The analytical results showed that the concentrations of the parameters considered (main pollutants and pollution indicators) are at average levels. The sodium adsorption ratio (SAR) has shown that the groundwater might cause soil salinization when used for irrigation in this area.

FLOOD RISK ASSESSMENT FOR SUSTAINABLE RENEWABLE ENERGY GENERATION

CASE STUDY: EGYPT'S RED SEA COAST

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Keywords: Egypt, flood risk assessment, multi criteria analysis, MCA, renewable energy

Abstract

Egypt is looking into the possibilities of expanding its development opportunities throughout the country. The main goals for expanding is providing a sufficient clean power supply, especially in rich and diverse ecosystems such as the Red Sea Governorate. For that end, the Governorate of Red Sea must have room to “invent a new model” for development, yet protecting the local environment as well as to reduce the Carbon Footprint. This is especially important since the conventional sources of energy are responsible for a wide range of environmental problems. Pollutant emissions may cause smog on the local level, acid rain on the regional level and a greenhouse effect on the global scale. For example, there is an extensive ongoing demand for desalinated water to meet the needs of the population and the industries along the Red Sea. Furthermore, stakeholders rush to coastal areas in pursuit of beautiful scenery and exquisite waters/location disregarding the potential hazards imposed by flash floods. In the current study, by means of a digital elevation model (DEM) implemented into a Geographic Information System environment (GIS), the entire coastline of the Red Sea was subjected to a multi-criteria analysis (MCA) process to calculate a morphological risk factor. The resulting risk maps were used to select a region of high wind potential and conduct a 2D model to locate the best possible position for wind turbines. Thus, the risk factor map could facilitate the identification of appropriate measures to mitigate probable hazards in area with prioritization to the critical regions.

WATER USES AND PRODUCTIVITY IN CROP/LIVESTOCK FARMS IN A SEMI-ARID REGION

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Keywords: Climate uncertainty, crop/livestock farms, profitability, semi-arid areas, water productivity

Abstract

The water productivity concept has recently been promoted to assess *in situ* water uses by farming activities. In the present study, the main assumption is that in crop/livestock farms, diverse sources of water (rainfall, surface water and/or groundwater as well as virtual water, i.e., purchases of goods that have needed water elsewhere) are used by farmers to achieve their production goals. This is particularly true in Mediterranean semi-arid areas, where rainfall is limited (less than 600 mm/year) with a long dry season imposing irrigation for several crops, particularly during the hot summer days, where temperatures may reach 45°C. As a consequence, groundwater depletion risks may be exacerbated and that could hinder the objectives of increasing the agricultural output. A study was, therefore, conducted in the Saïss Plain (North East Morocco) in four farms to establish references with regards to water volumes used, their origin and the profitability they allow. The research necessitated a farm follow-up protocol with monthly visits to get reliable data about water and inputs' uses as well as products' sales. The results clearly demonstrate that orchards and summer vegetables contribute to groundwater depletion. Fruit trees allow a significant increase in water economic profitability, but vegetables' one is more erratic, due to crops' variable yields coupled to farm gate prices volatility. At the opposite, autumn cereals and pulses as well as livestock products depend almost entirely on rainfall, but their water economic productivity is rather limited. Altogether, the results imply that in semi-arid areas, additional attention should be devoted to the sustainability of water uses, and the integration of water of several origins is urgently needed, with a priority to rainfall in the water mix. This might allow increasing the resilience of farming systems in front of climate and market uncertainties.

ASSESSMENT OF WATER MANAGEMENT IN IRRIGATION APPLICATIONS IN THE KARAPINAR BASIN, KONYA, TURKEY

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Keywords: Crop pattern, Global warming, Karapınar Basin, Renewable energy, Water management

Abstract

Global warming, population increase and environmental pollution have adversely affected water resources in many countries and in Turkey as well. Due to strong relationship between sustainable water management and economic development, sustainable use of irrigation water has high priority for agriculture in semi-arid and arid regions. Karapınar Basin in Konya District is one of the driest regions in Turkey having an arid climate, and shows desertification tendency through wind erosion. Therefore, Karapınar Basin is at the forefront of the risky areas that are listed in the “desertification risk map” of Turkey as “highly risky area”. Current agricultural activities have resulted in excess water uses with almost 90% of total water consumption in Karapınar. Available data are collected from national agencies and sources, and are evaluated. This study aims to discuss the effects of crop pattern on water consumption in agriculture in the Konya-Cumra-Karapınar Basin. A new crop pattern project will be introduced in order to decrease the water demand. Due to the important role of renewable energy on mitigating global warming and climate change, current efforts on introducing the solar energy in the basin will be shown as well.

C/N RATIO MAPPING USING GEOSTATISTICS FOR VARIABLE RATE TECHNOLOGY APPLICATION IN EGYPT

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Keywords: C/N Ratio, Management Zones, Ordinary Kriging, Egypt

Abstract

Recognition of spatial distribution of Carbon to Nitrogen (C/N) ratio is essential to know where and how much organic matter and/or nitrogen fertilization should be added to soil. The objective of this study is to delineate the field in different zones according to the C/N ratio. To achieve this objective, 61 soil samples were collected from a 2.8 ha field located in Belbies directorate, Sharkia Governorate, Egypt. Soil samples were then subjected to total nitrogen (TN) and organic carbon (OC) analysis. Ordinary kriging was applied successfully to develop spatial maps for TN and OC. The spatial map of OC was divided by the spatial map of TN to obtain a final spatial map of C/N ratio that was delineated into 3 classes. Results showed three delineated management zones named as low, medium and high with C/N ratio values of 9.8, 12.05 and 14.48, respectively. A prescription map was developed to adjust the C/N ratio to reach a value around 8:1 to improve soil biological activity.

INTERNET OF THINGS AND CLOUD COMPUTING FOR SMART PRECISION AGRICULTURE

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Keywords: Internet-of-Things, cloud computing, big-data analysis, mobile computing, sensors

Abstract

This paper presents a state-of-the-art survey of research literature on how emerging technologies are used to solve agricultural problems, especially related to precision agriculture (PA). A proximal sensing allows measuring many soil and plant properties *in situ*. These include portable X-ray, spectroscopy, digital camera, smartphone, and multi-stripe laser triangulation scanning. Smart sensors for soil, water and crops utilizing new technologies are applied to increase the efficiency of agriculture, enabling agricultural users to reduce and to save the input farming cost, to manage the agricultural resources in smart ways, and to gain higher productivity and profit. Field estimation of soil-plant analyses is possible and can be evaluated with accuracy levels suitable for soil and plant monitoring requirements. This paper also proposes a smart-based PA system based on key technologies: Internet-of-Things (IoT), cloud-computing, smartphone-computing, and proximal sensors. Environmental sensors have been used in applications as per the need to build smart PA. The Cloud is a collection of platforms and infrastructures, on which data are stored and processed, allowing farmers to retrieve and to upload their data for a specific mobile application at any location with Internet access. Combining the Cloud, IoT and sensors is vital so that the sensing data can be stored or processed. The proposed system consists of the sensor, the transmission, the Cloud services, and the application layers. Finally, advantages and the possible limitations of the system are discussed.

BIO-TREATMENT EFFICIENCY OF DIFFERENT WASTEWATER SOURCES AND ITS POTENTIAL APPLICATION ON HEAVY METAL REDUCTION AND FOOD PRODUCTION

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Keywords: Wastewater, moringa seed extract, water quality, heavy metals, potato

Abstract

Moringa is a multipurpose tree with considerable economic and social potential and its cultivation is currently being actively promoted in many developing countries. Seeds of this tropical tree contain water-soluble, positively charged proteins that act as an effective coagulant for water and wastewater treatment. The powdered seed of the Moringa has coagulating properties that have been used for various aspects of water treatment such as for reducing the turbidity, alkalinity, total dissolved solids, and hardness as well as for the removal of toxic metals. A pot experiment was carried out on potato tubers (*Solanum tuberosum* cv. Diamant) for the growing season 2017 to study the effects on different water sources, e.g., well water (WW), drain water (DW), sewage water (SW) and groundwater (GW) with or without moringa seed extract (MSE) on reducing water and soils contaminants and its effect on yield and heavy metal accumulation. Results showed that the lowest values of SSP, SAR, SCAR, RSC, RSBC, PI, PS, KR and MAR were observed in DW, followed by GW, SW and WW after treatment with MSE. MSE coagulant has better coagulation capability to reduce heavy metals compared with untreated water. Application of MSE to different water sources increased fresh tubers yield, dry yield, N,P,K uptake of tubers potato compared to with the untreated waters. Addition of MSE to different water sources gave a significant decrease of Pb, Cd, Ni, Fe, Cu, Zn and Mn accumulation of tubers potato plants compared with untreated water. Overall, MSE was a good measure to improve the water quality and to remove heavy metals from different water sources, tubers potato and soil under study.

GREY WATER MANAGEMENT IN JORDAN: TECHNOLOGY AND FUTURE PERSPECTIVES

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Keywords: Domestic wastewater, ecological sanitation, grey water, recycling, yellow water

Abstract

Grey water (GW) is the water collected separately from sewage flow that originates from clothes washing, showers and sinks, but does not include toilets and in certain cases kitchen sinks. Resource recovery and conservation of resources have been attracting increasing attention in the recent years for finding sustainable solutions to environmental problems. One of such efforts is segregation of domestic wastewater streams as grey, yellow, and brown or black water. This paper focuses on grey water reuse as opposed to reuse after conventional combined collection, and the use of plant nutrients in yellow water as an alternative source of fertilizers. Three different treatment options were selected and discussed in this article. The examined treatment systems are a 2-Barrel System, a 4-Barrel System, and a Confined Trench System. The following recommendations can be made regarding the appropriateness of GW reuse technologies: The scheme or technology should be a felt priority in public or environmental health, and both centralized and de-centralized technologies should be considered. The technology should be of low-cost and require low energy input and mechanization, which reduces the risk of malfunction. The technology should be simple to operate, local labor intensive, and maintained by the community not relying on expensive chemical inputs, such as chlorine or ozone in order to meet quality guidelines. The treatment should be capable of being incrementally upgraded as user demand or quality standards and treatment guidelines increase.

AGRICULTURAL WATER RESOURCES MANAGEMENT ENVIRONMENTAL AND FINANCIAL EVALUATION – A CASE STUDY

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Keywords: Agricultural water use, irrigation methods, irrigation costs, investment costs, nutrient losses

Abstract

About 70% of all freshwater resources in the world are used in irrigation. This rate may vary depending on various factors such as the level of development of the countries, water availability of the land, water budget, plant variety, parcel sizes of the irrigated land, etc. This rate is 74% in Turkey. This ratio is quite high compared with other sectors. It is possible that this ratio is lowered by the right management of the water. Surface irrigation is the most widely used method in Turkey. This is an important reason for overuse of water. Excessive water use causes pesticide and fertilizer to be introduced rapidly into surface and groundwater. On the other hand, the productive surface soil is also exposed to erosion. For these reasons, it is important to develop irrigation investments rapidly in favor of pressurized irrigation systems.

URBAN SPRAWLING IN EGYPT AND ITS IMPACT ON LAND USE REFORM

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Keywords: Agricultural reform, informal settlement, land use change, urban sprawl, sustainable development

Abstract

The land use in Egypt had been dramatically changed over the last sixty years due to various reasons. One of the main drivers of this change was the agricultural land reform law in September 1952, in addition to the high population growth rate and consequently high urbanization. In old cities, most of urban land was expanded and encroached upon arable areas. In this study, examples of urban sprawl on arable agricultural lands will be explored to analyze the effects, causes and negative impacts. The period from 1960 to 2018 will be analyzed to identify the different economic, political and social factors that led to increase this negative phenomenon. The impacts on water, wastewater, and food security will be discussed. Using the satellite images from different dates, the percentage of urban expansion and decrease of agricultural lands is estimated. The results show that among the new urban land, about 70% was converted from arable land to urban settlement in greater Cairo. Unfortunately, the urban sprawl had not been associated with adequate infrastructure development to serve these new communities, as a big portion was referred to be informal settlements. Different environmental problems appear in these new urban lands, i.e., water quality, wastewater, air pollution, lack of energy and solid waste management. Different sustainable development procedures and environmental planning concepts are suggested to mitigate the negative impacts. The concepts related to sustainable urban reforms include mixed land uses, renewable energy, effective water management, and appropriate managerial policies will be also described in this paper.

UTILIZATION OF UNUSED WASTEWATER FOR FODDER PRODUCTION IN JORDAN

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Keywords: Heavy Metals, Isotopes, Jordan, Mining Wastewater, Jordan

Abstract

24 effluents and 10 groundwater samples in addition to the effluents produced by the washing process at the Al-Hisa and Al-Abyad phosphate mines in Central Jordan were investigated for major ion composition, heavy metals and isotopes contents. There was a significant difference in water chemistry between input (groundwater) and output (effluent water), but although the investigated area is highly fractured, the analytical results of stable isotopes indicated little or no mixing between the effluent water and groundwater in the area. This is attributed to the precipitation of clay-sized particles along the drainage channel. The effluent water from the two mines was found to be relatively low in sodium contents and radiation strength, and suitable for irrigation of salt tolerant plants. A pilot study was conducted at the Al-Abyad area near close to the phosphate mining in Jordan. 6 plots of 50 m² each were planted with two types of plant species (*Zea mays spp.* and *Medicago lupulina spp.*) and irrigated using 3 types of water (fresh groundwater, mine wastewater, and hybrid water consisting of 50% fresh water and 50% mining wastewater) in order to investigate the suitability of utilizing mining wastewater for food production in the area. Plots irrigated with mining wastewater showed slightly higher heavy metals concentrations and soil salinity than plots irrigated with fresh and hybrid water. Crop yields was estimated at the end of the experiments and showed that the yield from *Zea mays* plots was higher yield than the *Medicago lupulina* plots and the yields were inversely proportional to salinity as an increase of salinity by 2-folds resulted in reducing the yields by almost 50%. However, no risk of heavy metals contamination was found in plants and soil.

WATER FOOTPRINT OF SUGARCANE CROP IN EGYPT

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Keywords: Water Footprint, green water, blue water, grey water, sugarcane

Abstract

Water footprint (WF) accounting as proposed by the Water Footprint Network (WFN) can potentially provide important information for water resource management, especially in water scarce countries relying on irrigation to help meet their food requirements. The agricultural water footprint addresses the quantification of water consumption in agriculture, whereby three types of water to grow crops are considered, namely green water (consumed rainfall), blue water (irrigation from surface or groundwater) and grey water (water needed to dilute pollutants). In this paper, water footprint resulting from sugarcane cultivation is calculated, including water footprint from green, blue and grey water. The cultivation area was the Upper Egypt zone comprising five governorates (Menya, Suhag, Qena, Luxor and Aswan). The highest value of water footprint of sugarcane 226 m³/t was found in Aswan governorate and the lowest 211 m³/t in Minay governorate. The average water footprint of sugarcane for the five governorates was 217 m³/t. The blue water footprint percentage was 81%, while the grey water footprint was 19% from total water footprint. The green water footprint was nearly zero because of the small amount monthly rainfall being negligible.

ENERGY FOR WATER IN JORDAN'S WATER SECTOR

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Keywords: Hydropower, energy sector, water sector, water energy nexus, Jordan

Abstract

The severe water shortage in Jordan is coupled with a severe shortage in the energy resources, as evidenced by the fact that Jordan imports more than 97% of its energy demand in the form of crude oil. The water sector in Jordan consumes about 15% of Jordan's total energy demand, which raises concerns about its sustainability and brings the need to review its energy demand thoroughly, for the objective of making it more energy efficient and environmentally friendly. This paper looks into the energy consumption in Jordan's water sector, which includes drinking water supply pumping, treatment and distribution, and wastewater collection and treatment. The paper further investigates renewable energy opportunities in Jordan's water sector and looks into their feasibility. The results showed that opportunities do exist to make the water sector in Jordan more sustainable and environmentally friendly by improving its energy efficiency and reducing its dependability on conventional energy resources through increasing the share of renewable energy resources in the energy mix, i.e., hydraulic, solar, wind and bio energy. In addition, increasing the share of renewable energy resources in the energy mix will result in a more environmentally friendly water sector by reducing the carbon dioxide emissions into the atmosphere.

WASTEWATER/WASTE TO ENERGY IN MENA REGION A REVIEW OF OPPORTUNITIES

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Keywords: Wastewater, bioremediations, MFCs, solid waste, renewable energy, MENA region

Abstract

Unconventional renewable energy sources have been extensively investigated due to the environmental concerns caused by the employment of fossil oils and gases. MENA countries are in need to strategically developing diverse renewable and other domestic energy resources as part of a robust energy portfolio for the long term. Population growth, urbanization and economic prosperity in MENA region has accelerated consumption rates and increased the rate of waste production of all kinds. The aim of this paper is to present an overview of MENA's wastewater/waste to energy technologies and their current status as well as the opportunities for generating energy and water resource alternatives from municipal solid waste and wastewater in the region with the hypothesis that to date the research in this area has been somewhat disjointed. For the purpose of rising up the human and environmental security in MENA region (control risk) by highlighting management structures and strategies, it is essential to consider Waste to Energy (WtE) as a sustainable waste management strategy and cost-effective fuel source for the future. Moreover, plastic waste has high energy content with an incredible potential to use technologies like gasification for converting these materials into fuels, base chemicals, and other products. On the other side, the most promising sustainable methods for wastewater treatment are anaerobic techniques resulting in bio-methane gas production, biological wastewater treatment for hydrogen production, and biological treatment for power generation through the use of Microbial Fuel Cells (MFCs).

A REVIEW ON SMART CITY CONCEPT AND SMART WATER MANAGEMENT

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Keywords: Information and communication technologies, ICT, smart cities, smart water management, urban water systems

Abstract

It is estimated that 67% of the world's population are going to live in cities by 2050. Therefore, sustainable management of cities are crucial. Recently, information and communication technologies (ICTs) play an important role in everyday life of many people. A new concept, called smart city, has attracted a worldwide attention for sustainable management via integration of ICTs, which are helpful tools for improving sustainability. Urban water cycle, which is under pressure due to climate change and urbanization, plays an integral part of daily life. Sustainable management of water resources is one of the most important issues around the world, especially in countries suffering from water scarcity. Smart water management (SWM) aims to overcome challenges in the water sector by promoting the coordinated development and management of water via integration of ICT tools. Integration of ICTs into SWM can be adapted to continuously monitor and to diagnose problems, to prioritize and to manage maintenance issues, and to use data for optimizing all aspects of urban water systems. This study aims to provide brief information about smart cities and the emerging concept of smart water management for enhancing resilience and improving sustainability of urban water systems.

LAKE MANAGEMENT UNDER THE STRESS OF CLIMATE CHANGE AND AGRICULTURAL WATER USE: BEYŞEHİR LAKE, TURKEY

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Keywords: Beysehir Lake, optimization, GAMS, lake management, lake modelling

Abstract

Effective and sustainable management of available water resources has great importance by considering the current increasing trend in world population and consequent decreasing trend in fresh water resources. It is possible to estimate the stresses on water resources due to some factors such as current population growth ratio and variations of water consumption habits. Turkey has to protect and to manage effectively and sustainably its limited water resources to be able to leave them to its future generations as healthy and sufficient as possible. This study is aimed to develop climate dependent optimum dynamic management model of Lake Beyşehir, which is one of the most important and yet the largest fresh water lakes of Turkey. The concept of optimum dynamic model refers to the determination of minimum allowable water surface elevation of lake management by using climate data, hydrometric data and groundwater elevation of the lake basin. Optimization model is developed by using GAMS (General Algebraic Modeling System) software. Daily evapotranspiration is calculated by using Penman-Monteith method, which is suggested by FAO (United Nations Food and Agriculture Organization). Crop-water requirement is calculated by Blaney-Criddle method, which is widely used by agricultural engineers. Groundwater levels are obtained from the regional ground water flow model of the lake, which was generated with MODFLOW software.