

# Proceedings of the Expert Workshop Water Challenges in MENA Region 2016-2050

Editors: Arwa Hamaideh, Anwar Jiries, Bülent Topkaya

April 24-29, 2016 - Aqaba, Jordan



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Middle East and North Africa Region (MENA) is one of the water scarcest regions on earth. There, lack of water resources is common, and water scarcity has become an increasing constraint to their economic development, particularly of the agriculture, which is the biggest water consumer. Many countries in this region have been exploiting their non-renewable fossil water resources in order to relieve the acute pressure of water stress, depleting their resource base, and undermining their long-term economic development and food security, with additional consequences for human health and the environment. Disputes over water lead to tension within communities, and unreliable water services are prompting people to migrate in search for better living conditions. Water investments absorb large amounts of public funds, which could often be used more efficiently elsewhere. These challenges appear likely to escalate.

Besides the availability of water, the efficiency of usage, e.g. in the agriculture, the suitability of plants cultivated, the yield values, etc. plays also an important role in decision making processes. As the region's population continues to grow, water availability per capita is set to fall by 50% by 2050, and most of the countries in the region are going to face with "absolute water scarcity".

The expert workshop aimed at evaluating the options for coping with water scarcity through assessing the water demand and supply up to the year 2050, thereby considering issues like climate change, population growth, and economic development.

Editors

Prof. Dr. Arwa Hamaneh, Prof. Dr. Anwar Jiries, Prof. Dr. Bülent Topkaya



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**Water Challenges in MENA Region 2016-2050**

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## PREFACE

Middle East and North Africa (MENA) Region is part of Exceed-Swindon Project. The partner countries, namely Turkey, Jordan, Egypt, Tunisia and Morocco, are located at eastern as well as the southern part of the Mediterranean Sea. Countries in the region have some common characteristics: Water scarcity, high rate of population increase, dependence on food imports, and potentially high impact of climate change. More than 75% of the scarce water resources is allocated to agriculture, which in turn contributes to 10-15% of the overall GDP of the countries. It did, however, account for approximately 50% of overall employment.

It is estimated that the total population of the region will increase to more than 450 million in 2025. This issue will bring the average amount of water per capita in the region to far below the scarcity level. At same time, the region is the biggest food importing one. It accounts for some 15-20% of total global food imports. The region is not capable to feed itself, but relies on food imports. In order to increase the own food production, irrigation is needed, which will help to increase agricultural yields and to stabilize food production and prices.

On the other hand, there is no new water for irrigation and, with time, rainfall is expected to decrease in the region. This decline in rainfall, along with the increase in evaporation, will lead to more aridity. Even with the current situation of water and arable land scarcity, the warming scenarios, whether by 2 or 4 °C would exert more pressure on water resources and agriculture, and will likely lead to increased migration and risks of regional and international conflicts.

Consequently, any agricultural expansion must come parallel with water savings and increasing efficiency. Achieving *“more crop per drop”* is one of the main challenges of the MENA region within the coming decades.

This workshop, organized in Aqaba, with an arid hinterland, provided the best place for discussing the *“water challenges”*. 30 participants from all partner institutions participated at this Regional Expert Workshop, presented their know-how and experiences in the field of sustainable water management on water management, best practices, wastewater reuse, impacts of climate change, among others. This proceedings book brings twelve papers selected out of eighteen presented in workshop.

We hope and we are confident that the readers will gain benefit from reading these papers.

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# INTRODUCTION TO EXCEED SWINDON PROJECT AND FUTURE ASPECTS

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**Keywords:** Developing Countries, Exceed Network, MDG, SDG, Sustainable Water Management

## **Abstract**

Water is among the 21<sup>st</sup> century's key development issues. The Project Exceed of Braunschweig University addressed the Millennium Development Goals MDG 7/C "*Ensure Environmental Sustainability*". Based on the world-wide network of 35 partner universities in 18 countries on 4 continents, this Excellence Centre focused on capacity building in developing countries through training and networking. To achieve these goals, the existing study programs at partner universities related to Sustainable Water Management SWM were analyzed and upgraded; new courses initiated for further education of scientific and technical staff at universities, enterprises, and public authorities. Summer schools, international workshops, and expert seminars as well as an intense exchange of students, young scientists, and academic teachers in all directions south-north, north-south, and south-south were organized for capacity building. After five years of successful performance 2009-2014 this project was extended for another five years until 2019 as Exceed Swindon Project for meeting the Sustainable Development Goals SDG 6 "*Ensure availability and sustainable management of water and sanitation for all*", establishing a self-sustaining network of excellence on SWM and linking university members with stakeholders from public administrations, NGOs, and industrial partners.

# IMPACT OF CLIMATE CHANGE AND SEA LEVEL RISE ON GROUNDWATER QUALITY AND QUANTITY IN COASTAL AQUIFERS

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**Keywords:** Climate change, Nile Delta aquifer, sea level rise, seawater intrusion, SEAWAT

## **Abstract**

Climate change and sea level rise presents enormous challenges for water resources management in coastal areas. Sea level rise could have many effects on coastal areas in the long term, including increase of coastal erosion, submergence of shore cities which in turn would result in migration of people, saltwater intrusion, loss of agricultural land, and rise in coastal groundwater table. Increasing abstraction is considered the main cause of seawater intrusion. Also, the rise in sea level accelerates seawater intrusion. This paper presents a numerical study using SEAWAT code to investigate seawater intrusion in the Nile Delta aquifer under the effect of likely sea level rise. In this study, two scenarios of sea level rise are considered: 50 cm and 100 cm. The results showed that the rise of the sea level has a significant effect on the position of the transition zone. Sea level rise of 100 cm gave extreme intrusion of saline water as equiconcentration line 35 and 1 reached 67.75 and 97 km. Compared to the current situation as equiconcentration line 35 and 1 reached 63.75 and 93.75 km. The transition zone moved inland 4.0 km. The Nile Delta aquifer is vulnerable to sea level rise and, therefore, protection from seawater intrusion is crucial.

# WATER POLLUTION CHALLENGE AND ITS IMPACT ON EGYPT'S LIFE AN OVERVIEW

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**Keywords:** aquatic toxicity, bioaccumulation, biotransformation, carcinogenicity, heavy metals, mutagenicity, pesticides, water pollution

## Abstract

Water is the base of life and one of the most important resources for economic and sustainable development. Water quality is a big challenge for water resources management. Egypt shares most of the environmental challenges of developing countries, and the future looks miserable if the country does not succeed in framing and implementing water resources management approach, which can match the limited freshwater supply with the increasing demand. If the water quality degrades, so does the health and economy as well. In Egypt, untreated sewages of more than 355 factories are discharged directly into the Nile River and the Mediterranean Sea. Moreover, the Nile River and its waterways currently suffer from discharge of polluted agricultural drainage, of oil and grease originating from navigation and of untreated domestic wastewater from urban areas. Some groups of chemicals like neurotoxins, carcinogenic and mutagenic compounds are often resistant to common treatment methods of wastewater. The danger imposed by chemical discharges involves contamination of drinking water, hazards to agriculture as well as to fisheries, phytotoxicity, aquatic toxicity, bioaccumulation, and biotransformation. Water pollution and the man-made causes of this challenge in Egypt are the main objectives of this overview.

# EGYPTIAN STRATEGY FOR UNCONVENTIONAL WATER RESOURCES 2015-2030

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**Keywords:** Groundwater, Nilotic countries, water management, water reuse, water quality

## **Abstract**

In light of the scarcity of fresh water available in Egypt and its decreasing amount per capita is reaching almost the water poverty. Egypt developed a strategic plan to face these challenges. With the assigned share of Egypt from the Nile River (55.5 billion cubic meters) that is even now threaten to be reduced due to the current developments at Ethiopia; the Egyptian government is compelled to find new unconventional water resources. A good management of water resources in Egypt raises the efficiency of the use, in addition to improving water quality. As the amount of sewage generated from sewage treatment plants (i.e., primary, secondary, or tertiary) is about seven billion cubic meters per year, equivalent to 8% of the annual quota of Egypt in the Nile waters. The main target of this strategy plan is to reduce water losses from some Nilotic countries and lakes management to increase water resources from Nile River. Optimizing the use of the different unconventional water resources, i.e., groundwater, floods, desalination, and reuse of wastewater will certainly help.

# INDUSTRIAL WASTEWATER RESOURCES IN JORDAN FOR THE PERIOD (1999 – 2006)

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**Keywords:** Climate change, hazardous pollutants, industrial estates, industrial wastewater,  
Jordan

## **Abstract**

Jordan is suffering from deep water shortage. Thus it is vital to exploit new water resources (e.g., seawater desalinization, Red Sea – Dead Sea channel, and deep aquifer exploitation). The industrial wastewater resources become important as Jordan has large industrial enterprises like phosphate, fertilizers, potash, and oil shale industries. They usually use large amount of fresh water from the priceless groundwater. In 2006, the industrial sector produced 38.5 million cubic meters (MCM) of wastewater, and it is expected to reach 300 MCM in 2022. Phosphate mines alone produced more than 10 MCM of wastewater annually. Although previous studies confirmed its applicability for agricultural uses and showed that it does not cause pollution to groundwater aquifers, however, this huge amount of wastewater was allowed to drain in the surrounding wadies. The amount of industrial wastewater is subject to increase due to the large-scale industries, which would produce huge amounts of wastewater. A growing share of industrial wastewater is coming from the effluents produced from the industrial estates; it is expected to reach up to 10 MCM annually in 2022. The pollutants available in this wastewater will dangerously affect the ecosystem components. Therefore, it is essential to optimize this industrial wastewater in order to decrease its environmental impact and to reuse them.

# KONYA PLAIN PROJECT (KOP)

## KONYA IRRIGATION, INDUSTRIAL AND DOMESTIC WATER PROJECTS

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**Key words:** Domestic Water, Industrial water, Irrigation water, KOP, Water transfer between basins.

### **Abstract**

The land surface area of Konya region is about 63,757 km<sup>2</sup> which is about 8% of the total surface area in Turkey. About 4% of national population lives in Konya region. Annual mean precipitation amounts in Konya closed basin is about 378 mm, while it is 643 mm for the whole country. The amount of land that is suitable for agriculture in Konya region is 2,754,243 ha, while the land area that could be irrigated is about 1,100,000 ha. About 835,000 ha of this land are irrigated at present. KOP Project is planned to be completed in 2020. When the project is completed, all of the 1,100,000 ha land will be irrigated. In the frame of the KOP Project, waters flowing to the Mediterranean Sea from upper Göksu basin will be diverted through Bağbaşı, Bozkır and Avşar dams together with Blue Tunnel to Konya closed basin. The mean annual water amount diverted from upper Göksu basin to Konya closed basin will be 414 million m<sup>3</sup> by this project. In this work, some important benefits providing components of KOP Project, which consist of 18 project bunch, about drinking water, industrial water and irrigation water are presented.

# ASSESSMENT OF SURFACE RUNOFF CHANGE DUE TO URBANIZATION GROWTH IN HELIOPOLIS BASIN

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**Keywords:** Arid Regions, Drainage, Heliopolis Basin, Remote Sensing, Urbanization

## **Abstract**

Due to continuous increase in population, many new communities have been established in Heliopolis basin, one of the main watersheds located east of Cairo. The main objective of the present study is to highlight and to analyze the change in surface runoff due to the change in land use in Heliopolis basin between years 1984 and 2009 using Landsat satellite data for the years 1984, 2006 and 2009 with the aid of Digital Elevation Models (DEM). The techniques utilized in this investigation involved a supervised classification of the Landsat images. Results showed that urban area located in Heliopolis basin has increased more than 30% during the last 30 years which led to a decrease in infiltration rates and an increase in surface runoff depth.

## DETERMINATION OF CURRENT USE AND REUSE POTENTIAL OF WATER RESOURCES IN BÜYÜK MENDERES WATERSHED

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**Keywords:** Wastewater Reuse, Watershed, Water Resources Planning

### Abstract

Growing needs for water due to rapid population growth, lack of appropriate sources, and developing industrial and agricultural activities result in over-exploitation, and pollution has become importance for water resources management, especially at the watershed level. For the integrated management of Turkey's watersheds, the "Project on Watershed Protection Action Plans" had been initiated by Ministry of Forestry and Water Affairs and conducted by the Environment and Cleaner Production Institute of Marmara Research Center, TUBİTAK. Within this Project, present situation of 25 watersheds in Turkey was determined in terms of water resources potential, point and non-point sources of pollution, and water quality. Later, short, medium and long term planning was made considering priorities, technological and economic feasibility, and sustainability. This paper summarizes one chapter of the project in Büyük Menderes Watershed. In this work package, water resources of Büyük Menderes watershed and the current use status of these are determined according to data obtained from General Directorate of State Hydraulic Works. Present data on potential of surface and groundwater resources, their usage purposes, and allowance of water resources and future planning were specified. Reuse potential of treated wastewater was evaluated. Water and Water Resources Planning Recommendations have been prepared.

# MODELING OF SALTWATER INTRUSION IN COASTAL AQUIFERS

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**Keywords:** Coastal aquifers, saltwater intrusion, seawater, simulation

## Abstract

Increasing population density and intensifying agricultural activities in coastal areas have intensified the groundwater pumping to meet water demands which, in turn, caused saltwater intrusion into groundwater. Salt water intrusion can be defined as the migration of saltwater into freshwater aquifers under the influence of groundwater development. Saltwater intrusion process is modeled using basic groundwater flow equations by incorporating variable density flow and transport theory. Saltwater in the transport equation can be treated as if a pollutant concentration that increases the density of water. Saltwater intrusion process can be simulated successfully to understand the effect of groundwater pumping, artificial recharge, land use changes, and climate change scenarios on coastal aquifers. It also helps to understand the mechanism of land–sea exchange, ecosystems' health, and climate-change-related processes in coastal environment. Generally, two different modeling approaches have been used in the literature to represent the freshwater – saltwater relationship, one of which is sharp interface approximation *and* the other approach is the transition zone between freshwater and seawater.

# STORMWATER RUNOFF QUALITY GENERATED FROM AN URBAN AND A RURAL AREA IN AMMAN-ZARQA BASIN

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**Keywords:** Amman-Zarqa basin, urban, rural, stormwater runoff quality

## Abstract

Six storm events were monitored during winter season extended from October 2012 to April 2013 to investigate the stormwater runoff pollutant concentrations on urban and rural sites in Amman-Zarqa basin. The average pollutant concentrations of stormwater runoff were significantly different from the urban and rural site. The results showed that the urban site generated stormwater runoff with the highest concentrations of organic pollutants COD and BOD<sub>5</sub> (1,685 mg/L and 91 mg/L), and dissolved heavy metals Zn, Cu, Pb and Mn (0.106 mg/L, 0.033 mg/L, 0.02 mg/L and 0.189 mg/L, respectively). This is mainly due to the high traffic volume at urban site compared with the rural site. While the rural site generated the highest concentrations of total suspended solids TSS (6,029 mg/L), nutrients T-N and T-P (31.2 mg/L and 34.3 mg/L) and fecal bacteria TCC, TFCC and *E. coli* (4.06E+07, 8.00E+05 and 1.31E+05 MPN/100 mL, respectively) carried by the stormwater runoff. This is reflecting the presence of anthropogenic pollution sources such as using chemical and nature fertilizers in rural site. The key constituents of runoff quality (COD, TSS, TKN, T-P, Zn and Pb) from both urban and rural sites are considered very high compared to those reported in other countries. This study has provided a better understanding of the concentrations and sources of stormwater runoff pollutants generated from urban and rural site which is posing a serious threat to water bodies within the Amman-Zarqa basin. Therefore, best management practices and proper land management measures should be taken to minimize the impacts of stormwater runoff.

## OCCURENCE AND FATE OF PHARMACEUTICALS IN KONYA WASTEWATER TREATMENT PLANT

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**Keywords:** Pharmaceuticals, wastewater, conventional treatment plant, ecotoxicological risk assessment.

### **Abstract**

The occurrence and removal of pharmaceuticals including antibiotics, analgesics, anti-inflammatory, beta-blockers, lipid regulators, psychiatry drugs, and cancer drugs were determined in Konya Municipal Wastewater Treatment Plant (WWTP). Risk assessment for pharmaceutical compounds determined in the WWTP outlet water was also carried out. Pharmaceuticals were extracted by solid phase extraction (SPE) and analyzed by HPLC/MS/MS. The hazard quotient (HQ) for each compound was calculated according to EU guidelines as the quotient between the measured environmental concentration (MEC) and the Predicted No Effect Concentrations (PNEC). PNEC values were derived from the available aquatic toxicity data using three different species (algae, crustacean and fish) from different trophic levels. ACETAM, NAPROX, IBUP and CLAR were the most frequently detected drugs. Concentrations of antibiotics, analgesics, anti-inflammatory, beta-blockers, lipid regulators, psychiatry drugs and cancer drugs were found between < dl and 2,211 ng/L, < dl and 2,220 ng/L, 12.3 and 4,335 ng/L, < dl and 362 ng/L, < dl and 1,121 ng/L, < dl and 178 ng/L, 0.03 and 2.8 ng/L, respectively. Detected concentrations of pharmaceuticals in the winter period were the highest, and in the summer period the lowest ones. The highest removal rates in WWTP were found for analgesics, while the lowest ones were observed for cancer and psychiatry drugs by conventional treatment. Removal rates of ACETAM, PRA, and AZI in advanced treatment were observed as 100%. A high and moderate risk was found for CLAR, AZI, CIPRO, DICLO, and IBUP in the effluent samples.

**TRAINING, EDUCATION AND CAPACITY BUILDING  
IN SUSTAINABLE SOLID WASTE MANAGEMENT  
TOWARDS WATER RESOURCES AND CLIMATE PROTECTION**

**Manal Ali, Andrea Pfeiffer, Peter Harborth, Klaus Fricke**

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**Keywords:** Capacity building, e-learning, sustainable waste management, technology transfer, training and education

**Abstract**

Poor solid waste management has serious impacts on water resources and climate change. However, the practice of solid waste management shows a vast gap between developed and developing countries. This emphasizes the importance of technology and knowhow transfer. Germany, as a leading country in solid waste technology, demonstrates a good example for sustainable solid waste management. It can be considered as a blueprint for countries with poor solid waste management. Besides, it can provide training and education in this field.

The Department of Waste and Resource Management at TU Braunschweig has a great professional competence and transnational training experience in sustainable waste management. One main focus of its work is to develop projects that enhance technology and knowhow transfer. The results and experiences obtained in these projects are integrated in a multilingual e-learning platform for training and education in waste management, which is being established now. Another focus is to prepare in short time proper solutions for acute conditions, where local authorities are overloaded. One example is the actual waste management in refugee camps and refugee hosting communities.