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# Water Perspectives in Emerging Countries

## Water Resources and Climate Change: Impacts, Mitigation and Adaptation

Abbas Al-Omari, Mehmet Emin Aydin (Eds.)

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Sustainable development in the already vulnerable MENA Region faces several challenges, among which is climate change. Though the MENA Region is not a main contributor to climate change, it is predicted that several vital sectors will be negatively impacted, which is a threat to the sustainability of its socio-economic development. Water availability in the MENA Region is expected to be negatively impacted by climate change due to the predicted reduction of rainfall and increased evaporation. In addition, domestic and agricultural demands for freshwater will dramatically increase due to the expected temperature rise, which will enlarge the already existing gap between supply and demand in several MENA countries. It is important to note that the negative impacts on water resources will directly translate to other sectors due to their strong connectivity with the water sector. These sectors are food security, health, ecology, environment, economy and social.

Predicted sea level rise due to melting of the poles is expected to result in land use change, which will in turn have severe social and economic consequences. Proper mitigation and adaptation options that take into consideration the multi-dimensional nature of the climate change impacts are imperative to conserve these sectors and to sustain the socio-economic development of the MENA Region.

The objective of this book is to provide readers with state-of-the-art knowledge of diverse experiences related to the possible climate change impacts, mitigation and adaptation options in the MENA Region, and to identify and to deliberate upon the research needs and concepts against the background of increasing threats to ecosystems, economy and human health.

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## **PREFACE**

Sustainable development in the already vulnerable MENA region faces serious challenges, among which is climate change. Though the MENA region is not a main contributor to Green House Gases' (GHG) emissions, the driver of climate change, it is projected that several vital sectors in the MENA region will be negatively impacted by climate change, which is a threat to the sustainability of its socio-economic development.

Water availability in the MENA region is predicted to be negatively impacted by climate change due to the projected reduction in rainfall and increased evapotranspiration as a consequence of temperature rise. In addition, domestic and agricultural demands will dramatically increase due to the projected temperature rise, which will enlarge the already existing gap between supply and demand in several MENA countries. It is important to note that the negative impacts on water resources will directly transfer to other sectors due to their strong mutual connectivity. These sectors are food security, health, ecology, environment, economy and social. Predicted sea level rise as a consequence of melting of the poles due to the forecasted temperature rise will result in land use change, which will in turn have severe social and economic consequences. Proper mitigation and adaptation options that take into consideration the multi-dimensional nature of the climate change impacts are a must to conserve these sectors and to sustain the socio-economic development in the MENA region.

This workshop in Amman, Jordan seeks to assemble professionals of multidisciplinary backgrounds and expertise over three days to present and to discuss their diverse experiences related to the possible climate change impacts, mitigation and adaptation options in the MENA region. This workshop is expected to strengthen the already existing professional connections among the EXCEED network partners in addition to establishing new professional connections with new participants from the region. The workshop intended to help the participants gain better understanding and share experiences related to climate change causes, impacts, mitigation measures and adaptation options. The newly gained knowledge and expertise will move downstream to the participants' students, research community and social community, which will help raise level of awareness about climate change and contribute to the adaptation efforts in the MENA region.

Prof. Dr. Abbas Al-Omari - The University of Jordan, Amman, Jordan

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## WATER RESOURCES IN MOROCCO AS IMPACTED BY CLIMATE CHANGE

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**Keywords:** Water resources, climate change, adaptation, irrigation, wastewater

### **Abstract**

Global warming is currently well established. The average rate of warming over the last 50 years ( $0.13 \pm 0.03$  °C per decade) is nearly twofold higher than that recorded over the last 100 years. Changes in temperature and precipitations have impacted the hydrologic processes and water resources availability for agriculture, for water relying activities and for population. The change in intensity and frequency of precipitations is behind frequent floods observed in different regions. The potential of water resources that remain available in Morocco is estimated at 22 BCM (Billion m<sup>3</sup>/yr.); 80% of it is provided by the north part of Morocco. The main part is provided as surface waters (16 BCM) regulated partly by 140 dams and 1,100 km pipes. In agriculture, the predicted increasing aridity will have negative effects on agricultural yields. Rain fed crops will be the most affected ones, such as cereals production accompanied by widespread land degradation, reduction of economic benefit, lower income of rural households, spread of poverty and increased rural to urban migration. The coastal zone in Morocco is also affected subsequent to accelerated sea level rise that leads to flooding, erosion of sandy beaches, and destruction of coastal wetlands. Water quality could be directly or indirectly affected through different biochemical processes. Furthermore, the specific effects will vary among different regions and types of water bodies. Different actions were taken at legislative and technical levels to cope with impact of climate change (CC). In agriculture, growers are encouraged to shift from traditional to drip by drip irrigation, to introduce resistant varieties of crops, to conduct direct seeding, to improve of storage capacity while building more big dams, protecting against flooding, transferring of raw water resources in the basins of the North to the South, desalinizing sea water. At institutional level, different national and international actions are taken.

## **IMPACTS OF CLIMATE CHANGE ON MOUHOUN RIVER IN BURKINA FASO: QUANTITATIVE AND QUALITATIVE ASPECTS**

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**Keywords:** Climate change, adaptation, water resources management

### **Abstract**

Water and climate change are regularly cited among the more dangerous crises that the world will face in the next ten years. Water is a central element, through which climate change will affect societies and ecosystems. Integrated Water Resources Management (IWRM) has been widely considered as the most effective approach for an efficient management of water resources and ecosystem goods. In Burkina Faso as many African countries, there is a low degree of the implementation of IWRM practices in order to optimize socio-economic and environmental benefits from ecosystem goods and its services in response to the effects of climate change. To aid in attainment of the Sustainable Development Goals (SDGs) mainly items 6, 13 and 14, which are focused on water availability and climate action, this study investigated the effects of climate change on water resources using both qualitative and quantitative aspects. Data and water samples were collected and analyzed. Results showed that the temperature increases and precipitations got some modifications causing a decrease of agriculture yields in this region, and other negative effects on water resources are observed. In addition, the decrease of agriculture yields and the pollution of Mouhoun River due to climate change were noted.

## **CLIMATE ADAPTATION GOVERNANCE FOR AGRICULTURE SECTOR: EVIDENCES FROM PAKISTAN**

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**Keywords:** Adaptation governance, agriculture sector, climate policies, Pakistan, subnational

### **Abstract**

Climate change adaptation policies are important for protecting farmers from future climate vulnerability. However, there are various implementation challenges for these policies at the subnational level. This study is conducted to understand the responses of subnational governments and to uncover those challenges by studying the case of Punjab province and the province of Khyber Pakhtunkhwa. Pakistan is ranked in the list of most vulnerable countries to climate change, and its agriculture sector is highly exposed to its adverse impacts. The subnational/provincial governments in Pakistan are responsible for implementing climate change policies and action plans. The scope of the present study is to identify the adaptation initiatives towards agriculture sector in the provinces of Punjab and Khyber Pakhtunkhwa. Moreover, the drivers behind these initiatives are identified. Khyber Pakhtunkhwa government has formulated provincial climate change and implementation plan for the policy that is also in progress. However, provincial climate change policy in Punjab is in the final stages for approval. Punjab, however, is ahead in terms of carrying out research work and developing institutional capacity. The most important initiative of the Punjab government, inter alia, is launching an awareness campaign about climate change adaptation by publishing related literature in local languages, establishing a radio station, arranging farmer day, and writing articles for newspapers. The drivers at the planned adaptation level are driven primarily by coordination among the respective departments, engagement with academics, and availability of financial resources. Autonomous initiatives of the two provinces are essentially similar and principally driven by the previous experiences of farmers, sustainability in agriculture production, and knowledge sharing among the farmers' community.

## **CLIMATIC CHANGE AND LIFE CYCLE ASSESSMENT OF WATER AND WASTEWATER TREATMENT SYSTEMS: CASE OF MOROCCO**

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**Keywords:** Climatic change, Life Cycle Assessment, Water

### **Abstract**

The context of climate change marked by several phenomena: On a global scale, sea-level rise is threatening populations and natural ecosystems in coastal areas, at local level, droughts and heat waves pose an increased risk of water shortages for populations. Severe precipitation that causes flooding can result in significant damage. Indeed, climate change, combined with population growth and urbanization, has major impacts on water resources. The scarcity of these resources is also a major component to be taken into account. The purpose of this work is to present a synthesis on the theoretical approach of a water life cycle analysis and to synthesize the global context of the evolution of water resources in the context of climate change.

## COMPARATIVE STUDY OF WASTEWATER TREATMENT TECHNIQUES FOR ADAPTATION TO CLIMATE CHANGE

**S. El Hajjaji<sup>1</sup>, C. Bakkouche<sup>1</sup>, S. Kherraf<sup>1</sup>, J. Mabrouki<sup>1</sup>, N. Labjar<sup>2</sup>, A. Dahchour<sup>3</sup>**

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**Keywords:** Adaptation, climate change, wastewater treatment efficiency

### Abstract

The scarcity of water resources is a major constraint on a global scale under the combined effects of the irregularity of rainfall, the increasing needs of the countries to respond to the demographic pressure and the appeal of the competing economic sectors (agriculture, industry, drinking water, tourism, etc.). This situation is further exacerbated by the impact of climate change. The increasing demand for water for human, industry, and agriculture, and repeated droughts at national level have led decision-makers to consider wastewater as a valuable source. This paper was devoted to comparatively study urban wastewater treatment systems. This study illustrates the approach that would support the choice to retain the most appropriate technology. It is now possible to count the types of wastewater treatment facilities suitable for the initial load. The elements of choice are listed in five classes: The quality and quantity of wastewater; the receiving water body; the natural constraints of the place; economic aspects (investment and maintenance); and subjective constraints (visual, olfactory). Each treatment plant has advantages and disadvantages. In specific context, the choice of the most appropriate technique is possible. This study helps to introduce this thoughtful method.

## A DECISION MAKING MODEL BASED ON ENSEMBLE FLOOD FORECASTS

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**Keywords:** Bayesian Network model, climate change, ensemble forecasts, flood forecasting

### **Abstract**

Climate change will increase the risk of heavy rainfall and storm surges combining to cause extreme flooding around the world. The present study tries to develop an ensemble flood warning system using ensemble precipitation forecasts. This study is conducted on the Kan basin, Iran. In the first step, the Weather Research and Forecasting (WRF) model was applied to simulate the heavy rainfalls using five different cumulus schemes. Then, the Bayesian Networks (BN) was used to predict the flood peak using the ensemble precipitation forecasts. As a final step, a FUZZY-TOPSIS model was developed for decision making to determine the flood warning level considering all effective criteria in flood warning. The results showed that FUZZY-TOPSIS model is well-suited to determine the flood warning level. According to the reasonable results of the present study, using the same FUZZY-TOPSIS approach based on ensemble precipitation forecasts can be suggested in similar catchments for addressing the uncertainties and choosing flood warning level.

## **BIAS CORRECTION OF REGIONAL CLIMATE MODEL SIMULATIONS OF TEMPERATURE IN EGYPT**

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**Keywords:** Bias correction, Egypt, Quantile Mapping, Regional Climate Model, Temperature

### **Abstract**

Recently, regional climate models (RCMs) have become very important tools to describe and to predict different hydrological processes, e.g., precipitation and evapotranspiration. However, their applications in climate change studies are challenging due to inherently systematic errors. This paper, therefore, aims to correct RCM simulations of temperature with reference to observed daily temperature data of 24 stations in Egypt within the five-year control period (2001–2005). Furthermore, the performances of three commonly used bias correction methods of temperature are evaluated: linear scaling, variance scaling, and empirical quantile mapping. The results show that RCM simulated temperature data are significantly biased from observed data at most stations in Egypt, and the performances of the three methods are reasonably well in correcting these simulations. Although all methods are able to correct the mean values, their abilities to capture other statistical properties of temperature data, e.g., standard deviation and percentiles are quite different and depend on the region and the evaluation indices. The analyses suggest that further investigation is essential to evaluate the IPCC climate change scenarios with different bias correction methods in order to have a comprehensive assessment of climate change impacts on different hydrometeorological processes in Egypt.

## **RESPONSES AND STRATEGIC CLIMATE ACTIONS RECOMMENDED IN TUNISIA**

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**Keywords:** Climate change, recommendations, Tunisian strategy

### **Abstract**

This work presents a framework for decision making on climate change and provides concrete recommendations on policies, plans and programs to address climate change in Tunisia. The proposed actions align with the 2012 Interim Strategy Note (NSI) of the World Bank for Tunisia, which will guide the World Bank's investments in Tunisia over the next two years. The NSI focuses on three main areas of intervention: (1) sustainable growth and job creation, (2) promoting social and economic inclusion by improving access to basic services for underserved communities and improving the effectiveness of social safety net programs, and (3) strengthening governance by improving access to public information as a basis for greater social accountability and transparency. The specific recommendations are related to five main themes: (1) improve the quality and accessibility of public information on climate change; (2) improve human, technical and other resources and services to support action on climate change; (3) provide social protection and other measures to ensure that the poor and the most vulnerable can withstand climate change; (4) develop a supportive policy and institutional framework for climate change; and (5) strengthen the capacity to produce and to manage revenues, and to analyze the needs and financial opportunities related to adaptation.

## **WATER MANAGEMENT AND CLIMATE CHANGE MITIGATION STRATEGIES ALONG IRAN'S LAKE URMIA BASIN**

**I.O. Kunlere<sup>1,2,3</sup>, L. Goodarzi<sup>4</sup>, A.S. Kunlere<sup>3,5</sup>, A.A. Mumuni<sup>6</sup>, O.O. Atilola<sup>1,7</sup>**

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**Keywords:** Lake Urmia, Lake Orumieh, water availability, water crisis, water management

### **Abstract**

Water plays key roles in basic life functions and activities of the living cell, in sustenance of life, maintenance of complex ecosystems, in agriculture, in global transport, etc., and is an indispensable part of life. However, despite its strategic importance to life, across the world, there is hardly enough supply of water for everyone. In Iran, significant challenges affect both the supply and quality of water available and accessible to Iranians. This situation is complicated by the fact that Iran is an arid to semi-arid country. On the other hand, population growth, industrial development, agricultural activities, etc. are rapidly growing, further stretching existing water resources. Lake Urmia (also known as Lake Orumieh), a key saltwater lake in Iran that was once lost about 90% of its water is a good example of the dire water situation in Iran. However, a number of initiatives involving citizens at the grass root, the Iranian government and various international partners have resulted in significant gains that have stemmed and reversed the rapid water loss from the lake and recorded steady net increase in the volume of water in the Lake. This study thus explores the response of the Iranian people, government and the international community to the crisis at Lake Urmia. It highlights major policies and strategies put in place to address the water crisis around Lake Urmia and the reasons, why those policies produced the modest breakthroughs recorded on water management in Iran's Lake Urmia Basin. It then makes recommendations on how lessons from the Iranian experience in the Urmia Lake can be consolidated and adapted to other hotspots in Iran to better mitigate the impact of climate change on water resources and to improve water availability to Iranians.

## **CLIMATE CHANGE MITIGATION MEASURES IN JORDAN BY SUSTAINING THE SOIL PRODUCTIVITY UNDER WATER STRESS CONDITIONS BY USING MICROBES: PRELIMINARY RESULTS**

**T. El-Hasan<sup>1</sup>, K. Khlifat<sup>1</sup>, A. Sprocati<sup>2</sup>, C. Alis<sup>2</sup>, G. de Giudici<sup>3</sup>, D. Al-Majali<sup>4</sup>**

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**Keywords:** Microbial formula, bare soil, climate change, soil productivity, water stress

### **Abstract**

The microbial community of semi-arid bare soil of Al-Ghweir Agricultural Research Station (GARS) from Jordan was identified and classified for its plant growth functions. This work is a part of an international research project under the frame of ERANETMED called (SUPREME). It aimed to find out a suitable mitigation measure for confronting the negative impacts of climate change and the deterioration conditions of soil productivity in the Mediterranean region. 42 colony morphotypes were isolated and identified at the ENEA Institute in Rome, from which 16 bacterial formula (consortium) were formulated depending on their Community Level Physiological Profiling (CLPP) after culturing them in three agar media TSA, MM and N-fix. These 16 species reached the microbial load of  $8 \times 10^5$  CFU. This formula was enhanced by bioaugmentation process. Then a pot experiment of barely plantation using original GARS soil was executed at the labs of Spienza University, Rome. The experiment was done under room temperature and with optimal and water stress conditions, using three variables (i.e., Blank, Fertilizers (DAP), and Bacterial formula). The preliminary results showed the positive effect of bacterial formula as a tool for enhancing the soil capabilities and productivity under water stress conditions in terms of biomass fresh weight and roots length and density. Thus, it can reduce the effect of climate change on crop production. The next step is to implement this formula in a real field plantation experiment on three sites at Jordan, Cyprus and Italy for comparison purposes.

## ECOLOGICAL WASTEWATER TREATMENT STATION FOR SUSTAINABLE DEVELOPMENT IN MOROCCAN VILLAGES

**J. Mabrouki<sup>1</sup>, K. Azoulay<sup>1</sup>, I. Bencheikh<sup>1</sup>, A.Moufti<sup>3</sup>, A. Dahchour<sup>3</sup>, S. El Hajjaji<sup>1</sup>**

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**Keywords:** Ecological wastewater treatment station, sustainable development

### **Abstract**

In several villages in rural area in Morocco, houses do not have a sewerage system and the mode of sewage collection. As a result, the resources of groundwater and the ecosystem of the region are threatened. This study is part of the solution of these problems by the development of ecological treatment plants, which will be equipped with a system of filters, based on valorized wastes and renewable energy. This study aims to define the technical and operational provisions needed to provide solutions to these environmental problems by the collection and treatment of wastewater discharged into the ecosystem.

## **PESTICIDE WASTES MANAGEMENT AS A STRATEGY FOR CLIMATE CHANGE MITIGATION IN MOROCCO**

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**Keywords:** Climate change, empty pesticide containers, obsolete pesticides, pesticide leftovers, pesticide wastes management

### **Abstract**

Horticulture is one of the most relevant segments of the Moroccan agriculture sector. Morocco country reaches the self-sufficiency in fruit and vegetable production. This sector provides also an employment for the working rural population and important source of hard currency towards exportation to the European Union, Canada, Russia and USA. The intensive conditions of the horticulture crops (citrus, tomato, pepper, green bean, etc.) seem to be favourable to many insects and the development of some that cause high damage and affecting the yield quality. Growers are often applying pesticides to protect their production and the yield quality. In the context of climate change and sustainable development adopted by Morocco, pesticide waste disposal is a concern for all professional of agriculture and environment. Mismanagement of pesticides waste will be affect also climate change by Green House Gas (GHG) emissions. Common practices of farmers on disposal pesticides waste have been surveyed in Souss Massa, a main area of Moroccan horticultural regions. Some interviews and discussions were carried out with all actors involved in pesticides waste management principally institutional framework of agricultural and environmental department, private sector of pesticides and Croplife Morocco, farmers associations and NGOs. The data of the surveys have shown that the majority of pesticide wastes were related to empty pesticide containers, left over spray solutions, obsolete pesticides and contaminated clothing after pesticide application. Pesticide wastes management depends mainly on the certification level of the farms. The traditional or non-certified farms have a poor knowledge on pesticide disposal. The certified producers are facing problems in terms of eliminating the empty containers and the obsolete pesticides due to the absence and unlicensed facilities for management of hazardous waste (treatment, recycling, etc.). Some approaches and strategies of pesticide waste management policy in terms of sustainable development and environmental protection have been implemented by the professionals involved in the pesticide sector with the support and funding of the World Bank, FAO, the Global Environment Facility (GEF), Pesticide industry associations (Croplife Morocco, Croplife International), professional associations, and the NGOs.

## **CONTRIBUTION TO A PRE-FEASIBILITY STUDY OF A CONSTRUCTED WETLAND SYSTEM FOR THE TREATMENT OF THE HAMDOUN RIVER WATER, TUNISIA**

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**Keywords:** climate change adaption, free water surface constructed wetland, Oued Hamdoun, single linear reservoir model

### **Abstract**

In order to receive fundamental data for the pre-design of a constructed wetland (CW) for treatment of the Hamdoun River in Tunisia, data acquisition was conducted on site. Next to that, literature research was done and assumptions were made. For the input data of the executed pre-design of an off-stream free water surface CW (FWS CW), the measured long-term precipitation was reduced by calculated losses due evaporation, which amounted to 39.5% of the annual areal precipitation of 351 mm/a. To transform the precipitation data into a discharge, a single linear reservoir model was used. Additionally, the effluents of the four relevant WWTPs were considered. The pre-design was conducted according to the hydraulic loading rate. Assumptions for treatment of the entire river with a FWS CW led to a required area of 488 ha. On a limited area of 21 ha, 4.3% of the river discharge could be treated. Using a vertical subsurface flow (VSSF) CW requires half of the area and could treat the double amount of river water on the limited area of 21 ha. Less land might be needed, when constructing the CW in three sequenced ponds or as hybrid system. It could be an approach to set up a pilot system, which could be scaled up later.

## **BORON REMOVAL FROM WASTEWATER OF CONCENTRATOR AND BORIC ACID PRODUCTION**

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**Keywords:** Boric acid, boron removal, membrane capacitive deionization

### **Abstract**

The difficulty of access to clean water with the purpose of drinking and usage is increasing day by day. For this reason, efficient uses of resources, the increase of recycling and new energy-efficient treatment technologies are required. Water with high saline and ionic content should be made available for usage by treating, and this will mean the acquisition of a great water potential. In addition, when the water with high ionic content is discharged to the environment without treatment, it will cause pollution. Boron is still important due to the fact that it is a difficult ion to remove from water, and the search for its removal technology is inadequate. Boron can pose a threat to life even at low concentrations. The important environmental concern of boron is that the toxic limit value and the amount required for living things are very close to each other. The pond, which is belong to the Espey Concentrator Facility operated by the General Directorate of Turkey, Eti Mining Operations, is located in Emet District of Kütahya, and it is supplied with wastewater with a flow rate of 600 m<sup>3</sup>/h. By this pond, the pollution is caused to spread, and in the near future, the need for a new pond is arising. For this reason, a series of studies have been carried out in order to examine the treatability of wastewater from the Espey Concentrator Plant Waste Pond by the capacitive deionization process. Two different bases, NaOH and Ca(OH)<sub>2</sub>, were used to provide the system pH higher than 10.5 and boron is removed by 94% and 96%, respectively. As a result, according to the regulations in Turkey, Capacitive Deionization Process (CDI) only provides discharge criteria, but sufficient treatment is not provided for reuse.

## **FLOOD ANALYSIS OF DAMLADAG RIVER**

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**Keywords:** Flood Analysis, HEC-RAS, Flood Risk Map, Flood Damage, HEC-GEORAS

### **Abstract**

Floods are the main causes of natural disaster in the world after earthquakes. It is a fact that the topographic structure and precipitation regime in different geographic regions cause flood in many streams during different precipitation periods. The increase in the number of residential areas as a result of rapidly growing population, improper planning, uncontrolled water structures and increasing number of settlements in the river bed increase the loss of life and property due the flood events. In order to reduce the damage caused by floods, river beds and structures need to be rehabilitated. For these reclamation studies, it is necessary to know the topography, the cross-sectional changing of the river, hydraulic structures on the river (bridge, regulator, etc.) and the characteristics of the flood. Numerical calculation methods can be used to make such calculations. In this study, the flood phenomenon of Damladag River, occurred on 11.06.2018 in Konya, has been modelled by HEC-RAS numerical model. At the beginning of the study, the topographic map of the region was obtained and a digital elevation model was created with ARC-GIS, and the river cross sections were obtained by HEC-GEORAS. The obtained cross sections were transferred to the HEC-RAS program, and the hydraulic characteristics of the floodplain were determined. As a result of flooding, inundated areas have been determined like residential areas, schools, university campus area and agricultural fields on the river bed.

## **INDUSTRIAL EFFLUENT OUTFALL IN COASTAL REGION AND ITS IMPACTS ON CLIMATE CHANGE**

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**Keywords:** Water quality, climate change, marine outfall, industrial effluents, numerical simulation

### **Abstract**

Due to the continuous increase in population, urbanization, and industrialization in cities, large amounts of wastewater are produced that need to find a sustainable way to treat and to release back to the environment to be reused. In Egypt, different water bodies are exposed to domestic, industrial and agricultural partially treated wastewater. Gulf of Suez had been subjected to wide variety of pollution due to the intensive industrial activities, being preserving around 85% of Egyptian petroleum industry, as the petroleum industry produces highly saline wastewater (brine) as one of the main wastewater components. This brine needs to be treated and then discharged to the sea, in case of coastal fields with the permissible limits stated by the EEAA. Taking into consideration the effect of climate change on coastal regions, sea water rise, and warming of sea water, the brine marine effluent should be studied effectively to not augment these negative impacts. The brine disposal in many cases may affect negatively the surrounding marine life in addition if not treated and then discharged in a proper way. This research work attempts to investigate the short-term and long-term impacts of the wastewater high saline disposal on the environment adjacent to the brine outfall of one petroleum company located at the Gulf of Suez. The complex way of diffusion of discharge to the sea, governed by the hydrodynamic conditions of different fluids with their corresponding properties primarily depending on environmental aspects will be described and simulated using relevant numerical modeling. The prevailing climate conditions will be studied to suggest the suitable location for effluent outfall position to get maximum dilution. Studying and understanding the hydrodynamic conditions of the discharging area around the effluent pipe will ensure safe environmental conditions for both marine and human life. The diffuser pipe dimensions and qualifications are tested as to produce the best diluted plume under different climate scenarios for the currents and winds prevailing within the study area. The conclusions outlined in the paper will clarify the quality of the wastewater effluents propagation resulting from petroleum industry in the Gulf of Suez study area.

## **IMPACTS OF DROUGHT AND DROUGHT MANAGEMENT STRATEGIES IN TURKEY**

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**Keywords:** Climate change, drought management, Turkey

### **Abstract**

Drought is considered as the most frequent climate-related disaster that often results in water deficiencies and food security. Drought has adverse effects on large segments of population, destroying natural resources and livestock. In recent years, climate change have increased the frequency of droughts and intensified their effects in Turkey. Policy makers prepared Drought Management Plans by focusing on the most vulnerable basins, including Konya Closed Basin. Strength of Turkey for drought management mainly depends on organizational capacity, while lack of data appears to be the main weakness. In this study, it is aimed to evaluate the impacts of drought in Turkey with a Strengths, Weaknesses, Opportunities, Threats Analysis (SWOT) and to give determined action plans before, during and after droughts.

## **AGRICULTURAL PRODUCTION AND FOOD SECURITY IN MENA COUNTRIES UNDER CHANGING CLIMATE AND WATER SCARCITY**

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**Keywords:** Agricultural production, food security, water demand, water scarcity, water security

### **Abstract**

Large amount of water is used for agricultural purposes in the MENA region, where water is scarce in the most parts. The MENA region is the most food import-dependent and the largest cereal importer in the world. An increase in net food imports and a decrease in water availability in the region are projected due to climate change and population growth. Limited sources of water and arable land are the constraints to meet the demand by domestic production. Increasing population and rising income in MENA region are driving forces for higher demand of food. Therefore, food security, especially for the MENA region, has become highly important. The main goal for the MENA region is securing sustainable agricultural growth and improving food security. This study aims to provide an evaluation on agricultural production and food security in the MENA region under changing climate and water scarcity.

## **GROUNDWATER MANAGEMENT IN MOGHRA REGION CONSIDERING CLIMATE CHANGE IMPACTS**

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**Keywords:** ArcGIS, MODFLOW, Climate change, Groundwater Management, Moghra Region, Solar energy

### **Abstract**

As an arid country, Egypt suffers from lack of water needed for ambitious reclamation projects in new desert lands. As the available rainfall and Nile water rates are limited, groundwater is the most promising source that can fulfil the requirements for irrigating new reclamation lands. In order to achieve the sustainability, renewable energy systems should be applied to save the required power for water pumping and supply. In Egyptian deserts, solar energy is one of the most efficient energy sources. Saving requirements of water and energy can be altered due to climate changes especially in the arid regions. Climate changes may lead to longer droughts periods and, consequently, affect negatively the potentiality of groundwater. Also, changes in temperature and solar radiation will surely lead to the increase of evaporation rates and will affect the potentiality of solar energy. In this paper, a groundwater model was developed using MODFLOW software to simulate Moghra aquifer system, Western Desert of Egypt. The model development was based on the available topographic, climatic, geological and hydrological data processed using the GIS software ArcGIS. The model was used to investigate scenarios of sustainable groundwater management applying solar energy for water pumping to cover the irrigation requirements of the target reclamation area. It was concluded that the best scenario is to use 1000 wells to extract 1.2 Mm<sup>3</sup>/d of water to serve a total area of 85,700 acres. In addition, the model was used to investigate the impacts of climate change on the hydrological conditions. It was found that the rise of sea water level as well as the increase of evaporation rates has mild effects on groundwater levels due to the vast aquifer dimensions. Also, the increase of solar radiation and number of sun-shining days per year will positively enhance the solar energy potentiality to pump more water quantities needed for expansion of reclamation land areas.

## **HYDROGEOLOGICAL, HYDROGEOCHEMICAL AND ENVIRONMENTAL ASSESSMENT OF THE GROUNDWATER IN AL-ABYAD PHOSPHATE AREA**

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**Keywords:** Al-Abyad Phosphate Mine, Jordan, Hydrochemistry, Geoelectric and Groundwater.

### **Abstract**

A detailed geophysical survey supported by hydrochemical analysis was conducted at Al Abyad phosphate mining area, Central Jordan in order to evaluate the groundwater quality and distribution, and to estimate the environmental impacts of the leaching phosphate wastewater. To this, some thirteen vertical electrical resistivity traverses were conducted, the seismic survey of a 260 m refractive survey section was carried out, and hydrochemical analyses were made of water samples collected from three wells and from the leaching phosphate ponds. The resistivity survey revealed the presence of five subsurface layers beneath the study area with variable resistivities in the range 4 Ohm.m to 1,500 Ohm.m. The fresh water aquifer is represented by the fourth deduced layer, whose resistivity is mostly in the range 20 – 80 Ohm.m. Beneath the north-eastern part of the study area close to the leaching pond, its calculated resistivity is reduced to about 4 – 5 Ohm.m as caused by contamination due to leaching water from the nearby phosphate pond. The seismic refraction survey revealed the presence of four subsurface layers beneath the study area. The seismic velocity of the uppermost layer is 0.36 km/s, typical for residual of phosphate. The velocity of the second layer is 1.43 – 1.48 km/s. The third layer represents marly lime stone with a velocity 3.08 km/s. At a total depth 46 – 58 m, the velocity of the fourth layer is 4.0 km/s velocity and indicates that this layer consists of very hard massive limestone. The calculated isosalinity contour maps (EC and TDS) clearly show that their values increase in a northeast direction towards the leaching pond. This increase correlates well with the calculated resistivity decrease in the same direction. The water types occurred in the study area correlate inversely with the resistivities of the natural and polluted ground and surface water resources. This is indicated by the further hydrochemical evaluation, water type and genesis as shown in Piper and Durov diagrams.