



Technische
Universität
Braunschweig

Network Partner of

International Network on
Sustainable Water Management
in Developing Countries

ex)ceed

SWINDON

Water Perspectives in Emerging Countries

Linking Water Security to Sustainable Development Goals

Marcelo Nolasco, Elvis Carissimi, Ernesto Urquieta-Gonzalez (Eds.)

August 29 – September 1, 2018 - São Paulo, Brazil



Funded by:



Federal Ministry
for Economic Cooperation
and Development

ex)ceed
EXCELLENCE CENTERS
FOR EXCHANGE AND DEVELOPMENT

DAAD

Water Security is emerging as a primary sustainability challenge across the globe in the 21st century. It is a determinant for security in various societal and environmental aspects including food, energy, economy, environment and public health, and thus has a complex political momentum that goes far beyond the traditional water sector. In order to understand, to project, to address and to plan for water security challenges, one must collectively understand exposure to climate and environment driven hazards, as well as socio-economic determinants, and the cultural and political context, within which mankind live, work and play. Technologies (ranging from model-based scenarios and predictions to green and grey infrastructure and treatment systems, and from remote sensing to social media) and innovative financing and governance systems are proposed to address water security.

This proceedings book of an International Workshop in São Paulo, Brazil will provide the reader the opportunity to acquire knowledge on Water Security considering water governance and management, technological innovation and emerging solutions for water conservation, reuse and recycle in order to achieve the Sustainable Development Goals proposed by the United Nations. More specifically, it intends to deliver essential state-of-the-art knowledge concerning

- Water Security and its role in addressing the Sustainable Development Goals,
- Challenges and opportunities to reach Water Security considering quality and availability, and
- Water Security lessons learned and long term implications in developing countries

Editors

Prof. Dr. Marcelo A. Nolasco - Universidade de São Paulo, Brazil

Prof. Dr. Elvis Carissimi - Universidade Federal de Santa Maria, Brazil

Prof. Dr. Ernesto A. Urquieta-Gonzalez - Universidade Federal de São Carlos, Brazil

Water Perspectives in Emerging Countries

**Linking Water Security
to the Sustainable Development Goals**

Marcelo A. Nolasco, Elvis Carissimi, Ernesto A. Urquieta-Gonzalez

29.08. – 01.09.2018 – São Paulo, Brazil

Issue Editors

Prof. Dr. Marcelo A. Nolasco (Chairman of the Workshop)

Universidade de São Paulo, São Paulo-SP, Brazil; mnolasco@usp.br

Prof. Dr. Elvis Carissimi (Co-organizer)

Universidade Federal de Santa Maria, Santa Maria-RS, Brazil; elvis.carissimi@ufsm.br

Prof. Dr. Ernesto A. Urquieta-Gonzalez (Co-organizer)

Universidade Federal de São Carlos, São Carlos-SP, Brazil; urquieta@ufscar.br

Exceed Chairman & Editor-in-Chief

Prof. Dr.-Ing. Norbert Dichtl

Technische Universität Braunschweig, Institute of Sanitary and Environmental Engineering,
38106 Braunschweig, Germany; n.dichtl@tu-bs.de

Publishing Editor

Prof. em. Dr. mult. Dr. h.c. Müfit Bahadır

Technische Universität Braunschweig, Leichtweiss Institute, Exceed Office,
38106 Braunschweig, Germany; m.bahadir@tu-bs.de

ISBN 978-3-7369-9901-5

eISBN 978-3-7369-9901-6

This publication was financed by the German Academic Exchange Service (DAAD) and the Federal Ministry for Economic Cooperation and Development (BMZ).

All rights reserved including translation into foreign languages. The publication or parts thereof may not be reproduced in any form without permission from the publishers.

Printed in Germany by Cuvillier Verlag, Göttingen, Germany, © 2018

Bibliografische Information der Deutschen Nationalbibliothek

Die Deutsche Nationalbibliothek verzeichnet diese Publikation in der Deutschen Nationalbibliografie; detaillierte bibliografische Daten sind im Internet über <http://dnb.d-nb.de> abrufbar.

1. Aufl. - Göttingen: Cuvillier, 2018

© CUVILLIER VERLAG, Göttingen 2018
Nonnenstieg 8, 37075 Göttingen
Telefon: 0551-54724-0
Telefax: 0551-54724-21
www.cuvillier.de

Alle Rechte vorbehalten. Ohne ausdrückliche Genehmigung des Verlages ist es nicht gestattet, das Buch oder Teile daraus auf fotomechanischem Weg (Fotokopie, Mikrokopie) zu vervielfältigen.

1. Auflage, 2018

Gedruckt auf umweltfreundlichem, säurefreiem Papier aus nachhaltiger Forstwirtschaft.

ISBN 978-3-7369-9901-5
eISBN 978-3-7369-8901-6

CONTENT

Preface	1
A treatise of appreciation of the relationship between the Water Security Index (WSI) and the Sustainable Development Goals (SDG) in Tropical Africa <i>(G. Ajeagah, M. Kapso, A.W. Letah Nzouebet, J.R. Njimou, G.V. Djumyom Wafo, C. Kowenje, B. Gnon, S. Pare)</i>	2
Social footprint of water and sanitation improvements in low HDI countries <i>(H.H.S. Souza, P.L. Paulo, M.A. Boncz, P. Fullana-i-Palmer)</i>	10
Indicators of water access and incidence of diseases in slums of the PROAP Program <i>(J.M. Hidalgo Jr)</i>	26
Social learning and communities of practice – driving water sensitive design in South Africa? <i>(K. Carden, A. Bennett, K. Winter)</i>	32
Challenges of watershed hydro-environmental master plans (Case Study) <i>(M. Moura, S. Montenegro, A. Ribeiro Neto, S. Silva)</i>	40
Water quality of Beysehir Lake and irrigation and drainage channel between Beysehir Lake and Salt Lake <i>(M.E. Aydin, M. Nazar, S.Aydin, A. Ulvi)</i>	54
Impact assessment of Bahr El-Baqar diversion project on water quality status in Lake Manzala, Eastern Nile Delta, Egypt <i>(A. Hassan, A. El-Hamaimi, A. Mirdan, M. Elshemy)</i>	64
Performance of biological indices in comparison to a water quality index in assessment of aquatic ecosystems health of Zio Basin (Togo) <i>(L. Tampo, I. Kaboré, K.V. Akpataku, B.L. Moctar, G. Djaneye-Boundjou)</i>	79
Endocrine disruptors: Efficiency of removal by different treatment systems and concentrations found in wastewater, surface and ground waters around the world <i>(J.M. Campos, S.C.N. Queiroz, D.M. Roston)</i>	94
Microcontaminants and toxicity removal in sanitary sewage treated by constructed wetlands <i>(N.S. Santang, R. Colombo, S.I. Borrely, H.H.B. Andrade, M.A. Nolasco)</i>	104
Micropollutants in the aquatic environment and their removal in membrane bioreactors <i>(G. Onkal Engin, A. Caglak, H. Sari Erkan, A. Adiller)</i>	115
Geochemistry of high concentrations of fluoride and major ions of Sminja Aquifer in Zaghouan (north-east of Tunisia) and risks to human health from exposure through drinking water <i>(M. Ameer, F. Hamzaoui-Azaza, M. Gueddari)</i>	122

Arsenic pollution through drinking groundwater in Burkina Faso: Research of a cheap removal technology (<u>Y. Sanou</u> , <u>S. Pare</u>)	137
Natural products as adsorbent for wastewater valorisation (<u>S. El Hajjaji</u> , <u>K. Azoulay</u> , <u>I. Bencheikh</u> , <u>A. Dahchour</u>)	149
Hydrophobic carbon of yam peels as sustainable adsorbent to treat water oil spillage (<u>U.N. Obioha</u> , <u>O.O. Oloyede</u> , <u>E.A. Urquieta-González</u> , <u>F.A. Dawodu</u>)	159
Quality and potential use of water from green roofs made with Tetra Pak® carton boxes (<u>P. Fensterseifer</u> , <u>R. Tassi</u> , <u>D.G. Allasia</u> , <u>D.E. Ceconi</u> , <u>B. Minetto</u>)	170
Regulation of hydrogen peroxide dosage during lignin degradation by the heterogeneous photo-Fenton process (<u>K. Saldaña-Flores</u> , <u>V. Alcaraz-Gonzalez</u> , <u>E. Urquieta-Gonzalez</u>)	186

PREFACE

Water Security is emerging as a primary sustainability challenge across the globe in the 21st century, and is conceptualized as the capacity of a population to safeguard sustainable access to adequate quantities of acceptable quality of water for sustaining livelihoods, human well-being, and socio-economic development. *Water Security* is a determinant in various societal aspects including food, energy, economy, environment and public health, and thus has a complex political momentum that goes far beyond the traditional water sector.

In this sense, the academia plays an important role in providing new science based knowledge and multidisciplinary approaches in order to deal with water security challenges and its solutions. The collaboration among researchers, stakeholders, governments, non-governmental organizations, and the communities in a systemic way are necessary, as this complex issue requires to be addressed long-term.

Like many other *Developing Regions* worldwide, the *Metropolitan Region of São Paulo, Brazil*, one of largest conurbation and human agglomeration in the world, shows many problems regarding the distribution and availability of fresh and drinking waters, water scarcity, quality and pollution aspects of water, water governance, transboundary water, and other related issues in the context of the climate change. In summary, it faces a cyclic water problem: water comes often too little, sometimes too much, and in general too dirty.

This book presents a contribution to the advancement of knowledge as part of the results of the work performed by the participants of the workshop “*Linking Water Security to the Sustainable Development Goals*” held at the Institute of Advanced Studies of the University of Sao Paulo, Brazil in August, 2018. The workshop aimed to develop a creative co-learning among different experts, and knowledge exchange through experiences from different parts of the world, contributing to produce and to disseminate knowledge regarding water and sanitation.

We are grateful for the financial sponsorship given by Exceed-Swindon and the local support provided by the Institute of Advanced Studies and School of Arts, Sciences and Humanities, University of São Paulo. The International Workshop allowed the attendees a unique opportunity to acquire and to share important know-ledge regarding Water Security considering the global and regional aspects of water governance and manage-ment, emerging technological innovation, and nature-based solutions for water conservation to achieve the Sustainable Development Goals proposed by the Agenda 2030 of the United Nations in their regions.

Prof. Dr. Marcelo Nolasco, São Paulo-SP, Brazil

Prof. Dr. Elvis Carissimi, Santa Maria-RS, Brazil

Prof. Dr. Ernesto Urquieta-Gonzalez, São Carlos-SP, Brazil

A TREATISE OF APPRECIATION OF THE RELATIONSHIP BETWEEN THE WATER SECURITY INDEX (WSI) AND THE SUSTAINABLE DEVELOPMENT GOALS (SDG) IN TROPICAL AFRICA

**G. Ajeegah¹, M. Kapso¹, A.W. Letah Nzouebet¹, J.R. Njimou¹,
G.V. Djumyom Wafo¹, C. Kowenje², B. Gnon³, S. Pare⁴**

¹University of Yaounde 1, Faculty of Science, P.O. BOX 812 Yaoundé, Cameroon; ajeegahg@yahoo.com; mireillekapso@yahoo.fr

²University of Maseno, Maseno, Kenya

³University of Kara, Kara, Togo

⁴University of Ouagadougou, Ouagadougou, Burkina Faso

Keywords: water security index, sustainable development goals, SDG, Tropical Africa

Abstract

The combined effects of population growth, increasing demands for water to enhance activities, security, development and the challenges of climate change give rise to an urgent need to carefully monitor and to assess trends and variations in aquatic resources. Over 1.7 billion people are currently living in river basins, where water use exceeds recharge, leading to the desiccation of rivers, depletion of groundwater, and the degradation of ecosystems and the services they provide. As countries develop and populations grow, global water demand (in terms of withdrawals) is projected to increase by 55% till 2050. Already by 2025, two thirds of the world's population could be living in water-stressed countries, if current consumption patterns continue. The economic loss from the inadequate delivery of water and sanitation was estimated to amount to 1.5% of gross domestic product (GDP) of the countries included in a WHO study on meeting the millennium development goals (MDGs). Water is only renewable, if well managed. Water can pose a serious challenge to sustainable development, but managed efficiently and equitably, water can play a key enabling role in strengthening the resilience of social, economic and environmental systems in the light of rapid and unpredictable changes. Water security and the sustainable development goals (SDGs) are key ingredients of "*Our Common Future*", which is defined as "*development that meets the needs of the present without compromising the ability of future generations to meet their own needs.*" This is the overture of our expression on the relationship between the water security index (WSI) and the Sustainable Development Goals in Tropical Africa.

SOCIAL FOOTPRINT OF WATER AND SANITATION IMPROVEMENTS IN LOW HDI COUNTRIES

H.H.S. Souza¹, P.L. Paulo¹, M.A. Boncz¹, P. Fullana-i-Palmer²

¹Postgraduate Program in Environmental Technologies (PGTA) at Federal University of Mato Grosso do Sul (UFMS), Faculty of Engineering, Architecture and Urbanism, and Geography (FAENG), Av. Costa e Silva S/N, bloco 7B, CEP 79070-900, Campo Grande – MS, Brazil; hugohenriquesouza@gmail.com

²UNESCO Chair in Life Cycle and Climate Change, Escola Superior de Comerç Internacional (ESCI), Pompeu Fabra University, Passeig Pujades n° 1, 08003 Barcelona, Spain

Keywords: Life cycle assessment; social LCA; sustainable development goals; water and sanitation services;

Abstract

Investment in water and sanitation is needed to achieve the Sustainable Development Goals (SDG). Improving access to safe water and sanitation facilities has substantial effects on health. This paper aims to assess social impacts of intervention scenarios regarding water and sanitation improvement in five low Human Development Index (HDI) countries. These improvements should result in establishing a better public health and a higher environmental quality, which in turn should result in lower public healthcare expenses, liberating resources for other areas like education and security. Social impacts were assessed combining impacts on productivity and impacts on human well-being according to the social footprint impact assessment, considering characteristics of each country studied. In different levels between the analyzed countries, economic benefits of providing access to safe drinking water and wastewater treatment services to the population would vary from US\$ 186,000 to more than US\$ 150,000,000 annually, considering just the reduction of diarrheal disease incidence. In this way, sanitation improvements will not be only economically feasible, but also socially affordable from a sustainability perspective according to the SDG.

INDICATORS OF WATER ACCESS AND INCIDENCE OF DISEASES IN SLUMS OF THE PROAP PROGRAM

J.M. Hidalgo Jr

Universidade Católica de Petrópolis – UCP, Centro de Engenharia e Computação, Rua Barão do Amazonas, 124, Centro, Petrópolis/RJ - Brazil; jaime.hidalgo@ucp.br

Keywords: Infrastructure, diagnosis, health

Abstract

The popular settlement urbanization program (PROAP) aimed to improve the quality of life of residents of low-income informal settlements in the city of Rio de Janeiro. The objective of the program was to equip these settlements with basic urban infrastructure, to develop social programs and to promote land and social regularization. A diagnosis made in the year 2014 identified urban and social infrastructure problems, indicating the basis for the project proposals. The same diagnosis was repeated in 2017 after the works of the program to be able to identify the impacts caused, using a methodology of monitoring and evaluation. The diagnosis has promoted indicators of urban infrastructure, health, environment, housing, family income and others. The present article presents a summary of these indicators that allow crossing data of urban infrastructure with the data of health of the populations of the favelas presented.

SOCIAL LEARNING AND COMMUNITIES OF PRACTICE – DRIVING WATER SENSITIVE DESIGN IN SOUTH AFRICA?

K. Carden, A. Bennett, K. Winter

Future Water Research Institute, University of Cape Town, Rondebosch, South Africa; kirsty.carden@uct.ac.za

Keywords: Water Sensitive Design; Community of Practice; alternative water resources; greywater

Abstract

South Africa (SA) is a water-scarce country facing significant water management challenges, including rapid urbanisation, environmental degradation and fragmented institutional structures. Alternative approaches to conventional water management, which aim to facilitate a change from ‘*water-wasteful*’ to ‘*water-sensitive*’ environments, are required, if serious economic and socio-political threats are to be averted. As one step towards advancing this vision for South African cities, a Water Sensitive Design (WSD) Community of Practice (CoP) programme was established with the aim of highlighting the critical linkages between the various aspects of this new paradigm through engagement with a wide range of stakeholders. The main focus areas are the identification of possibilities for collaborative and participatory interaction between all relevant actors, including awareness-raising and appropriate WSD training activities using the recently-published implementation framework and guidelines for the adoption of WSD in South Africa. The paper focuses specifically on the outcomes of two separate activities that are associated with the CoP programme and which are based in the City of Cape Town – a local-level CoP known as the Liesbeek Life Plan, and the development of guidelines for the use of greywater as a resource. The impact that these activities are having in terms of driving the uptake of WSD in the country and towards achieving the SDGs is discussed. Initial findings indicate that the CoP programme has the potential to generate a new understanding about innovative practices and reflexive learning within WSD in South Africa, and to develop knowledge connected to policy development and change to influence planning and design towards water sensitive cities.

CHALLENGES OF WATERSHED HYDRO-ENVIRONMENTAL MASTER PLANS (CASE STUDY)

M. Moura¹, S. Montenegro¹, A. Ribeiro Neto¹, S. Silva²

¹*Federal University of Pernambuco, Postgraduate Program in Civil and Environmental Engineering- Av. Prof. Moraes Rego, 1235 - Cidade Universitária, Recife-PE, Brazil, 50670-901; micaellaraissa@hotmail.com*

²*University of Pernambuco, Postgraduate Program in Civil Engineering- R. Benfica, 455 - Madalena, Recife-PE, Brazil, 50720-001*

Keywords: Capibaribe; Hydro-Environmental Master Plan; Water infrastructure;

Abstract

This work aimed to identify the main challenges to the implementation of the water infrastructure actions foreseen in the Capibaribe's Hydro-Environmental Master Plan, also suggesting a methodology for monitoring process optimization. The study was developed through a survey of data in several governmental institutions, internship at the State Agency of Water and Climate and participation in Capibaribe Committee meetings. Thus, the methodology was structured in the stages of documentary research, critical analysis of the data, methodological proposal for monitoring optimization and also characterization of the study area. The results showed that the water infrastructure actions were not implemented in accordance with the hydro-environmental plan, due to lack of coordination between the agencies to monitor the investments, among others.

WATER QUALITY OF BEYSEHIR LAKE AND IRRIGATION AND DRAINAGE CHANNEL BETWEEN BEYSEHIR LAKE AND SALT LAKE

M.E. Aydin¹, M. Nazar², S. Aydin³, A. Ulvi³

¹*Necmettin Erbakan University, Civil Engineering Department, Konya, Turkey;
meaydin@konya.edu.tr*

²*General Directorate of State Water Works, Konya, Turkey*

³*Necmettin Erbakan University, Environmental Engineering Department, Konya, Turkey*

Keywords: Beyşehir Lake; drainage channel; water quality; irrigation channel; Konya basin.

Abstract

The aim of this study was the assessment of water quality of Beyşehir Lake, and irrigation and drainage channel between Beyşehir Lake and Salt Lake; the determination of pollutants and their sources; to establish measures necessary for the conservation and control of water quality. For this purpose, surface water samples were taken from 10 different quality observation points in Konya Closed Basin, Turkey. The results obtained were evaluated according to water resources classes in Water Pollution Control Regulation (WPCR) and Surface Water Quality Regulation (SWQR) of Turkey. Surface water sources in the basin are generally classified as class I in terms of temperature, pH, sulphate, sodium, and nitrate, class I and II in terms of dissolved oxygen, chloride, EC, and ammonium, and class III and IV in terms of color, nitrite, boron, COD and BOD₅. Class II water can be used for irrigation purposes. In this case, only two surface water sources are suitable for irrigation according to the WPCR. Surface waters that could be used for irrigation purposes were evaluated according to Turkish regulations. It was generally found to be suitable in terms of EC and chloride but not of sodium and boron. Sources causing pollution in the basin have been defined as domestic wastewater discharges, industrial discharges, agricultural activities, irregular solid waste repositories, drought, animal husbandry activities, and rapid population growth. As a solution recommendation, new urban wastewater treatment plants (WWTPs) should be built, improvement of treatment of existing WWTPs should be ensured, a Water Quality Monitoring Network should be established, new regular solid waste sites should be constructed, and good agricultural practices should be introduced.

IMPACT ASSESSMENT OF BAHR EL-BAQAR DIVERSION PROJECT ON WATER QUALITY STATUS IN LAKE MANZALA, EASTERN NILE DELTA, EGYPT

A. Hassan¹, A. El-Hamaimi², A. Mirdan³, M. Elshemy⁴

¹*Faculty of Engineering, Ain Shams University, 1 Elsarayat St., Abbaseya, 11517 Cairo, Egypt, ahmad9657@yahoo.co.uk*

²*Faculty of Engineering, Port Said University, Port Fouad, 42526 Port Said, Egypt*

³*Faculty of Engineering, Port Said University, Port Fouad, 42526 Port Said, Egypt*

⁴*Faculty of Engineering, Tanta University, Campus of Seberbay, 31511 Tanta, Egypt*

Keywords: Bahr El-Baqar Drain; Lake Manzala, MIKE21; Water Quality Management

Abstract

Lake Manzala is the largest Egyptian coastal lake, which lies on the eastern north coast of Egypt. It is considered as one of the most valuable fish sources in Egypt. In the last decades, water quality status of the lake has been dramatically degraded due to the rapid increase of industrial, municipal and agricultural wastewater discharges from the six main drains of Eastern Nile Delta. Bahr El-Baqar drain is the largest and highest polluted contributor that disposing its pollution load into the southern part of the lake. An ambitious project is under planning to treat the total discharge of Bahr El-Baqar drain and to divert it to Sinai for land reclamation purposes. In this work, MIKE21 Model is used to develop and to calibrate a hydrodynamic and water quality model for Lake Manzala. Eight water quality parameters in addition to three hydrodynamic parameters are simulated to investigate the lake water quality status. The calibrated model shows good agreement between the simulated and the observed water depth, water temperature, salinity and water quality records. The model is used to investigate the impacts of diverting Bahr El-Baqar Drain on the hydrodynamic and water quality characteristics of the lake. Significant improvements in the lake water quality status are noticed; about 12% increase in Dissolved Oxygen concentration, while all the other investigated water quality parameters are significantly decreased by a percentage between 43% and 67% comparing with their original records. The developed model can be used to investigate other water quality management scenarios for the lake.

PERFORMANCE OF BIOLOGICAL INDICES IN COMPARISON TO A WATER QUALITY INDEX IN ASSESSMENT OF AQUATIC ECOSYSTEMS HEALTH OF ZIO BASIN (TOGO)

L. Tampo¹, I. Kaboré², K.V. Akpataku¹, B.L. Moctar¹, G. Djaneje-Boundjou¹

¹University of Lomé, Faculty of Sciences, Laboratory of Water Chemistry, BP1515, Togo; charlestampo@gmail.com

²University of Ouagadougou, Laboratory of Animals Biology and Ecology, Burkina Faso, 03 BP 7021 Ouagadougou 03, Burkina Faso

Keywords: Biological indices, macroinvertebrates, water quality, watershed, human activities

Abstract

Water quality indices are important tools for ecosystem health assessment and potential water security indicators, but still missing in Togo. To fill this gap, biological and water quality indices performance in a basin of Lake Togo watershed were investigated. Fifty sampling sites were selected in three sections of rivers/streams (upstream, middle stream, downstream) through the basin. To test performance of biological and chemical water quality indices in Lake Togo context, one biotic index, Family Biotic Index (FBI), two metrics (number of taxa in the insects' order of *Ephemeroptera*, *Plecoptera* and *Trichoptera* (EPT), number of taxa in the insects' order of *Ephemeroptera*, *Trichoptera* and *Odonata* (ETO), and one chemical water quality index, Prati's Index (WQI) were used. The biotic index and metrics were calculated using macroinvertebrates features (number of taxon, diversity index and abundance) of Zio River basin. The chemical-based water quality index was derived from measurements of water physicochemical parameters. The result showed that all biological indices were sensitive to a set of organic pollution and bacteriological indicators, which correspond to a set of human pressures affecting the ecological integrity of all basin waterbodies ($r > 0.60$; $p < 0.05$). A factor analyses show three types of sites, which characterize three degree of water quality and ecological conditions. This study reveals that biological indices are complementary methods of classic chemical methods and may be integrated in management of hydrosystems health including riparian human health. This work highlights a method for monitoring and decision making in water management of Lake Togo watershed.

ENDOCRINE DISRUPTORS: EFFICIENCY OF REMOVAL BY DIFFERENT TREATMENT SYSTEMS AND CONCENTRATIONS FOUND IN WASTEWATER, SURFACE AND GROUND WATERS AROUND THE WORLD

J.M. Campos¹, S.C.N. Queiroz², D.M. Roston¹

¹*Department of Water and Soil, School of Agricultural Engineering, University of Campinas, Candido Rondon Avenue, 501 -13083-875 - Campinas - SP, Brazil; julyenne.mc@gmail.com*

²*Embrapa Meio Ambiente, Laboratory of Residues and Contaminants, SP 340 Road, Km 127,5, 13820-000, Tanquinho Velho, Jaguariúna – SP, Brazil*

Keywords: constructed wetlands; macrophytes; ethynilestradiol; bisphenol A; levonorgestrel.

Abstract

Endocrine disruptors are increasingly found in water bodies and in the environment, which may come from industrial, pharmaceutical, or cosmetic origin. Among these substances, one can highlight the drugs, hormones, triclosan (bactericide used in cosmetics), pesticides, and insecticides, among others. These substances may interfere and cause adverse effects on the endocrine system of humans and animals, and can cause feminization of the male fish, early menarche in girls as well as thyroid problems. Conventional water and wastewater treatment plants are scarcely able to remove completely the present endocrine interferers, and some of the techniques capable of eliminating such compounds as advanced oxidative processes and reverse osmosis, for example, are technologies having high implantation and maintenance costs. Constructed wetlands are natural wastewater and surface water treatment systems that have low implantation and maintenance costs, and have been cited as an efficient method for the removal of endocrine disruptors. In this context, the present work aimed to carry out an extensive bibliographical research on the state of the art of the concentrations of endocrine disruptors found in wastewater, surface and groundwater around the world as well as the efficiency of removal of these compounds by different treatment systems. It was concluded that constructed wetlands are systems that have high efficiency of treatment of endocrine disruptors in wastewater, which can be used alone in rural and isolated communities or as tertiary treatment in conventional wastewater and water treatment plants.

MICROCONTAMINANTS AND TOXICITY REMOVAL IN SANITARY SEWAGE TREATED BY CONSTRUCTED WETLANDS

N.S. Santana¹, R. Colombo¹, S.I. Borrelly², H.H.B. Andrade¹, M.A. Nolasco¹

¹*School of Arts, Sciences and Humanities, University of São Paulo, Arlindo Béttio street, 1000, CEP 03828-000, São Paulo, SP- Brazil; dinha.santana@gmail.com*

²*Nuclear and Energy Research Institute, Radiation Technology Center, Av. Prof. Luciano Gualberto, 380, CEP 05508-01, São Paulo- SP, Brazil.*

Keywords: constructed wetlands, ecotoxicology, emerging microcontaminants.

Abstract

The present study analyzed the performance of two different constructed wetlands (CW) systems for sanitary sewage treatment, with the main objective of evaluating the ability of both systems to remove emerging microcontaminants (EMCs) and to reduce the acute toxicity of the sewage. In this way, four categories of MCEs were analyzed: (i) plasticizers and surfactants - Bis(2-ethylhexyl) phthalate, Diethyl phthalate, Bisphenol A and 4-n-nonylphenol; (ii) natural and synthetic hormones - 17 α -Ethinylestradiol, Estrone, 17 β -Estradiol and Estriol; (iii) drugs - Diclofenac, Acetaminophen, Gemfibrozil, Sulfamethoxazole and Caffeine, and (iv) personal care products - 4-n-nonylphenol and triclosan. The evaluation of CWs to reduce the acute toxicity of the sewage was carried out with the bacteria *Vibrio fischeri* exposure test. Two treatment lines were evaluated, Treatment Line I (TL I) composed of a hybrid vertical-horizontal CW (P5), and Treatment Line II (TL II) with aerated free-flow CW with a settling unit (P3), followed by vertical subsurface flow CW (P4). From the 14 EMCs analyzed, 11 were detected in the raw sewage (P1) and the following average removal efficiencies for TL I were obtained: DEF=67.9%; ACE=85.0%; CAF=92.2%; SUL=80.4% and DIC=68.2. For TL II was obtained: DEF= 89.1%; ACE=89.3%; CAF=98.9%, SUL=62.1% and DIC= 78.4. The mean toxicity reducing efficiency in the *V. fischeri* assays in the assessment of those CW were 71.1% for TL I and 90.5% for TL II.

MICROPOLLUTANTS IN THE AQUATIC ENVIRONMENT AND THEIR REMOVAL IN MEMBRANE BIOREACTORS

G. Onkal Engin¹, A. Caglak¹, H. Sari Erkan¹, A. Adiller²

¹*Department of Environmental Engineering, Yildiz Technical University, Esenler, 34220 Istanbul, Turkey; gengin@yildiz.edu.tr*

²*Department of Environmental Health, Vocational School of Health Services, Üsküdar University, 34664 Istanbul, Turkey*

Keywords: Micropollutants; endocrine disrupting compounds; membrane bioreactors

Abstract

In recent years, the endocrine disrupting chemicals (EDCs) including pharmaceuticals, personal care products, some industrial and household chemicals, and pesticides are increasing in the environment due to the results of growing population rates, urbanization and personal preferences (Caliman and Gavrilesco, 2009). Many EDCs can reach aquatic media from a variety of sources from wastewater treatment plant effluents to leakages of septic tanks, or from landfill sites to terrestrial run-offs. It is important to increase the removal rates of micropollutants before their discharge into aquatic media. Membrane bioreactor (MBR) systems offer satisfactory removal rates for conventional water quality parameters. Recently, some studies showed that micropollutants might be removed by MBRs. In this study, a variety of different micropollutants in domestic wastewater were treated by MBR and the results obtained were found to be promising.

GEOCHEMISTRY OF HIGH CONCENTRATIONS OF FLUORIDE AND MAJOR IONS OF SMINJA AQUIFER IN ZAGHOUAN (NORTH-EAST OF TUNISIA) AND RISKS TO HUMAN HEALTH FROM EXPOSURE THROUGH DRINKING WATER

M. Ameur, F. Hamzaoui-Azaza, M. Gueddari

Research Unit of Geochemistry and Environmental Geology, Faculty of Sciences, University of Tunis el Manar, 2092, Tunisia; meriem_ameur@yahoo.fr

Keywords: Geochemistry; Fluoride; Hydrochemical facies; Human health; Sminja aquifer; Tunisia

Abstract

Sminja aquifer, located in Zaghouan district in Northeastern Tunisia, has been used to meet the needs of Zaghouan agglomerations for drinking purposes and irrigation uses. On the other hand, the region has suffered from inefficient usage and mismanagement of water resource as result of inappropriate legal, political, and economic frameworks taking into consideration the regional vulnerability to climate change and population growth. Tunisia is like most North African countries, which are characterized by a harsh arid and semi-arid climate with scarce water resources and poor water quality on most of its territory. The main objective of the study was to evaluate the chemical quality, to identify the sources of dissolved ions of Sminja aquifer, and to verify its suitability for various uses. 23 wells and boreholes were sampled during the winter and summer of 2013. Chemical analyses have involved the main physicochemical variables (temperature, pH, Total Dissolved Solids, Na^+ , Cl^- , Ca^{2+} , Mg^{2+} , SO_4^{2-} , K^+ , HCO_3^- and F^-). Two types of facies predominate the water of Sminja aquifer. The first hydrochemical facies is Na–Ca–Cl–SO₄, located in the recharge zone of the aquifer. The second facies is Na–Cl, corresponding to the downstream part of the Sminja aquifer (discharge area). The results showed that the fluoride concentrations in Sminja aquifer have been constantly increased in the last decades as a result of the point source inputs related to mining discharges, and diffuse inputs linked to the agricultural activity in the district. The soils, the unsaturated zone, and the aquifers have gradually become charged with fluorine over time. The results also confirmed that fluoride contents in Sminja aquifer range from 5 to 25 mg/L in 2013. These concentrations are very high and exceed allowable standards of World Health Organization (1.5 mg/L) and Tunisian National Standards NT.09.14 (1.2 mg/L). Many medical studies have proved the enormous danger of high doses of fluoride in water on human health, among others dental and bone fluorosis.

ARSENIC POLLUTION THROUGH DRINKING GROUNDWATER IN BURKINA FASO: RESEARCH OF A CHEAP REMOVAL TECHNOLOGY

Y. Sanou, S. Pare

*Laboratory of Analytical, Environmental and Bio-Organic Chemistry, University Ouaga 1 Prof.
Joseph KI-ZERBO, Chemistry Department, 03 BP 7021 Ouagadougou 03, Burkina
Faso; prosperyacson@gmail.com*

Keywords: arsenic pollution, groundwater, granular ferric hydroxide, ferrihydrite, laterite rock.

Abstract

In several parts of Burkina Faso, there is an urgent need of purifying arsenic contaminated water. The medical effect of the arsenic exposure has also been evaluated among the inhabitants of affected villages, indicating that the problem is critical. Results of previous investigations using a commercial Granular Ferric Hydroxide (GFH) as adsorbent material showed a capacity of 370 µg/mL of arsenic removal from water with arsenic concentrations varying between 90 and 196 µg/L. Being GFH very expensive, other adsorbent materials have been tested instead. In this study, natural laterite rock has been used as adsorbent in column experiments and the results indicated a low adsorption capacity (5.2 µg/mL). Then, the same lateritic sand has been coated in ferrihydrite by drying the two materials together in an oven. Results showed an adsorption capacity ranged between 31.2 and 48.1 µg/mL indicating an increase of the adsorption capacity. Although results showed an improvement after ferrihydrite-coating, the adsorption capacity is still significantly lower than the one of GFH. It is concluded that ferrihydrite-coated sand is still a possible low-cost adsorbent material for treating arsenic contaminated water in developing countries, although factors like sand material, grain size and coating method should be evaluated further.

NATURAL PRODUCTS AS ADSORBENT FOR WASTEWATER VALORISATION

S. El Hajjaji¹, K. Azoulay¹, I. Bencheikh¹, A. Dahchour²

¹Laboratory of Spectroscopy, Molecular Modeling, Materials, Nanomaterials, Water and Environment, (LS3MN2E-CERNE2D), Department of Chemistry, Faculty of Sciences, Mohammed V University in Rabat, Av Ibn Battouta, B.P. 1014, Rabat 10000, Morocco; hajjajisouad@yahoo.fr

²Department of Chemistry, IAV Hassan II, Rabat, Morocco

Keywords: Adsorption; Wastewater; Agricultural waste; Water quality

Abstract

Various countries in arid areas have oriented their efforts to use wastewater WWs as an alternative source to cope with water deficiency. Usage of recycled WWs depends on successful infrastructure, reliable treatment process, financial and economic analyses, and public acceptance (overcoming health and environmental concerns). Wastewater might contain excreted pathogens (bacteria, viruses, protozoa and helminths (worms)) that cause gastro intestinal diseases, highly poisonous chemical toxins, and hazardous materials from hospital waste, heavy metals, hormones and antibiotics. The magnitude of pollution of WWs was evaluated according to the importance for the population. Various reports attest to the failure of the different treatment processes used to clean WWs, raising concerns about the remaining pollutants in WWs released into the rivers or reused in agriculture. Usage of local material for treatment could improve the quality of WW. Adsorbents have been prepared from some vegetable waste. Individual tests of adsorption have been performed with pollutants and different adsorbents. Isotherms of adsorption have been derived in batch experiments. Different equilibrium concentrations of the pollutants will enable to draw the isotherm and to compare different common models such as Freundlich or Langmuir. The parameters of adsorption have been deduced from the more fitting model to the data and reported in this study.

HYDROPHOBIC CARBON OF YAM PEELS AS SUSTAINABLE ADSORBENT TO TREAT WATER-OIL SPILLAGE

U.N. Obioha¹, O.O. Oloyede², F.A. Dawodu³, E.A. Urquieta-González⁴

¹*Department of Chemistry, Lehigh University, Seeley G. Mudd Building 6E Packer Ave, Bethlehem, PA 18015-3172 USA; obioha.nancy@gmail.com; uno218@lehigh.edu*

²*Ecology and Environmental Biology Unit, Department of Zoology, University of Ibadan, Oyo State, Nigeria; loyede.oyebayo@gmail.com*

³*Department of Chemistry, University of Ibadan, Oyo State, Nigeria; fadawodu@yahoo.com*

⁴*Research Center on Advanced Materials and Energy, Sao Carlos Federal University, C. Postal 676, CEP 13565-905, Sao Carlos (SP), Brazil; ernesto.urquieta@gmail.com; urquieta@ufscar.br*

Keywords: Crude oil, Yam peels, Activated carbon, Adsorption, Isotherms

Abstract

The potential use of carbonized white yam peels (*Dioscorea rotundata*), a common food crop in West Africa and Nigeria, was examined as an adsorbent to remove crude oil from contaminated water. The efficiency on the adsorption was investigated through batch studies using direct reading from UV-Visible spectrophotometer. The recovered crude oil was characterized and properties such as viscosity (kinematic and dynamic), pH, density, specific gravity, and API gravity were determined. The thermal properties such as heat of combustion, thermal conductivity, specific heat capacity and latent heat of vaporization were also determined. Proximate analysis was carried out on the raw yam peels, and the physicochemical properties were examined after carbonization. Some of the carbonized yam peels were activated with ZnCl₂ and comparatively studied with the raw carbon. The activated carbon was found to be more effective than the inactivated one at removing the oil from water at varying pH (3-13), oil concentrations in water (2.0-5.0 g/L), adsorbent dosage (0.2-1.4 g), and contact time (0-80 min). The conditions for maximum adsorption capacity for inactivated carbon (285 mg/g) and activated carbon (316 mg/g) were pH 7, contact time 40 min, adsorbent dosage for activated carbon 0.4 g, and for inactivated carbon 1.4 g. The equilibrium adsorption data were better fit by the Langmuir isotherm for the adsorption of the crude oil on the activated carbon and by the Freundlich isotherm for the inactivated one, as was indicated by their high R² of 0.6698 and 0.7569, respectively. On the other hand, the kinetic studies showed that the pseudo second order model had a better fit for the adsorption experiment with R² of 0.994 and 0.9693 for the activated and inactivated carbon, respectively. The intra-particle diffusion experiments revealed the influence of film diffusion and external mass transfer.

QUALITY AND POTENTIAL USE OF WATER FROM GREEN ROOFS MADE WITH TETRA PAK® CARTON BOXES

P. Fensterseifer¹, R. Tassi², D.G. Allasia³, D.E. Ceconi⁴, B. Minetto⁵

¹*Master Program in Civil Engineering, Federal University of Santa Maria, Roraima Avenue, N° 1000, Technology Center, paula.fens@gmail.com*

²*Department of Sanitary and Environmental Engineering, Federal University of Santa Maria, Roraima Avenue, N° 1000, Technology Center, rutineia@gmail.com*

³*Department of Sanitary and Environmental Engineering, Federal University of Santa Maria, Roraima Avenue, N° 1000, Technology Center, dqa@ufsm.com*

⁴*Postdoctoral Program in Environmental Engineering, Federal University of Santa Maria, Roraima Avenue, N° 1000, Technology Center, deniceconi@gmail.com*

⁵*Sanitary and Environmental Engineering Program, Federal University of Santa Maria, Roraima Avenue, N° 1000, Technology Center, bruna.minetto@gmail.com*

Keywords: Low impact development, Storm water runoff, Urban drainage, Water quality

Abstract

In urban areas, where building coverings make up a large fraction of the landscape, the application of green roofs may be a way of partially offsetting the environmental and hydrological damages. Conventional roofs, which do not allow water retention and accelerate rainwater flow, once vegetated, can store part or all of rainwater, reducing runoff volume. This study aims to evaluate the quality of drained water from two experimental green roofs targeting the potential use of this water for non-potable purposes. For this, two small experimental green roofs made with Tetra Pak® boxes were built. After precipitation, water samples were collected from water reservoirs and sent for laboratory analysis. There was always a sample of each green roof and a third sample (reference) corresponding to rainwater collected from the atmosphere. Physical, chemical and microbiological parameters were evaluated and the quality of the green roof water was compared with the reference sample. After nine months of study, it was verified that the green roofs did not offer improvement in rainwater quality. However, comparing the results over time, an improvement in the general water quality was noticed, proving that the age of green roofs interfere with the drained water. It was also possible to conclude that green roofs made with carton boxes can be efficient and durable, allowing to install them in homes or small buildings. Moreover, when assembled from recycled material, they can become an affordable, inexpensive and an environment-friendly alternative.

REGULATION OF HYDROGEN PEROXIDE DOSAGE DURING LIGNIN DEGRADATION BY THE HETEROGENEOUS PHOTO-FENTON PROCESS

K. Saldaña-Flores¹, V. Alcaraz-Gonzalez¹, L.A. Martins-Ruotolo²,
E.A. Urquieta-Gonzalez³

¹*Department of Chemical Engineering, University of Guadalajara – CUCEI, Blvd. Marcelino García Barragán 1420, C. Postal 44430, Guadalajara Jal., México; victor.alcaraz@cucei.udg.mx*

²*Department of Chemical Engineering, São Carlos Federal University, C. Postal 676, CEP 13565-905, São Carlos (SP), Brazil*

³*Research Center on Advanced Materials and Energy, São Carlos Federal University, C. Postal 676, CEP 13565-905, São Carlos (SP), Brazil*

Keywords: Vinasses, tequila, cachaça, recalcitrant organic compounds, degradation, heterogeneous photo-Fenton process, hydrogen peroxide, automatic dosage, discrete control of dissolved oxygen

Abstract

The production of tequila in Mexico and cachaça in Brazil generates wastewater called vinasses, which contain recalcitrant compounds (RCs), whose degradation is difficult by using conventional wastewater treatment methods. If they are not properly treated they can cause negative effects in the environment. The heterogeneous photo-Fenton process is efficient in the degradation of RCs, where a ferrite catalyst, visible light and hydrogen peroxide (H_2O_2) are used. However, H_2O_2 can be consumed in scavenger reactions. Therefore, the objective of this study was to dose this compound in an automatic way using a control approach with the aim to improve the degradation of RCs. The degradation of lignin, one of the RCs most commonly found in vinasses, was performed. Experiments were divided in two types: open-loop and closed-loop modes. The open-loop experiment was carried out by applying a feed of a constant H_2O_2 flow. By using the obtained data and applying the reaction curve method a first-order transfer function model was achieved. The input variable was the H_2O_2 flow, and the output variable was the dissolved oxygen measured as oxygen saturation percent (%DO). The closed-loop experiment was performed with an automatic regulation of the H_2O_2 flow, using a discrete time direct synthesis approach. Thus, the obtained results showed that it is possible to model and to control the degradation of lignin applying a heterogeneous photo-Fenton process, which improved the TOC reduction performance using a lower H_2O_2 dosage.