

Advances in Science, Technology & Innovation
IEREK Interdisciplinary Series for Sustainable Development

Vincenzo Naddeo · Kwang-Ho Choo ·
Mohamed Ksibi *Editors*

Water-Energy-Nexus in the Ecological Transition

Natural-Based Solutions, Advanced Technologies and
Best Practices for Environmental Sustainability

Advances in Science, Technology & Innovation

IEREK Interdisciplinary Series for Sustainable Development

Editorial Board

Anna Laura Pisello, Department of Engineering, University of Perugia, Italy

Dean Hawkes, University of Cambridge, Cambridge, UK

Hocine Bougdah, University for the Creative Arts, Farnham, UK

Federica Rosso, Sapienza University of Rome, Rome, Italy

Hassan Abdalla, University of East London, London, UK

Sofia-Natalia Boemi, Aristotle University of Thessaloniki, Greece

Nabil Mohareb, Faculty of Architecture - Design and Built Environment,
Beirut Arab University, Beirut, Lebanon

Saleh Mesbah Elkaffas, Arab Academy for Science, Technology, Egypt

Emmanuel Bozonnet, University of La Rochelle, La Rochelle, France

Gloria Pignatta, University of Perugia, Italy

Yasser Mahgoub, Qatar University, Qatar

Luciano De Bonis, University of Molise, Italy

Stella Kostopoulou, Regional and Tourism Development, University of Thessaloniki,
Thessaloniki, Greece

Biswajeet Pradhan, Faculty of Engineering and IT, University of Technology Sydney,
Sydney, Australia

Md. Abdul Mannan, Universiti Malaysia Sarawak, Malaysia

Chaham Alalouch, Sultan Qaboos University, Muscat, Oman

Iman O. Gawad, Helwan University, Egypt

Anand Nayyar , Graduate School, Duy Tan University, Da Nang, Vietnam

Series Editor

Mourad Amer, International Experts for Research Enrichment and Knowledge Exchange
(IEREK), Cairo, Egypt

Advances in Science, Technology & Innovation (ASTI) is a series of peer-reviewed books based on important emerging research that redefines the current disciplinary boundaries in science, technology and innovation (STI) in order to develop integrated concepts for sustainable development. It not only discusses the progress made towards securing more resources, allocating smarter solutions, and rebalancing the relationship between nature and people, but also provides in-depth insights from comprehensive research that addresses the **17 sustainable development goals (SDGs)** as set out by the UN for 2030.

The series draws on the best research papers from various IEREK and other international conferences to promote the creation and development of viable solutions for a **sustainable future and a positive societal** transformation with the help of integrated and innovative science-based approaches. Including interdisciplinary contributions, it presents innovative approaches and highlights how they can best support both economic and sustainable development, through better use of data, more effective institutions, and global, local and individual action, for the welfare of all societies.

The series particularly features conceptual and empirical contributions from various interrelated fields of science, technology and innovation, with an emphasis on digital transformation, that focus on providing practical solutions to **ensure food, water and energy security to achieve the SDGs**. It also presents new case studies offering concrete examples of how to resolve sustainable urbanization and environmental issues in different regions of the world.

The series is intended for professionals in research and teaching, consultancies and industry, and government and international organizations. Published in collaboration with IEREK, the Springer ASTI series will acquaint readers with essential new studies in STI for sustainable development.

ASTI series has now been accepted for Scopus (September 2020). All content published in this series will start appearing on the Scopus site in early 2021.

Vincenzo Naddeo • Kwang-Ho Choo •
Mohamed Ksibi
Editors

Water-Energy-Nexus in the Ecological Transition

Natural-Based Solutions, Advanced
Technologies and Best Practices
for Environmental Sustainability

Editors

Vincenzo Naddeo
Sanitary Environmental Engineering Division
(SEED), Department of Civil Engineering
University of Salerno
Fisciano, Italy

Kwang-Ho Choo
Department of Environmental Engineering
Kyungpook National University
Daegu, Korea (Republic of)

Mohamed Ksibi
High Institute of Biotechnology
University of Sfax
Sfax, Tunisia

ISSN 2522-8714 ISSN 2522-8722 (electronic)
Advances in Science, Technology & Innovation
IEREK Interdisciplinary Series for Sustainable Development
ISBN 978-3-031-00807-8 ISBN 978-3-031-00808-5 (eBook)
<https://doi.org/10.1007/978-3-031-00808-5>

© The Editor(s) (if applicable) and The Author(s), under exclusive license to Springer Nature
Switzerland AG 2022

This work is subject to copyright. All rights are solely and exclusively licensed by the Publisher, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, reuse of illustrations, recitation, broadcasting, reproduction on microfilms or in any other physical way, and transmission or information storage and retrieval, electronic adaptation, computer software, or by similar or dissimilar methodology now known or hereafter developed.

The use of general descriptive names, registered names, trademarks, service marks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use.

The publisher, the authors, and the editors are safe to assume that the advice and information in this book are believed to be true and accurate at the date of publication. Neither the publisher nor the authors or the editors give a warranty, expressed or implied, with respect to the material contained herein or for any errors or omissions that may have been made. The publisher remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

This Springer imprint is published by the registered company Springer Nature Switzerland AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

Preface

The Water-Energy Nexus is one of the most important and priority issues to be resolved for both current and next generations. Water and energy underpin economic and social development. Water is needed for each stage of energy production, and energy is crucial for the provision and treatment of water. In the energy community, much of the attention has centred on the impact of water availability on the different processes of the energy sector and the energy sector's impact on water quality and quantity. This interdependency has significant implications for both energy and water security. With both water and energy needs set to increase, it has become ever more important to understand the linkages between the two, to anticipate future stress points and to implement policies, technologies and practices that soundly address the associated risks.

The findings show that there are ways to mitigate risks. Policies and technologies are already studied and proposed by scholars and technicians for sustainable development. However, a clear vision of both state of the art and all possible solutions is needed for decision-makers to assess the possible trade-offs and different scenarios. A successful action will require a strong, coordinated focus across different branches and levels of government and collaboration between policy-makers, researchers, industry and consumers.

This volume will include papers that broadly address recent and novel developments in technology and in the solutions that could be proposed to help ease chokepoints and reduce demand in both sectors, meaning that water does not have to be a limiting factor for the energy sector and a rise in water demand does not have to be accompanied by an equal rise in energy demand. This volume will provide an opportunity for knowledge exchange to advance our understanding of the current state of Water-Energy systems and their nexuses that will lead to guiding and developing sustainable and resilient systems. The scope of the volume is extended to the relative environmental, management and economic aspects related to the Water-Energy systems.

In detail, this volume includes selected contributions presented during the III edition of the international conference on WaterEnergyNEXUS, which was held in December 2020. This edition of the conference was organized by the University of Sfax (Tunisia), in cooperation with the Sanitary Environmental Engineering Division (SEED) of the University of Salerno (Italy), the Advanced Institute of Water Industry at Kyungpook National University (Korea) and The Energy and Resources Institute, TERI (India)). The first edition of Water-EnergyNEXUS was organized in Korea in 2017 during the Asian International Water Week, one of the more pertinent and significant meetings in Asia for scientists and professionals working in the field of water use and sustainability. The second edition was organized in Salerno (Italy) in 2018. The third WaterEnergyNEXUS conference provided an international digital platform where key topics on water management were discussed by participants with the presentation of nature-based solutions, advanced technologies and best practices by a panel of experts invited as plenary and keynote speakers. Another objective of the third edition of the WaterEnergyNEXUS conference is to enhance cooperation, integration and sustainable development in the Euro-Mediterranean region on the critical links between Water and Energy.

The WaterEnergyNEXUS series of conferences are supported by the UNESCO World Water Association Programme (WWAP) and the International Water Association (IWA). It also enjoys the patronage of several international scientific societies, associations and organizations and has established a publishing partnership with Springer Nature.

This volume gives an overview of current research focusing on emerging Water-Energy Nexus issues and challenges and their potential applications to a variety of environmental problems that are impacting the Euro-Mediterranean zone and surrounding regions. A selection of novel and alternative solutions applied worldwide will also be presented. The volume contains carefully refereed contributions selected from the conference. Topics covered include (1) Nexus framework and governance, (2) environmental solutions for the sustainable development of the water sector, (3) future clean energy technologies and systems under water constraints, (4) environmental engineering and management and (5) implementation and best practices.

Intended for researchers in environmental engineering, environmental science, chemistry and civil engineering, this volume is also an invaluable guide for industry professionals working in both the water and energy sectors.

Fisciano, Italy
Daegu, Korea (Republic of)
Sfax, Tunisia

Vincenzo Naddeo
Kwang-Ho Choo
Mohamed Ksibi

Contents

Nexus Framework and Governance: Economic Evaluations for Investment Projects in the Water and Energy Sectors	
Investments in the Water and Energy Sectors. Cost–Benefit Analysis and Multi-criteria Assessments to Support the Decision-Making Processes	3
Antonio Nesticò	
Sustainability and Energy Efficiency in Twentieth-Century Italian Built Heritage	7
Laura Gabrielli and Aurora Greta Ruggeri	
Long-Term Effects Evaluation for Investments in the Energy and Water Sectors	11
Gabriella Maselli and Antonio Nesticò	
Economic Sustainability of Direct Energy Efficiency Investments for Gas and Energy Distributors to Comply with the PAEE (Italian National Plan for Energy Efficiency)	15
Luigi Nicodemo	
Technical–economic Analysis of Novel Generation Aquaponic System for a Sustainable Development	19
Domenico Giaquinto, Gabriella Maselli, Antonio Nesticò, Tiziano Zarra, Shadi Wajih Hasan, Vincenzo Belgiorno, and Vincenzo Naddeo	
Cost Control in the Construction of Water Distribution and Collection Networks: Verification of a Multivariate Model Through Application to Case Studies	23
Enrico Gargione	
How Can We Use the Water Cost Instrument in a Scarcity Scenario for the Power Sector in Brazil?	27
Tarcisio Castro, Eveline Vasquez-Arroyo, Gerd Angelkorte, Rafael Kelman, and Sergio Leitão	
The Reorganization of Tariff Classes in the Integrated Water Service. An Optimizing Model for Define the Tariff Classes in Compliance with TICSİ	31
Maria Macchiaroli, Luigi Dolores, and Vincenzo Pellecchia	
An Economic Model for Urban Watershed Forestry Investments	35
Maria Rosaria Guarini, Pierluigi Morano, and Francesco Sica	
Financial Risk Analysis for Water and Energy Projects	39
Gabriella Maselli, Vincenzo Naddeo, and Antonio Nesticò	

Measures to Face Population Decline of Small Villages: Sustainable and Integrated Energy Strategies for the Internal Areas	43
Francesco Calabrò, Domenico Enrico Massimo, and Mariangela Musolino	
Risk Analysis for the Integrated Water Service Manager in the Selection of Investments—The ALARP Applied to the Program of Interventions	47
Maria Macchiaroli, Luigi Dolores, and Gianluigi De Mare	
The Investment in Sponsorship for the Managers of the Integrated Urban Water Service: A Model to Promote the Rational Use of Water Resources and Improve the Perception of the Service for Users	51
Emilio Coppola	
Nexus Framework and Governance: Innovation of Renewable Energies and Challenges for the Mitigation of Climate Change Impact in the Water-Energy-Food Nexus	
Energy Consumption of Irrigation Systems: A Functional Perspective	57
Kevin Daudin, Flavie Cernesson, Gilles Belaud, and Christiane Weber	
Exploring the Interplay Between Water Availability and Solar and Wind Energy Potential in the Algarve (Portugal)	63
Maria da Conceição Neves and Rui Mendonça Neves	
Strengthening Understanding on Renewable Energy Access for Broader Development Outcomes in West Africa	67
Mariama Camara and Mary Thompson-Hall	
Integrative Energy-Water Audits in Public Buildings	73
Ana Poças, Emanuel Delgado, Silvino Spencer, Pedro Quaresma, Pedro Cardoso, Patrícia Corigo, and Filipa Newton	
Balancing Equity and Efficiency? Water Governance Reform in South Africa . . .	77
JeeEun Song and Marcela González Rivas	
Embracing Water-Energy-Climate Change in South Africa Through the Integrated Water Resource Management Approach	81
Steven Matome Mathetsa, Mulala Danny Simatele, Issac Tebogo Rampedi, and Gerhard Gericke	
Looking at the Past to Understand the Present and Future of Urban Water–Energy Nexus	85
Ana Luiza Fontenelle, Drielli Peyerl, and Ieda Geriberto Hidalgo	
Urban Farming for the Development of Sustainable Cities	89
Domenico Giaquinto, Maria Federica Siani, Pasquale Cucco, Federica Ribera, Vincenzo Belgiorno, and Vincenzo Naddeo	
Climate Change and the Water–Energy Nexus in the MENA Region	93
Manfred A. Lange	
WATER-ENERGY-FOOD NEXUS Challenges and Opportunities for Mauritius	99
Manta Devi Nowbuth, Yashwaree Baguant, and Sandhya Gunness	
Implications of Rainfall Variabilities in Light of Climate Change on Crop Production in the Sudano-Sahelian Belt of Nigeria	103
Adeyemi Olusola and Samuel Adelabu	

Water Conservation Indexing: The HVAC of Suranaree University of Technology Hospital Main Building Case	107
Andreas Prasetyadi and Atit Koonsrisuk	
Water and Carbon Footprints for the Control of Wastewater Treatment Plants	111
Valentina Cieri, Tiziano Zarra, Shadi W. Hasan, Vincenzo Belgiorno, and Vincenzo Naddeo	
Urban Density, Electricity Consumption, and Greenhouse Gas Emission: An Analysis of Italian Cities	115
Valentina Antonucci and Giuliano Marella	
Guidelines on Assessment of Urban Development Impact on Water Security and Environmental Sustainability	119
Samson Senbore, Saheed Oke, Ntsoaki Malebo, and Olusola Ololade	
Climate Change and Salinity Intrusion in the Water Sources of Coastal Khulna District, Bangladesh	123
Molla Rahman Shaibur, Shahnaz Parvin, Ishtiaque Ahmmed, Md. Hasibur Rahaman, and Sabiha Sarwar	
Advanced Technologies and Nature-Based Solutions for the Environmental Sustainability of the Water Sector: Water and Wastewater Technologies for Developing Countries	
Investigation of Graphene Oxide (GO)-Manganese Oxide (MnO₂) Nanocomposite in Metal Ions Adsorption from Wastewater	129
Yazan Ibrahim, Vijay S. Wadi, Mariam Ouda, Vincenzo Naddeo, Fawzi Banat, and Shadi W. Hasan	
Facile Synthesis and Characterization of Super-Hydrophobic Fe₂O₃ for Membrane Distillation	133
Mariam Ouda, Vijay S. Wadi, Yazan Ibrahim, Vincenzo Naddeo, Fawzi Banat, and Shadi W. Hasan	
Biofouling Mitigation Using Graphene Oxide Functionalized Polyethylenimine/Sulfonated Polysulfone Composite Membranes	137
Vijay S. Wadi, Yazan Ibrahim, Mariam Ouda, Vincenzo Naddeo, and Shadi W. Hasan	
Influence of CO₂ Addition and Semi-Continuous Feed Regime on Pathogen Removal—Shaded HRAP	141
Graziele Ruas, Sarah Lacerda Farias, Maria Alice Nantes, Mayara Leite Serejo, Paula Loureiro Paulo, and Marc Árpád Boncz	
Removal of <i>Clostridium Perfringens</i> and <i>Staphylococcus</i> sp. In Microalgae-Bacterial System: Influence of Microalgae Inoculum and CO₂/O₂ Addition	145
Graziele Ruas, Sarah Lacerda Farias, Bruno Aquino Bezerra dos Reis, Mayara Leite Serejo, Paula Loureiro Paulo, and Marc Árpád Boncz	
Self-assembled Positively Charged MWCNT-GO Composites for Wastewater Treatment	149
Lobna Nassar, Hiyam Khalil, Vijay S. Wadi, Vincenzo Naddeo, Fawzi Banat, and Shadi W. Hasan	

Membrane Bioreactor (MBR) Treated Domestic Wastewater for Reuse in a Recirculating Aquaculture System (RAS)	153
Jan Hoinkis, Ephraim Gukelberger, Talha Atiye, Francesco Galiano, Alberto Figoli, Bartolo Gabriele, Raffaella Mancuso, Julian Mamo, Samuel Clough, and Kyra Hoevenaars	
Self-assembled Negatively Charged GO-MWCNT Composite for Wastewater Filtration	157
Hiyam Khalil, Lobna Nassar, Vijay S. Wadi, Vincenzo Naddeo, Fawzi Banat, and Shadi W. Hasan	
Intermittent Aeration and Oxygen Flowrate Monitoring for Nitrogen Removal Enhancement in a Full-Scale Wastewater Treatment Plant	161
Sami Abid, Maroua Haddad, and Hassib Bouallagui	
Synthesis and Characterization of Fe₃O₄-Ag Composite Nanoparticles for Oil–Water Separation	165
Ahmed Aboulella, Vijay S. Wadi, Vincenzo Naddeo, Fawzi Banat, and Shadi W. Hasan	
Application of Response Surface Methodology in Physicochemical Wastewater Treatment	169
Tran Le Luu	
Environmental Impact Assessment of Desalination Plants in the Gulf Region	173
Mariam N. Soliman, Fatima Z. Guen, Somaya A. Ahmed, Haleema Saleem, and Syed Javaid Zaidi	
Exploitation of Micro-geodetic Data in the Auscultation Study of the Sidi Salem Dam (Tunisia)	179
Wiem Benali, Belhassen Ben ameur, Sahar Ben Skander, Faiez Msallem, Abdeljelil Afli, and Aymen Khemiri	
Treatment of Olive Mill Wastewater by a Simple Low-Cost Adsorption Method Using <i>Luffa cylindrica</i> (Palestinian Territories)	183
Dorothea Elisa Engl and Amer Marei	
Effectiveness of Water Hyacinth and Arum Shoot Powders to Remove Cr and Cu from Tannery Effluents	187
Molla Rahman Shaibur	
Salinity Levels in Pond, Deep Tube Well and Pond Sand Filter Water in Two Unions of Southwestern Coastal District Satkhira, Bangladesh	193
Molla Rahman Shaibur	
Effect of Olive Oil Mill Wastewater Treated by Coagulation–Flocculation on the Soil	199
Souad Guesmi, Kaouther Ardhaoui, Yousra Suidi, and Mohamed Moussa	
Nitrogen Removal from Secondary Effluents Through a Simple and Double Filtration on Sand Filter	203
Saifeddine Eturki, Feryel Hajjaji, and Kawther Ben Moussa	

Advanced Technologies and Nature-Based Solutions for the Environmental Sustainability of the Water Sector: Green Technologies for Sustainable Water and Wastewater Management	
Advanced Wastewater Treatment by Electro Self-Forming Dynamic Membrane Bioreactors: Pilot-Scale Application	209
Fabiano Castrogiovanni, Laura Borea, Giuseppe Giannella, Sebastia Puig, Shadi Wajih Hasan, Vincenzo Belgiorno, and Vincenzo Naddeo	
Water-Soluble Chitosan Nanofibrous Membranes for Efficient Dye Removal	213
Md. Nahid Pervez, George K. Stylios, Yingjie Cai, Shadi Wajih Hasan, Tiziano Zarra, Vincenzo Belgiorno, and Vincenzo Naddeo	
Sustainable Production of Affordable Ceramic Membranes from Readily Available Raw Materials	217
Sushila Yadav, Vidya S. Batra, Nilay Srivastava, Vincenzo Naddeo, and Malini Balakrishnan	
Hydraulic and Energy-Integrated Study of Reclaimed Wastewater in the Lower Mijares River Basin (Castelló)—Spain	221
Gabriel Gómez-Martínez, Clara Eugenia Estrela-Segrelles, Bernat Castro-Quiles, and Miguel Ángel Pérez-Martín	
Analysis of Membrane Fouling Reported in Membrane Photobioreactors (MPBRs) for Treatment of Secondary Effluents	227
Luisa Vera, Enrique González, Ignacio Ruigómez, Ignacio Ortega, and Cristina González	
Advanced Process for PFAS Removal from a Leachate Landfill: On-site Plant Based on Reverse Osmosis and Evaporation Technology	231
Roberto Zocchi, Gianluca Breviglieri, Federico Arlati, Alma Rodriquens, Mariachiara D’Aniello, and Khadija Ajmi	
Tunisian Geothermal Potential for Desalination	237
Nihel Chekir and Dhouha Hassen	
Involvement of Citizens in the Measurements of Water Salinity Using Test Kits in the Medjerda Watershed (Northern Tunisia)	241
Safa Chaabane, Raed Fehri, Khalifa Riahi, Slaheddine Khelifi, and Marnik Vanclooster	
Anaerobic Membrane Bioreactor (AnMBR) Equipped with Waste-Based Ceramic Membranes: Relation with Life Cycle Cost (LCC)	245
Sourbh Dhiman, Malini Balakrishnan, Vincenzo Naddeo, and Naved Ahsan	
South African Hotels and Hospitality Industry Response to Climate Change-Induced Water Insecurity Under the Sustainable Development Goals Banner . . .	249
Kaitano Dube	
NEW Humidification–Dehumidification System Operating on the Principle of an Airlift Pump with Variable Height	253
Adel Oueslati and Adel Megriche	
Investigation of Biochar Potential to Improve Plant Growth and Water Retention in a High-Quality Potting Mixture	257
Mohammad Danish, Snigdhendubala Pradhan, Gordon McKay, Tareq Al-Ansari, and Hamish Robert Mackey	

Farmers' Willingness to Accept Compensation for Crops Conversion Programs in Semi-Arid Regions of Tunisia: The Case Study of Nabeul Governorate	261
Lamia Soltani	
Numerical Analysis of Heat and Mass Transfer in a Naturally Ventilated Greenhouse with Plants	265
Marouen Ghoullem, Khaled El Moueddeb, and Ezzedine Nehdi	
Simulated Performance of a Solar Greenhouse Dryer for Drying of Olive Mill Wastewater	269
Chaima Bouraoui, Gérald Debenest, and Fayçal Ben Nejma	
Advanced Technologies and Nature-Based Solutions for the Environmental Sustainability of the Water Sector: Advanced Technologies and Nature-Based Solutions in Water Cycle	
Biogas Upgrading Technologies in Municipal Solid Waste Treatment Plant for Energy Recovery Optimization	275
Valentina Cieri, Tiziano Zarra, Shadi W. Hasan, Vincenzo Belgiorno, and Vincenzo Naddeo	
Microfiltration and Ultrafiltration as Efficient, Sustainable Pretreatment Technologies for Resource Recovery	279
Md. Nahid Pervez, Amir Mahboubi, Shadi Wajih Hasan, Tiziano Zarra, Vincenzo Belgiorno, Vincenzo Naddeo, and Mohammad J. Taherzadeh	
Modeling Directional Water Flux in Fractured Rock	283
Goodluck Ofoegbu and Biswajit Dasgupta	
A Satellite-Based Framework to Investigate the Impact of Sand Dams on Landscapes in Semi-arid Regions	287
Carolyn Walper, Andreas Braun, and Volker Hochschild	
Perspectives on Performance of Anaerobic Reactors Treating Wastewater on Restart Post-shutdown—A Review	291
Sachin Kumar Tomar, Aditi Deshpande, and Malini Balakrishnan	
Steam Reforming of Biogas from Different Feedstocks for H₂ Production and Its Use in PEMFC: Thermodynamic Analysis	295
Kantilal Chouhan, Shishir Sinha, Shashi Kumar, and Surendra Kumar	
The Effect of Solar Tracking System on Thermal Performance of Solar Dryer . . .	299
Saad A. Mutasher	
State of the Art on Water Consumption and Wastewater Reuse in Developing Countries	303
Eric Awere, Sara Pennellini, and Alessandra Bonoli	
Polysulfone-Based Ultrafiltration Membranes: Preparation, Characterisation and Use	307
Rafik Eddine Belazzougui, Scheherazade Mimoune, and Ahmed Benaboura	
Control of Hazardous Substances and Recovery of Renewable/Valuable Resources: Renewable/Valuable Resources for Recovery and Utilization	
Modular Treatment of Arsenic-Laden Brackish Groundwater Using Solar-Powered Membrane Capacitive Deionization (MCDI) (Vietnam)	313
Ulrich Hellriegel, Edgardo Cañas Kurz, Vu Tan Luong, Jochen Bundschuh, Alberto Figoli, Bartolo Gabriele, and Jan Hoinkis	

Tungsten Oxide-Blended PVDF-HFP Electrospun Nanofiber Membranes for Solar-Driven Interfacial Water Evaporation	317
Musthafa O. Mavukkandy, Faisal Al-Marzooqi, Emad Alhseinat, Georgios Karanikolos, and Shadi W. Hasan	
Model-Based Feasibility Assessment of a Resource Recovery Strategy in the Largest Italian WWTP	321
Sina Borzooei, Giuseppe Campo, Alberto Cerutti, Barbara Ruffino, Marco Simonetti, Gerardo Scibilia, and Maria Chiara Zanetti	
Methane Production from Pretreated Anaerobic Sludge	325
Priscila Guenka Scarcelli, Mayara Leite Serejo, Grazielle Ruas, Mateus Nishiyama Akayama, Paula Loureiro Paulo, and Marc Árpád Boncz	
Forested Infiltration Area (FIA) Design in the Arborea Nitrate Vulnerable Zone (Sardinia, Italy)	329
Alberto Carletti, Mario Pirastru, Mario Deroma, Antonio Sessini, Giorgio Ghiglieri, and Pier Paolo Roggero	
Technological Development of Aquaponic Systems to Improve the Circular Bioeconomy in Urban Agriculture: A Perspective	333
Domenico Giaquinto, Antonio Buonerba, Paolo Napodano, Tiziano Zarra, Sebastia Puig, Shadi Wajih Hasan, Vincenzo Belgiorno, and Vincenzo Naddeo	
Modeling of Groundwater Flow in the Mio-Plio-Quaternary of the Valley of Oued Righ in the Southeast of Algeria	337
Sabrine Guettaia and Abderrezzak Boudjema	
Urban Riparian Areas—Ecosystems that Can Improve the Quality of Life and Water and Mitigate Climate Change	343
George Nick Zaimes, Georgios Gkiatas, Paschalis Koutalakis, Valasia Iakovoglou, and Anastasia Savvopoulou	
Effects of Phosphogypsum Amendment on Soil Physical Properties and Erodibility in the Sandy Soil of South Tunisia	347
Nissaf Karbout, Zied Zriba, Latifa Dhaouidi, and Mohamed Moussa	
Control of Hazardous Substances and Recovery of Renewable/Valuable Resources: Control of Nutrients and Hazardous Compounds	
Abatement of Atmospheric Pollutants: UV–Ozone Oxidation for the Degradation of Gaseous Toluene	353
G. Oliva, T. Zarra, V. Senatore, M. G. Galang, F. Ballesteros, V. Belgiorno, and V. Naddeo	
Wastewater Treatment and Membrane Fouling Control Using an Algae-Sludge Membrane Bioreactor (AS-MBR)	357
Mary Vermi Aizza Corpuz, Vincenzo Senatore, Fabiano Castrogiovanni, Antonio Buonerba, Laura Borea, Tiziano Zarra, Vincenzo Belgiorno, Kwang-Ho Choo, Shadi W. Hasan, Florencio C. Ballesteros, and Vincenzo Naddeo	
Fate of Critically Ranked Carbapenem-Resistant <i>Klebsiella Pneumoniae</i> in Plasma-Treated Water	361
Kaveshni Naik, Oluyemi Olatunji Awolusi, and Samuel Ayodele Iwarere	

Monitoring Water Bodies Using Sentinel-1 Imagery for the Effective and Sustainable Mosquito Larvae Control [Greece]	365
Georgios Ovakoglou, Ines Cherif, Thomas Alexandridis, Xanthoula-Eirini Pantazi, Afroditi-Alexandra Tamouridou, Dimitrios Moshou, Xanthi Tseni, Stella Kalaitzopoulou, and Spyridon Mourelatos	
Removal of Pharmaceutical Pollutants from Wastewater: Adsorption of an Antibiotic (Amoxicillin) on Activated Carbon	369
Soumaya Tadjine, Fairouz Khalida Kies, Hadjer Cherfaoui, and Nihad Boussouar	
Study of Water in a Rainwater Harvesting Technique (Majels and Fesguias) in the Matmata Mountains	373
Habib Lamourou, Nisaf Karbout, and Mohamed Moussa	
Energy-Saving Technologies and Future Clean Energy Solutions: Future Urban-Energy Systems with Considerations of Water and Food Security	
Thermal Energy Recovery from Drinking Water Systems: Assessing Water Quality and Downstream Temperature Effects	379
Andreas Moerman, Nikki van Bel, Frank Oesterholt, Vincent de Laat, and Mirjam Blokker	
Estimation of Electrical Power Needed Using Solar Panels for Optimum Rose Flower Cultivation Under Greenhouse Condition/AI-Quds University/Palestine	383
Vincent Robiller and Amer Marei	
Improvement of the Photovoltaic Greenhouse Irrigation Using Computational Fluid Dynamic: Efficient Use of Water	387
Reda Errais, Younes El Fellah, Khalid Guissi, Oussama Drissi Maliani, Allal Senhaji, Ahmed Bekkaoui, Hassan Majdoubi, Wissal Bozalmat, and El Houssain Baali	
Economic and Technical Potential of Geothermal Energy in the Kingdom of Saudi Arabia	391
Omar K. M. Ouda, Abdulaziz M. Al-Bassam, and Aref A. Lashin	
Shallow Groundwater Quality Assessment for Irrigation Purposes Based on Irrigation Water Quality Criteria and Its Zoning with GIS in the Guenniche Plain (North Tunisia)	397
Nizar Troudi, Fadoua Hamzaoui-Azaza, Ourania Tzoraki, Fatheddine Melki, and Mounira Zammouri	
Assessment of Groundwater Abstraction for Irrigation Practices Using FAO-CROPWAT Model and GIS: Case Study of Hajeb Layoun-Jelma Basin (Central Tunisia)	403
Soumaya Aouiti, Fadoua Hamzaoui Azaza, Fetheddine Melki, Monji Hamdi, Fulvio Celico, and Mounira Zammouri	
Evaluation of the Performance of Membrane Distillation Systems Coupled with Solar Energy	407
Nader Frikha, Samira Ben Abdallah, and Slimane Gabsi	

Energy-Saving Technologies and Future Clean Energy Solutions: Environmental Biotechnology and Bioenergy

Advanced Membrane PhotoBioReactor (mPBR) Versus Traditional BioReactors for the Control of Greenhouse Gas Emissions (GHGs): A Comparative Analysis in Terms of Performance and Energy Consumption 413

Vincenzo Senatore, Tiziano Zarra, Antonio Buonerba, Giuseppina Oliva,
Vincenzo Belgiorno, and Vincenzo Naddeo

The Effect of Cattle's Feed Treatment on Biogas Upgrading 417

Ambar Pertiwinigrum, Ajeng Rizki Kartika Putri, Cuk Tri Noviandi,
Andang Widi Harto, and Margaretha Arnita Wuri

Anaerobic Digestion Engineering Opportunities for Fruit and Vegetable Waste Management in the Water–Energy–Waste Nexus 421

Nesrine Gharsallah, Sami Sayadi, Firas Feki, Julie Jimenez, and Sonia Khoufi

Pilot-Scale Anaerobic Digestion of Food Waste Under Mesophilic Conditions: A Case-Study at Umbria Region (Italy) 425

Mawaheb Mouftahi, Pietro Bartocci, Nawel Tlili, Nejib Hidouri, Federica Liberti,
and Francesco Fantozzi

Sustainable Treatment of Volatile Organic Compounds (VOCs) by Integrated Algal–bacterial Photobioreactor 429

Rekich R. Pahunang, Vincenzo Senatore, Tiziano Zarra, Giuseppina Oliva,
Vincenzo Belgiorno, Florencio C. Ballesteros, and Vincenzo Naddeo

Natural Clays as Adsorbents for the Removal of Heavy Metals from Phosphogypsum 433

Kawther Ben Moussa, Saifedine Etturki, Feryel Hajjaji, Johan De Grave,
and Mohamed Moussa

Evaluation of Biodiesel Produced from Frying Oil in an Internal Combustion Engine 437

Nabil Korniti, Mounia Baali, Mohamed Bouzbib, Abdelkrim Maaroufi,
Ahmed Bekkaoui, Khalid Guissi, Younes El Fellah, Reda Errais, Mohamed Jmili,
Oussama Drissi Maliani, and El Houssain Baali

Implementation and Best Practices

At the Nexus of Water and Energy Sectors: Flexible Electricity Generation from Anaerobic Digestion of Sewage Sludge 443

Mauro Lafratta, Rex B. Thorpe, Sabeha K. Ouki, Achame Shana, Mark Willcocks,
Eve Germain, and Jacquetta Lee

Efficient Operation of a WWTP Under High-Load Conditions: A Model-Based Feasibility Analysis for Implementing the Side-Stream Deammonification 447

Sina Borzooei, Jun-Jie Zhu, Gerardo Scibilia, and Maria Chiara Zanetti

Wastewater Characterization During Wet Weather Events: Practical Complications of Investigating an Overlooked Necessity 451

Sina Borzooei, Gerardo Scibilia, and Maria Chiara Zanetti

Water-Energy-Efficient Solutions for Residential Buildings: A Comparison Between Italian and Spanish Legislations 455

Ester Lepore, Patricia Aguilera Benito, Carolina Piña Ramírez, Giacomo Viccione,
and Pierfrancesco Fiore

Architectural Development of the Buildings' Envelope to Improve Energy Efficiency	459
Rabeb Ayed, Sara Baddadi, Salwa Bouadila, Safa Skouri, and Mariem Lazaar	
Nitrogen Reducing the Inhibitory Action of Saline Water on Barley (<i>Hordeum vulgare L.</i>) Development	463
Fatma Ezzahra Ben Azaiez, Sawsen Ayadi Kallel, Zied Hammami, Zoubeier Chamekh, and Youssef Trifa	
Municipal Solid Waste Life Cycle Study and Its Influence on Water Security in the Tunisian Context	467
Olfa Daboussi, Haythem Mtimet, Anwar Ben Jeddou, Oussema Ben Rbiha, Imen Hadj Salah, and Bahri Rezig	
Effect of the Sandy Amendments Practiced on the Water Characteristics of the Soil in the Oases of Southern Tunisia: Case of the Oasis of Nefzaoua	471
Zied Zriba, Nissaf Karbout, Habib Bousnina, and Mohamed Moussa	
Comparison Between PID and Predictive Controllers Applied to a Cooling System	475
Rim Ben Ali, Emna Aridhi, and Abdelkader Mami	
Economical Assessment of Supplementary Irrigation of Olive Trees in Jenin District/Palestine	479
Sabreen Khmour and Amer Marei	

About the Editors



Prof. Vincenzo Naddeo is Full Professor at Department of Civil Engineering of the University of Salerno (Italy) and Director of the Sanitary Environmental Engineering Division (SEED), where he drives research and academic activities in the Environmental Engineering fields. He serves as Affiliate Professor at both the Department of Civil and Environmental Engineering of the University of Washington (Seattle, WA, USA) and at the Department of Water Resources and Environmental Engineering of the Tamkang University (New Taipei City, Taiwan).

He is Editor of the *Water Environmental Research* (Wiley) and Associate Editor of *Case Studies in Chemical and Environmental Engineering* (Elsevier), *Euro-Mediterranean Journal for Environmental Integration* (Springer), *Scientific Report* (Nature Portfolio) and of the *Earth, Frontiers for Young Minds* (Frontiers). He is Special Issues Editor and Social Media Editor for *Journal of Hazardous Materials* (Elsevier), *Journal of Hazardous Materials Letters* (Elsevier) and *Journal of Hazardous Materials Advances* (Elsevier). He presently serves on the editorial board of several ISI journals including *Science of Total Environment* (Elsevier), *Desalination* (Elsevier), *PeerJ* (Life, Bio, Environment and Health Sciences), *Frontiers in Bioengineering and Biotechnology*, *Water* (MDPI) and *Bioengineered* (Taylor & Francis). Dr. Naddeo is also actively involved in a variety of scientific organizations, funding agencies, and European networks. He holds seven patents, four on innovative technologies for the advanced treatment of water or wastewater, two on the next generation of electronic nose (e.Nose) and one patent on an innovative photo-bioreactor for the sequestration of CO₂. Prof. Naddeo serves the editorial board of several ISI journals, and he is (co-) Author of over 200 refereed publications in ISI journals, congress proceedings and book volumes.



Prof. Kwang-Ho Choo received his Ph.D. degree from Seoul National University, Korea, in 1996 and since then has been working on membrane science and technology for water and wastewater, pursuing innovative solutions for sustainable water production and reuse. His recent research interests include membrane electro-oxidizers and quorum quenching membrane bioreactors. He is currently keen to find synergistic options for Water-Energy Nexus issues, using membranes in conjunction with physicochemical/biological strategies, such as iron oxide adsorption, photocatalysis, electrocatalysis and microbial quorum quenching. He has been actively involved in academic societies, such as International Water Association, Korean Society of Environmental Engineers, Membrane Society of Korea and Korean Institute of Chemical Engineers, as Active Board/Editorial Member.



Prof. Mohamed Ksibi completed his Ph.D. in 1993 in Applied Chemistry at the University of Poitiers, France. He also gained the Habilitation (HDR) in Chemistry from the University of Sfax, Tunisia, in 2003. He was appointed as Full Professor of Chemistry in 2009 at the Higher Institute of Biotechnology of Sfax (ISBS). His areas of research interest include removal and toxicology assessment of persistent organic pollutants in the environment (water and sediment/soil). He has supervised ten theses to completion and examined a further five Ph.D.s. He has also supervised 15 M.Sc. theses. He has co-published about 55 papers, 8 chapters and co-edited a book (2 volumes): *Recent Advances in Environmental Science from the Euro-Mediterranean and Surrounding Regions*. He is Co-editor-in-Chief of the *Euro-Mediterranean Journal of Environmental Integration* (h-index 24). He had been Institute's Deputy Director of the ISBS from August 2011 until December 2017, and he served as Director of the Department of Biotechnology and Health at ISBS from May 2008 until May 2011. He has also been Chairman for the 1st in 2017 and the 2nd in 2019 of the Euro-Mediterranean Conference for Environmental Integration (<https://www.emcei.net>).

Nexus Framework and Governance: Economic Evaluations for Investment Projects in the Water and Energy Sectors

Water Conservation Indexing: The HVAC of Suranaree University of Technology Hospital Main Building Case

Andreas Prasetyadi and Atit Koonsrisuk

Abstract

A water conservation indexing using availability and accessibility was proposed in order to have an index that is reliable, consistent, free of site character, and easy to interpret. A year simulation of the heating ventilating and air conditioning (HVAC) system of Suranaree University of Technology Hospital (SUTH) main building was conducted for the case using TRNSYS. Water availability was applied to show the total amount actually or potentially being harnessed during the process. Accessibility indicates the fitness of the available water. The results show that indexes of the water conservation of the system in 22, 24, and 26 °C temperatures setting are around 50%. It implies that there are amount of unused water. The higher the temperature setting is the less conserving the system becomes.

Keywords

Index of water conservation • Energy water nexus • HVAC

1 Introduction

Water conservation is a main issue and needs a metric to be measured (Proença and Ghisi 2010). Water conservation metrics tend to be biased of location due to uneven water distribution. It implies a difficulty in comparing the approaches in different locations.

A. Prasetyadi (✉)
Sanata Dharma University, Sleman, DIY 55282, Indonesia
e-mail: pras@usd.ac.id

A. Koonsrisuk
Suranaree University of Technology, Nakhon Ratchasima,
30000, Thailand

Indexing water conservation as a mix of quantity and quality of the water at use was proposed as a metric. The index shows the system performance level in conserving water during its use process. The metric ability to be free of location bias with different water potential conditions is expected.

2 Methods

The water conservation index has two main important features. They are water availability showing all the water amounts that people can obtain from the process and water accessibility. The concepts are derived from the work of Georgescu-Roegen (1975) about thermoeconomics. Generally, both metrics show the ratio of the actual condition over the ideal one.

2.1 Water Availability, Capped Water Availability, and Water Accessibility

Water availability (W_{av}) is determined to show ratio of available water over utilized water at the point of use through Eq. (1). W_a and W_r are the available water and the water required for the process, respectively.

$$W_{av} = W_a / W_r \quad (1)$$

The capped water availability (\hat{W}_{av}) shows ratio of water usage over available water at the point of use with maximum condition of 1 and is defined in Eq. (2).

$$\hat{W}_{av} = \begin{cases} 1, & 1 < (W_a / W_r) \\ W_a / W_r, & 1 > (W_a / W_r) \end{cases} \quad (2)$$

Water accessibility (W_{ac}) shows the water provision fitness to the water requirement. It is determined by Eq. (3) with C_i is the water energy coefficient.

$$W_{ac} = \sum_{i=1}^n C_i \hat{W}_{av,i} / \sum_{i=1}^n C_i \quad (3)$$

2.2 Water Conservation Level

The conservation level of water is defined as a score leveling system in conserving water amount and quality during the usage. It is calculated using Eq. (4), with W_{av}^* is determined by Eq. (5). WC is the water conservation level, and W_{av}^* is the availability factor.

$$WC = W_{ac} * W_{av}^* \quad (4)$$

$$W_{av}^* = \begin{cases} W_{av}, & 1 \leq W_{av} \\ W_{av}^{-1}, & 1 > W_{av} \end{cases} \quad (5)$$

2.3 SUTH Main Building HVAC Water

A year TRNYS simulation of the HVAC hospital system was conducted to find the HVAC water data as shown in author's former work (Prasetyadi and Koonsrisuk 2019). The procedure is shown in Fig. 1.

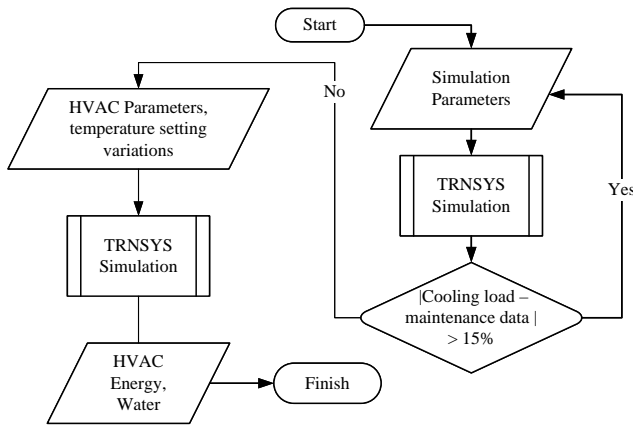


Fig. 1 Procedure of simulating the HVAC system of SUTH main building

3 Results and Discussion

The application of the coefficients to the water mentioned in Table 1 can provide the water availability, water accessibility, and water conservation level as shown in Table 2. The table shows that water accessibility of the system is 1 in various temperature settings. The table also reveals that the water need can be fulfilled in those temperature settings. The water conservation level is different for the temperature settings. The higher the temperature setting is the lower the water conservation level becomes.

Table 2 indicates that the system does not utilize water effectively. This is shown by the water availability score, being greater than 1 and was confirmed by the water accessibility score (1). If the water accessibility score is less than 1, but its availability score exceeds 1, the water conservation level is less than 1. The condition indicates that there is a water supply quality problem. In terms of amount, there is enough water, but it does not meet the requirement. If water availability and accessibility are less than 1, it shows that the system suffers from a shortage in the water supply.

The pattern relation of water availability and conservation level is shown in Fig. 2. When the water accessibility is less than 1, or the water quality does not match the requirement, water conservation becomes less than 1.

The water treatment and processing coefficients do not affect the index scale. Water accessibility is calculated using the energy for the water treatment and processing. The coefficient actually varies and depends on the site. However, Eq. (3) set shows that the maximum of accessibility becomes 1. This implies that the water conservation should not sacrifice the designed system capacity operation. Accordingly, the number is also free of the site character. Therefore, the water index conservation does not depend on the site.

4 Conclusion

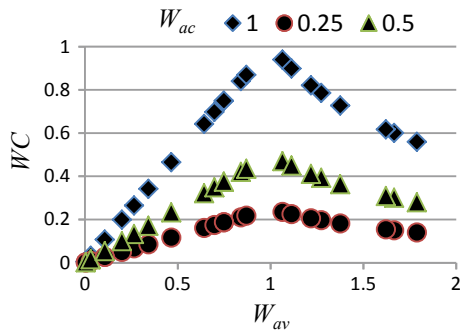
A water conservation index using availability and accessibility was developed and applied to HVAC system of SUTH main building with score of 0.50. The index is free of the site treatment and processing coefficients. It has range of 0–1

Table 1 Type of water, daily water amount, and its coefficient

Water type	Amount of water in m ³ at temperature setting			Coefficient (Wakeel et al. 2016) (kWh/m ³)	Note
	22 °C	24 °C	26 °C		
Tap water	38.54	27.96	20.89	0.22	Main resource
Softener water	38.54	27.96	20.89	0.36	Water requirement
Brine	6.42	4.66	3.48	0.22	Alternative resource
Condensate	29.10	21.30	17.40	0.36	Alternative resource

Table 2 Water availability, accessibility, and conservation levels at various temperature settings

Temperature setting (°C)	Water availability	Water accessibility	Water conservation level
22	1.92	1	0.52
24	1.93	1	0.52
26	2.00	1	0.50

**Fig. 2** Relation of water availability (W_{av}) and water conservation (WC). Water accessibility becomes the coefficient determining the maximum of water conservation, as well

with the higher score indicating a better condition of water usage. It shows the effect of temperature setting on the water conservation level. The higher the temperature setting is the lower the conservation level will be. The level of water conservation indicates the level of available water utilized by the system. The temperatures setting data show that alternative water resources are potentially harnessed to meet the energy need.

References

- Georgescu-Roegen N.: Energy and economic myths south. Econ. J. (41), 347–381(1975)
- Proença, L.C., Ghisi, E.: Water end-uses in Brazilian office buildings. Resour. Conserv. Recycl. **54**, 489–500 (2010)
- Prasetyadi, A., Koonsrisuk, A.: Second law analysis of the centralized HVAC system of Suranaree University of Technology. In: Proceedings of 14th Conference on Energy, Heat and Mass Transfer in Thermal Equipments and Processes, Krabi, Thailand (2019)
- Wakeel, M., Chen, B., Hayat, T., Alsaedi, A., Ahmad, B.: Appl. Energ. (178), 868–885 (2016)