Invited International Workshop

WASTEWATER ZERO for URBAN SUSTAINABILITY AND HEALTH

Virtual

May 13-14, 2021

Sponsors and Organizing Institutions:

U.S. National Science Foundation, Project FEWSUS

The University of Tennessee, USA

Oak Ridge National Laboratory, USA

Newcastle University, UK

1. BACKGROUND

Urban systems, including cities and surrounding regions, occupy less than 4% land surface area on the earth but support 66% of population and contribute more than 80% of gross domestic product and more than 70% of greenhouse gas emissions in the world. Wastewater and fecal sludge generation is one of central concerns in cities, particularly in developing countries, where fecal waste collection and treatment infrastructure is poor and failure prone. The growth of urban populations and food-energy-water (FEW) consumption is accelerating wastewater generation, causing a series of problems that jeopardize urban health. Research has demonstrated that systematic strategies for managing FEW systems can create economically innovative approaches to reducing wastewater and maximizing its reutilization. Unfortunately, wastewater treatment in small cities or towns always encounters various barriers at technological, social, policy, and economic levels. The roots of these problems are social (e.g., lack of transdisciplinary collaborations, disengagement of stakeholders, and siloed sectoral policies) and technical (including the costs, in time and money, of innovation). Therefore, a systematic analysis on the status and challenges of urban wastewater management among researchers, stakeholders, and policymakers are essential for creating opportunities that are policy-acceptable and in support of sustainable wastewater mitigation under the United Nations' Sustainable Development Goals 6, 11, and 12.

2. GOAL AND OBJECTIVES

This meeting aims to exchange research and perspectives and establish an international working group for collaboration of transdisciplinary research, education, and outreach in the area of safe reuse of urban wastewater. Specific objectives are to:

- Summarize technological progress of wastewater treatment and reuse
- Identify opportunities at simulation, technological, sociological, and policy levels
- Develop a research menu of mitigation and reuse of wastewater

3. WORKSHOP CO-CHAIRS (in alphabetical order)

- Tom Curtis, Newcastle University, UK
- Dr. Miguel Fuentes-Cabrera, Oak Ridge National Laboratory, USA
- Frank Löffler, The University of Tennessee & Oak Ridge National Laboratory, USA
- Dr. Jie (Joe) Zhuang, The University of Tennessee, USA

4. MEETING AGENDA

THURSDAY, MAY 13, 2021 8:00-10:00 am (U.S. Eastern Time), 2:00-4:00 pm (Central European Time) 8:00-10:00 pm (Beijing Time) Zoom link: **https://tennessee.zoom.us/j/91666697232** **Chairs:** Frank Löffler, The University of Tennessee & Oak Ridge National Laboratory, USA Tom Curtis, Newcastle University, UK	
8:00-8:15 am	**"Workshop Focus: Transdisciplinary Network Development"** Jie (Joe) Zhuang, The University of Tennessee, USA
8:15-8:30 am	**"From Wastewater to Our Plate: Are We Exposed to Wastewater-derived Pollutants?"** Benny Chefez, The Hebrew University of Jerusalem, Israel
8:30-8:45 am	**"Functionalized Membranes for Enhanced Water and Wastewater Treatment"** Xie Quan, Dalian Institute of Technology, China
8:45-9:00 am	**"Sewage Stabilization Ponds and Treatment Wetlands under Warm Climate Conditions"** Marcos Von Sperling, UF Minas Gerais Team Horizonte, Brazil
9:00-9:15 am	**"Bioremediation of Urban Soil and Water: The Role of Microbes and Microbial Communities"** Michael Seeger, Technical University Federico Santa Maria, Chile
9:15-9:30 am	**"Interdisciplinary Water Research: 30 Years of Experience on Socio-Technical Innovations in Water and Environmental Sanitation"** Miguel R. Peña Varón, Universidad del Valle, Colombia
9:30-9:45 am	**"Circular Economy and Sewage Treatment in Brazil: The Contribution of The INCT Sustainable Sewage Treatment Plants"** Carlos Chernicharo, UF Minas Gerais Team Horizonte, Brazil
9:45-10:00 am	**Q & A**

FRIDAY, MAY 14, 2021 8:00-10:00 am (U.S. Eastern Time), 2:00-4:00 pm (Central European Time) 8:00-10:00 pm (Beijing Time) Zoom link: **https://tennessee.zoom.us/j/91666697232** **Chairs:** Miguel Fuentes-Cabrera, Oak Ridge National Laboratory, USA Jie (Joe) Zhuang, University of Tennessee, USA	
8:00-8:15 am	**"Towards Full-scale Modelling of Microbial Communities Using Individual-based Models"** Paolo Zuliani, Newcastle University, UK
8:15-8:30 am	**"Application of Deep Learning Techniques to Microbial Images: Using Variational Autoencoders for Classifying the Shape of Bacterial Micro-Compartments in Cyanobacteria"** Miguel Fuentes-Cabrera, Oak Ridge National Laboratory, USA
8:30-8:45 am	**"Going Beyond, Scaling and Tuning Microbial Simulations towards Real-world Systems"** Stephen McGough, Newcastle University, UK
8:45-9:00 am	**"Individual-based Models: A Key Factor to Understand and Study Wastewater Systems"** Pablo Alejandro Araujo Granda, Universidad Central del Ecuador, Ecuador
9:00-9:15 am	**"Zeolite As a Chromium VI Removal Agent in Real Tannery Effluents"** Carolina Montero, Universidad Central del Ecuador, Ecuador
9:15-9:30 am	**"Semiconductor Photocatalysis for Toxicity Reduction of Urban and Industrial Wastewaters"** Juan Carlos Salcedo-Reyes, Pontificia Universidad Javeriana, Colombia
9:30-10:00 am	**Q & A and Group Discussion on Collaboration**

5. BIOGRAPHY OF INVITED SPEAKERS AND WORKSHOP CHAIRS

(in alphabetical order)

Dr. Pablo Araujo is a professor in Chemical Engineering Faculty at Universidad Central del Ecuador. He received his B.S. degree in 1999 in Chemical Engineering from Central University of Ecuador, M.S. Executive in 2004 in industrial Enterprises Management from Industrial Organization School -EOI, Madrid, Spain, and PhD degree in 2017 in Food Technology and Biotechnology from Universitat Politècnica de Catalunya, Barcelona, Spain. He served as director of many research projects in the past decade. His current research interest is focused on organic chemistry, biotechnology, and individual-based models. He is also a scientific communicator, cyclist, hiker, mountaineer, and amateur photographer

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Dr. Benny Chefetz is a Professor of Soil and Environmental Chemistry, Columbia Foundation Chair in Soil and Water Sciences, and Dean of R.H. Smith Faculty of Agriculture, Food and Environment, The Hebrew University of Jerusalem. He also directs The Hebrew University Center of Excellence in Agriculture and Environmental Health since 2011. His research interests relate to physico-chemical processes of organic pollutants occurring in water, reclaimed wastewater, soils and sediments. An overarching goal is to elucidate physical, chemical and biological processes that influence the fate of organic molecules in the environment with special emphasize on the agricultural environment. Special interests are: (1) Fate of pharmaceutical compounds in soil and water; (2) Sorption-desorption behavior of xenobiotics in soils and sediments; (3) Irrigation with reclaimed wastewater: effects on human health; (4) Nano particles in the environment; (5) Nature and reactivity of dissolved organic matter.

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Prof. Thomas P. Curtis was graduated in Microbiology and migrated to Environmental Engineering taking an MEng and PhD in Public Health Engineering at Leeds University on waste stabilisation ponds mostly in Brazil (WSP). He undertook prize winning research that hypothesised and demonstrated a wholly unexpected natural disinfection mechanism at work in WSP. After a period in construction in the Middle East and two years in Public Health Policy (on microbial risk assessment) with the UK government he joined Newcastle University where he is now holds The Tyne and Wear Chair in Environmental Control Engineering. His core interest is now the engineering of real open microbial systems and his abiding belief is that these systems obey a suite of fundamental rules and that engineers will only unlock the power of such systems when they grasp those rules. Working with mathematicians and modellers he has exploited and developed tools, concepts and theories that support this end. He has become particularly well known for his work on the prediction and engineering of the diversity and community assembly of

microbial communities. He is using this knowledge to develop energy neutral wastewater treatment technologies including low temperature anaerobic treatment of domestic wastewater and microbial electrolysis cells. He was an EPSRC Dream fellow and lead an EPSRC Frontiers in Engineering grant.
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Dr. Carlos Augusto de Lemos Chernicharo got his Ph.D. in Environmental Engineering from the University of Newcastle, UK. He was a full professor at the Federal University of Minas Gerais (Brazil) until his retirement in early 2020. He is a researcher of the Brazilian Council for Scientific and Technological Development (CNPq) and IWA Fellow. He is also Coordinator of the National Institute of Science and Technology on Sustainable Sewage Treatment Plants (INCT Sustainable STPs). Since 2013 he has been a guest lecturer at the IHE Delft Institute for Water Education. Before moving to academia, he had gained extensive experience working in international consultancy projects in the sanitation sector. Such experience has fostered the development of an internationally recognized group on applied research on anaerobic sewage treatment. Overall, he has authored/coauthored 6 books, 20 book chapters, more than 300 papers published in scientific journals and conference proceedings.
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Dr. Miguel Fuentes-Cabrera is a staff member of the Center for Nanophase Materials Sciences, Oak Ridge National Laboratory. He received his Ph.D. in Physics from the University of La Laguna, Canary Islands, Spain. Dr. Fuentes-Cabrera uses computational techniques to study a variety of problems from condensed matter to biology to microbiology. During the past years, he has been using machine and deep learning techniques to analyze experimental and simulated images of microbial communities as a way of providing figures-of-merits to gauge and improve the accuracy of simulations models.
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Dr. Juan Carlos Salcedo-Reyes is a full professor in the Physics Department, Faculty of Sceinces, Pontificia Universidad Javeriana, Colombia. He received his B.S. and M.S. degrees in Physics in 1997 and 2000, respectively, from Universidad Nacional de Colombia and Ph.D in 2005 from Cinvestav, México. He did a postdoctoral research of nanotechnology at the University of Texas, Dallas, USA in 2006 and a postdoctoral research of metamaterials at the Materials Science Institute, Madrid, Spain in 2012. His main research interests include semiconductor nanotechnology development and purification of domestic and industrial wastewater using visible semiconductor photocatalysis technologies.
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Dr. Frank Löffler received a B.S. degree in Biology and an M.S. degree in microbiology from the University of Hohenheim in Stuttgart, Germany. He performed his doctoral studies in biotechnology at the Technical University Hamburg-Harburg and received a Ph.D. degree (summa cum laude) in 1994. As an Alexander von Humboldt fellow, he conducted research in the NSF Center for Microbial Ecology at Michigan State University, before joining the School of Civil & Environmental Engineering at the Georgia Institute of Technology in Atlanta, GA. Since 2010, Dr. Loeffler serves as Governor's Chair Professor at the University of Tennessee and Oak Ridge National Laboratory, and he directs the university's Center for Environmental Biotechnology since 2016. The Loeffler laboratory explores the physiology, diversity, distribution, and ecology of microbes that control the turnover of nutrients and pollutants, with the ultimate goal to harness, manipulate, and predict their functions in both natural and managed habitats.
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Dr. Stephen McGough is a Senior Lecturer (Associate Professor) in Data Science within the Scalable Computing Group in the School of Computing Science at Newcastle University, UK. Stephen's research is in the areas of Machine Learning, Cloud Computing, Security, Big Data, and Sustainable Computing. He is a member of the EPSRC Peer College UK, member of the editorial board for the Journals of Sustainable Computing: Informatics and Systems, and a member of the editorial advisory board for the Journal of Open Research Software. Stephen has a substantial track-record for funding in the cross-sectional area of Big Data, machine learning and security having secured six competitively tended projects from funders such as the Defence Science and Technology Laboratory (UK) and the Engineering and Physical Sciences Research Council (UK). Stephen also holds a fellowship at the Alan Turing Institute, UK and held the position of Researcher in Residence at the Digital Catapult, UK.
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Dr. Carolina Montero is an Aggregate Professor at Chemical Engineering Faculty- Universidad Central del Ecuador since 2015. She was hired as a professor at Environmental Master´s Program-Universidad de las Fuerzas Armadas ESPE since 2017; Chemical Engineering Applied Master's Program-Escuela Politécnica de Chimborazo since 2018, Chemical Master´s Program- Universidad Técnica de Ambato; Ecuador. She received her bachelor's degree in Chemical Engineering in 2007 from Universidad Central del Ecuador and M.S. degree in 2009 and Ph.D. in 2015 in Chemical engineering process and sustainable development from Basque Country University, Spain. She received scholarships from Fundación Carolina (Spain) and SENESCYT (Ecuador). She is a Member of the National Sciences Academy from Ecuador since 2020. She won Central University Award in 2018 and 2020 in the STEAM area. Her

research interests are focused on heterogeneous catalyst, waste valorization, and wastewater treatment. She is a Senior researcher of five projects funded by UCE since 2016 and 1 project funded by SENESCYT. She has published 16 papers on journals indexed on SCOPUS; 2 on journals indexed on LATINDEX, and more than 30 conference papers. She is a reviewer from several journals as International Journal of Hydrogen Energy, Chemical Engineering & Processing: Process Intensification, Journal of Catalysis, Recent Innovations in Chemical Engineering, ACS Sustainable Chemistry & Engineering, and others. She was an external reviewer to research projects of National Science Centre, Poland (2020); IKIAM University, Ecuador (2019-2020), Cuenca University, Ecuador (2018-2019), Technologycal and Pedagogycal, Colombia (2018). She was an external reviewer of Doctoral Thesis from Basque Country University, Chemical Engineering Department (2018-2019). She is the lead of Research Office of Chemical Engineering Faculty, Universidad Central del Ecuador.
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Dr. Michael Seeger Pfeiffer is a Full Professor in Biotechnology, Biochemistry and Microbiology at Chemistry Department, Technical University Federico Santa Maria in Valparaiso, Chile. He is Director of the Laboratory of Molecular Microbiology and Environmental Biotechnology and Senior Scientist of the Center for Biotechnology "CBDAL". He is Biochemist and PhD in Biology of Universidad de Chile. His PhD thesis was conducted at German Research Centre for Biotechnology (Braunschweig, Germany) with Prof. Kenneth N. Timmis and Dr. Bernd Hofer. He is author of 100 WoS paper, 2 books, and 28 scientific publications on microbial metabolism and genetics, bioremediation, microbial ecology, bacterial leaching, and synthesis of bioproducts and nanoparticles. He is inventor of 5 international patent families. He has guided 15 postdocs, 34 PhD, and 38 Master/undergraduate students. He is Director of the Biotechnology PhD program UTFSM-PUCV, Coordinator of the Latin American Network of Biotechnology PhD programs RIABIN since 2009, and member of Milano-Bicocca Environmental Sciences PhD program (Italy, 2017-2021). He received the "Scopus-Conicyt" award 2013 for the highest impact research in Biology & Biotechnology in Chile, American Academy of Microbiology fellowship (2009), German Max Planck Society fellowship (Dec 2010 - March 2011) and was awarded with the Honorary Membership of the Chemical Society of Cuba (2018). He was president of Latin American Association of Microbiology (2004-2006) and Chilean Society of Microbiology (2004-2008), member of National Biotechnology Committee (2001-2006), FONDECYT Biology panel (2003-2007) and SOMICH Membership Committee (2012-2019), and co-Chair of First Latin American ISME-LA 2019 meeting (Valparaiso, Chile). Since March 2021 he is director of the Chilean Society of Biology. At international meetings, He has been president of the Organizing Committee, XVIII Latin American Congress of Microbiology and XXVIII Chilean Congress of Microbiology (Pucón, Chile, 2006) and vice president of the Organizing Committee of the XIX Latin American Congress of Microbiology (Quito, Ecuador, 2008), and co-Chair or the First Latin-American ISME-LA 2019 meeting

(Valparaiso, Chile, 2019). At national meetings, he has been president of the Organizing Committees of XXIV Chilean Congress of Microbiology (Punta de Tralca, 2002), XXVI Chilean Congress of Microbiology (Valparaíso, 2004), XXVII Chilean Congress of Microbiology and XLVIII Annual Meeting Biology Society (Pucon, 2005), and XXIX Chilean Congress of Microbiology (Viña del Mar, 2007).
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Dr. Xie Quan is a distinguished professor of Faculty of Chemical Engineering and Environmental & Biological Science and Technology at Dalian University of Technology. He currently serves as the Director of the Key Laboratory of Industrial Ecology and Environmental Engineering, Ministry of Education of China. He received B.S and M.S. degrees of chemistry at Northeast Normal University and received his PhD degree in 2000 from Karl-Franzens University of Graz, Austria. Dr. Quan has been a member of the Disciplinary Appraisal Panels under the Academic Degrees Committee of the State Council since 2009. His research interests include: (1) Advanced oxidation technologies (AOTs) for water and wastewater treatment (catalytic ozonation, Fenton reaction, photo- or electrocatalytic processes for water/wastewater treatment), (2) Environmental functional materials for pollution control, and (3) Promotion of biochemical treatment of wastewater by means of chemical approaches. He coauthored more than 500 journal papers with more than 26,000 citations. He won the Second Prize of State Natural Science Award of China in 2011, and the Second Prize of State Technological invention Award of China in 2017.
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Dr. Marcos Von Sperling is a civil engineer working in the field of wastewater treatment, full professor in the Department of Sanitary and Environmental Engineering at Federal University of Minas Gerais, Brazil, and Fellow of the International Water Association (IWA). He is an International Honorary Member of the American Academy of Environmental Engineers and Scientists (AAEES). He serves as Editor of the IWA Journal on Water Sanitation and Hygiene for Development and Coordinator of the IWA Specialist Group on Wastewater Pond Technology (2009-2013). Dr. Sperling received his PhD in Environmental Engineering from Imperial College London (UK) in 1990 and MSc in Sanitary Engineering from Federal University of Minas Gerais (Brazil) in 1983. His training experiences include specialization in Sanitary Engineering (IHE Delft, The Netherlands, 1981) and graduation in Civil Engineering (Federal University of Minas Gerais, Brazil, 1979). He was a guest lecturer at IHE Delft and authored seven textbooks on wastewater treatment, which were published in English (IWA Publishing), Portuguese, and Spanish, and more than 400 papers in scientific journals and conference proceedings.
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Dr. Miguel R. Peña Varón (Colombia) is full Professor in Environmental Science and Engineering at the Universidad del Valle, in Cali, Colombia. He was former Director of CINARA Institute at the Faculty of Engineering period 2014-2017. Professor Peña is a Sanitary Engineer from Universidad del Valle, earned his M.Sc degree in Engineering and Tropical Public Health from the University of Leeds, United Kingdom, and is also a Ph.D. from the same British university. He is currently a candidate for a Master of Arts degree in philosophy at the Department of Philosophy of the Universidad del Valle, with a dissertation on Environmental Ethics. Prof. Peña is a researcher in the areas of ecological engineering to solve environmental pollution problems; he also works on environmental health issues, specifically on the topic of environmental pollution and its impact on human health. In the last ten years he started a new area of research on environmental ethics as a framework to analyse conflicts in the *Society: Nature* relationship. He is also the author of several international articles in renowned environmental science and environmental engineering journals, has written several book chapters in co-authorship and is currently finishing the writing of two books on the subject of Nature Based Solutions for bioremediation of aquatic pollution. Professor Peña was formerly an Associate Editor of Water Science and Technology Journal at the International Water Association-IWA, in the period 2011-2019. He is currently being appointed as Review Editor of the International Journal of Public Health at FRONTIERS open access publishing system.

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Dr. Jie (Joe) Zhuang is a professor in Department of Biosystems Engineering and Soil Science and Center for Environmental Biotechnology at the University of Tennessee, Knoxville, USA. He has served as the deputy director of the China-US Joint Research Center for Ecosystem and Environmental Change since 2007. Dr. Zhuang created a US-China 100-PhD Program in Food, Energy and Environment in 2014 and has recruited more than 40 students for PhD study in the United States. Currently, with the financial support of National Science Foundation of the United States, Dr. Zhuang leads a project aiming to develop a global transdisciplinary research network of the nexus of food, energy, and water systems for supporting urban sustainability. This transdisciplinary project involves researchers, students, stakeholders, and policy-makers of many countries of the world. Over the past two decades, Dr. Zhuang has worked on many challenging research projects in the United States, Japan, and China. His research focuses on the fate and transport of contaminants (e.g., viruses, bacteria, colloids, emerging organic chemicals, radionuclides, and munitions constituents), physical foundation of soil viral ecology, soil hydrology modeling, and plant-water relations. He has been editorial board member or guest editor for eight international journals and serves more than 60 international journals as ad hoc reviewer. Dr. Zhuang has published more than 120 referred papers and book chapters and given more than 40 invited talks worldwide.

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Dr. Paolo Zuliani is Senior Lecturer (Associate Professor) in the School of Computing at Newcastle University, UK. He received his Laurea degree in computer science from the Universita' degli Studi di Milano, Italy, and his DPhil in computer science from the University of Oxford, UK. Dr. Zuliani's expertise lies largely in computational modelling and formal, automated methods for reasoning about computing systems, with an emphasis on systems biology and systems medicine. He is in particular interested in the verification of cyber-physical systems, biological and medical systems, and in efficient techniques for individual-based modelling of microbial systems and of skin diseases (psoriasis).

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