

# Quantification and Modelling of Fugitive Greenhouse Gas Emissions from Urban Water Systems

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# Quantification and Modelling of Fugitive Greenhouse Gas Emissions from Urban Water Systems

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Edited by

Liu Ye, Jose Porro and Ingmar Nopens



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# List of Contributors

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**Ahlem Filali**

Université Paris-Saclay, France

**Amanda Lake**

Jacobs, Scotland

**Antonio Delre**

Department of Environmental Engineering,  
Technical University of Denmark, Denmark

**Ariane Coelho Brotto**

Jacobs, UK

**Barth F. Smets**

Department of Environmental Engineering,  
Technical University of Denmark, Denmark

**Bing-Jie Ni**

Advanced Water Management Centre, The  
University of Queensland, Australia

**Carlos Domingo-Félez**

Department of Environmental Engineering,  
Technical University of Denmark, Denmark

**Chris Sweetapple**

Centre for Water Systems, College of  
Engineering, Mathematics and Physical  
Sciences, University of Exeter, UK

**David Butler**

Centre for Water Systems, College of  
Engineering, Mathematics and Physical  
Sciences, University of Exeter, UK

**Eveline I.P. Volcke**

Department of Green Chemistry and  
Technology, Ghent University, Belgium

**Evina Katsou**

Department of Civil & Environmental  
Engineering, Brunel University London, UK

**Fabrizio Sabba**

Department of Civil and Environmental  
Engineering and Earth Sciences, University of  
Notre Dame, USA

**Giacomo Bellandi**

AM-TEAM, Belgium

**Guangtao Fu**

Centre for Water Systems, College of  
Engineering, Mathematics and Physical  
Sciences, University of Exeter, UK

**Haoran Duan**

School of Chemical Engineering, The University  
of Queensland, Australia

**Ingmar Nopens**

Biomath, Ghent University, Belgium  
Captur

**Jose Porro**

Cobalt Water Global, Inc, USA

**Keshab R. Sharma**

Advanced Water Management Centre, The  
University of Queensland, Australia

**Krist V. Gernaey**

Process and Systems Engineering Centre,  
Department of Chemical and Biochemical  
Engineering, Technical University of Denmark,  
Denmark

**Liu Ye**

School of Chemical Engineering, The University  
of Queensland, Australia

**Lluís Corominas**

Catalan Institute for Water Research, Spain

**Longqi Lang**

TBI, Université de Toulouse, CNRS, INRAE,  
INSA, France

**Magnus Arnell**

Unit of Urban Water Management, RISE  
Research Institutes of Sweden, Sweden  
Division of Industrial Electrical Engineering  
and Automation, Department of Biomedical  
Engineering, Lund University, Sweden

**Maite Pijuan**

Catalan Institute for Water Research, Spain  
The University of Girona, Spain

**Mark C.M. van Loosdrecht**

Department of Biotechnology, Delft University  
of Technology, The Netherlands

**Mathieu Spérandio**

TBI, Université de Toulouse, CNRS, INRAE,  
INSA, France

**Matthijs R.J. Daelman**

Department of Biotechnology, Delft University  
of Technology, The Netherlands

**Oriol Gutierrez**

Catalan Institute for Water Research, Spain  
The University of Girona, Spain

**Peter A. Vanrolleghem**

ModelEAU, Département de génie civil et de  
génie des eaux, Université Laval, Canada

**Robert Nerenberg**

Department of Civil and Environmental  
Engineering and Earth Sciences, University of  
Notre Dame, USA

**Ulf Jeppsson**

Division of Industrial Electrical Engineering  
and Automation, Department of Biomedical  
Engineering, Lund University, Sw4424

**Vanessa Parravicini**

TU Wien, Institute for Water Quality, Resource  
and Waste Management, Austria

**Vasileia Vasilaki**

Department of Civil & Environmental  
Engineering, Brunel University London, UK

**Xavier Flores-Alsina**

Process and Systems Engineering Centre,  
Department of Chemical and Biochemical  
Engineering, Technical University of Denmark,  
Denmark

**Yinfen Zhao**

School of Chemical Engineering, The University  
of Queensland, Australia

**Ziping Wu**

School of Chemical Engineering, The University  
of Queensland, Australia

**Zhiguo YUAN**

Advanced Water Management Centre, The  
University of Queensland, Australia

# Foreword

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The *IWA Task Group on the use of water quality and process models for minimizing wastewater utility greenhouse gas footprints* and the idea of this book came about because we wanted to fill a gap in knowledge related to fugitive emissions of greenhouse gas from wastewater systems, so that we can then avoid or eliminate them. For instance, in the case of nitrous oxide ( $\text{N}_2\text{O}$ ) emissions, we wanted to better understand the  $\text{N}_2\text{O}$  mechanisms and pathways, because the mechanisms were initially thought to be associated with only one of the relevant processes, denitrification, but we later learned that they could include nitrification and multiple pathways within nitrification. Furthermore, we realized that fugitive GHG emissions in wastewater involved other aspects, such as methane ( $\text{CH}_4$ ) generation in sewers,  $\text{CH}_4$  emissions related to sludge storage and biosolids from anaerobically digested sludge, and fugitive emissions of both  $\text{CH}_4$  and  $\text{N}_2\text{O}$  from water bodies receiving discharges.

The main motivation or rationale behind the Task Group effort was to improve upon the Intergovernmental Panel on Climate Change (IPCC) emission factors or assumptions associated with quantifying GHG emissions from wastewater systems and provide corresponding tools for the industry so that any water reclamation facility in design or being retrofitted or optimized could eliminate these emissions. Specifically, the intent was to develop a more mechanistic approach to understanding the production of greenhouse gases and the use of mechanistic models to mitigate these emissions. However, it was quickly understood that developing a mechanistic model alone may not resolve or address all of the challenges in managing water utility greenhouse gas emissions; therefore, non-mechanistic approaches have also been considered, such as artificial intelligence including knowledge-based approaches and machine learning.

In terms of collaboration, what the Task Group and the overall approach to this book inevitably did was bring people together. It brought together researchers from Europe, Australia, and the United States to build a consensus-based approach, as well as to publish the models that were being developed. When the Task Group began, it was understood that it would take several years to develop consensus-based mechanistic models, as opposed to having one or several models already developed to build consensus around, which is mainly what previous Task Groups have done. The goal for this Task Group was different and tended to be a bit more ambitious by trying to spur model development

as much as also providing a consensus approach. Therefore, collaboration to integrate these models, which were mainly based on lab-scale or empirical data, as well as full-scale data-driven techniques was needed and continues today.

Fugitive emissions remain a risk. The water reclamation community is aware of this risk, but has not yet fully taken charge to address it. This is mainly because there has been a lack of tools and guidance on how to address fugitive GHG emissions. Therefore, water technology providers and consultants who implement water reclamation technologies have been making decisions in retrofits without adequate knowledge. This forward-looking book aims to change that. It is an optimistic report hoping to inspire the water community to take the lead in resolving and addressing these emissions themselves. It will provide modelers, process engineers, and water treatment practitioners with the tools and approaches to address the climate risk of GHG emissions. It also provides a science-based framework for regulators wanting to control such emissions. This book could not be more timely with respect to the climate crisis and the urgency for taking climate action. Now it's up to the water industry to put it to use and help make its mark on better protecting the planet.

**Sudhir Murthy, Ph.D., P.E.**  
*CEO of NEWhub Corp. and Senior VP of IWA*

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We believe this is a solid step in the journey to the net-zero emission goal that lies ahead of us...

From



Liu Ye (Lead Editor, The University of Queensland)



Jose Porro (Co-Lead Editor, Cobalt Water Global)



Ingmar Nopens (Editor, Ghent University)  
March 2022

For additional acknowledgements of Task Group members and supporters, please see *A note from the Task Group GHG* at the end of the book.