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

Scientific and Technical Report Series No. 26

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Published by **IWA Publishing**
Unit 104–105, Export Building
1 Clove Crescent
London E14 2BA, UK
Telephone: +44 (0)20 7654 5500
Fax: +44 (0)20 7654 5555
Email: publications@iwap.co.uk
Web: www.iwapublishing.com

First published 2022

British Library Cataloguing in Publication Data
A CIP catalogue record for this book is available from the British Library

ISBN: 9781789060454 (Paperback)
ISBN: 9781789060461 (eBook)
ISBN: 9781789060478 (ePUB)

This eBook was made Open Access in April 2022

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Foreword

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 (N_2O) emissions, we wanted to better understand the N_2O 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 (CH_4) generation in sewers, CH_4 emissions related to sludge storage and biosolids from anaerobically digested sludge, and fugitive emissions of both CH_4 and N_2O 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

Acknowledgements

Our sincere thanks to all the reviewers listed below (in alphabetical order) for their contributions to this important work.

- Adrian Oehmen, *The University of Queensland*
- Ben van den Akker, *South Australian Water Corporation*
- David de Haas, *GHD*
- Ignasi Rodriguez-Roda, *University of Girona*
- Imre Takács, *Dynamita*
- Joaquim Comas, *University of Girona and Catalan Institute for Water Research*
- Keshab Sharma, *The University of Queensland*
- Maite Pijuan, *Catalan Institute for Water Research*
- Romain Lemaire, *Veolia*
- Vanessa Parravicini, *TU Wien*
- Yan Zhou, *Nanyang Technological University*

We wish to acknowledge the significant contributions made by all the authors, especially the lead authors in each of the chapters, and their collaborative approach to delivery of this book.

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.