



Removal/recycling microcontaminants and plastic pollution in waters and soils through physical, chemical and/or biological processes

Joaquin R. Dominguez^{1,2} · Helder T. Gomes³ · Paulo A. Augusto⁴ · Juan García⁵ · Gassan Hodaifa⁶ · Silvia Álvarez-Torrellas⁵ · José A. Peres⁷ · Miguel Minhalma⁸ · Ana Charas⁹

© The Author(s), under exclusive licence to Springer-Verlag GmbH Germany, part of Springer Nature 2026



Preface

This Special Issue of *Environmental Science and Pollution Research* (ESPR) is dedicated to the scientific contributions presented at three international conferences held consecutively in Lisbon, Portugal, from 24 to 31 July 2024: the **7th International Congress on Water, Waste and Energy Management (WWEM-24)**, the **6th International Conference on Green Chemistry and Sustainable Engineering (GreenChem-24)**,

and the **3rd International Conference on Green Energy and Environmental Technology (GEET-24)**. These events, organized within a consolidated biennial series, have progressively become reference points for the global environmental science community, offering a structured platform for interdisciplinary discussion and fostering collaboration among researchers, industry leaders, policymakers, and emerging scientists.

Responsible Editor: Philippe Garrigues

✉ Joaquin R. Dominguez
jrdoming@unex.es

- ¹ Department of Chemical Engineering and Physical Chemistry, Area of Chemical Engineering, Faculty of Sciences, Universidad de Extremadura, Avda. de Elvas, S/N, 06006 Badajoz, Spain
- ² Instituto Universitario de Investigación del Agua, Cambio Climático y Sostenibilidad (IACYS), Avda de La Investigación S/N, 06006 Badajoz, Spain
- ³ Polytechnic Institute of Bragança. Campus de Santa Apolónia, 5300-253 Bragança, Portugal
- ⁴ Department of Chemical Engineering, Faculty of Chemical Sciences, University of Salamanca, Salamanca, Spain

- ⁵ Chemical Engineering and Materials Department, Faculty of Chemistry, Universidad Complutense de Madrid, Avda. Complutense S/N, 28040 Madrid, Spain
- ⁶ Molecular Biology and Biochemical Engineering Department, Chemical Engineering Area, University of Pablo de Olavide, 41013 Seville, Spain
- ⁷ Department of Chemistry, University of Trás-Os-Montes and Alto Douro, Quinta de Prados, 5001-801 Vila Real, Portugal
- ⁸ Instituto Superior de Engenharia de Lisboa, Instituto Politécnico de Lisboa, ISEL, Lisbon, Portugal
- ⁹ Instituto de Telecomunicações, Lisbon, Portugal

Historical evolution of the conference series

Since their inception more than a decade ago, the WWEM, GreenChem, and GEET conferences have evolved from modest, specialized meetings to internationally recognized scientific forums. Their historical trajectory reflects the maturation of environmental research itself: from early studies focused on pollutant characterization and isolated remediation strategies to the present-day emphasis on integrated environmental management, circular-economy methodologies, and the deployment of advanced, multifunctional technologies.

The WWEM series, initially created in 2012 to address scientific advances in water and wastewater treatment, gradually incorporated broader environmental dimensions, including waste valorisation, energy recovery, and resource optimisation. GreenChem built upon the growing recognition that green chemistry principles—prevention, atom economy, benign solvents, renewable feedstocks—should underpin not only laboratory-scale synthesis but also industrial and engineering applications. The GEET conference series, comparatively younger, emerged as global discussions around sustainable energy intensified, encompassing renewable technologies, energy storage, low-carbon infrastructures, and environmental–energy system interactions.

Together, these conferences illustrate a shift in environmental science: from reactive, contaminant-focused approaches toward integrative, systems-oriented solutions that acknowledge the complexity and interdependence of natural and human-made environments.

Scientific significance and global context

The 2024 edition brought together more than 300 participants from 31 countries, representing an impressive range of scientific perspectives and geographic contexts—from Europe and the Americas to Africa, the Middle East, and Asia. This diversity highlights not only the global nature of contemporary environmental challenges but also the uneven distribution of environmental burdens and technological capabilities.

The conference themes resonate strongly with current global concerns. Climate change, biodiversity loss, water scarcity, emerging contaminants, microplastic pollution, and the increasing demand for critical raw materials are shaping new scientific priorities. Simultaneously, the transition toward sustainable energy systems, the growing demand for circular resource flows, and environmental justice

considerations are driving new lines of inquiry that bridge engineering, chemistry, and environmental governance.

Against this backdrop, WWEM-24, GreenChem-24, and GEET-24 served as key arenas for presenting high-quality research addressing these multifaceted challenges through advanced scientific methodologies and innovative technological solutions. Over 300 contributions—including plenary lectures, oral communications, and poster presentations—demonstrated the field's ongoing evolution and the scientific community's willingness to engage in interdisciplinary efforts.

Overview of contributions to this Special Issue

This Special Issue presents a curated selection of manuscripts that successfully passed the rigorous peer-review standards of ESPR. Although the initial thematic focus – “*Removal of microcontaminants (organic or inorganic) and plastic pollution in surface waters and soils through physical, chemical and/or biological processes*” – served as the conceptual framework, the final selection reflects both the diversity of research presented at the conferences and the journal's commitment to scientific excellence.

The published contributions address a spectrum of environmental challenges through experimental, modelling, and materials-science approaches, including:

- A baseline evaluation of metal and microplastic contamination in sediments from a small harbour in the western Baltic Sea, providing critical spatial and compositional data relevant for marine ecosystem management.
- An assessment of water reserve adaptation strategies under climate change in Romania, combining hydrological modelling with practical insights for water governance.
- An investigation of shredded vehicle tyres as microplastic sources influencing soil stabilization behaviour, contributing to both geotechnical engineering and microplastic research.
- The synthesis of activated carbon from sewage sludge using phosphoric acid, demonstrating innovative waste-to-resource methodologies.
- Novel sorbents for hydrometallurgical recovery of gold from electronic waste, reflecting the growing importance of critical metal recovery and circular economy principles.

- A study on ZnFeAl hybrid materials formed via in-situ incorporation of Fe(II,III) into ZnAl-LDHs, revealing enhanced performance in Cr(VI) photoreduction and advancing photocatalytic material development.

Collectively, these papers contribute to the broader scientific discourse on pollution control, environmental remediation, sustainable resource management, and environmental technology innovation.

The role of ESPR in advancing environmental knowledge

The alliance between these conferences and *Environmental Science and Pollution Research* is especially appropriate. ESPR has long served as one of the central publication platforms for scientists investigating environmental pollution, treatment technologies, sustainability science, and environmental risk assessment. Its editorial philosophy—rigorous methodological scrutiny, relevance to real-world environmental problems, and interdisciplinary openness—aligns closely with the scientific spirit of WWEM, GreenChem, and GEET.

In the current global context, characterized by rapid environmental change and increasing resource pressures, journals like ESPR play a crucial role in validating, disseminating, and archiving high-quality scientific knowledge. Their contribution extends beyond publication: they structure scientific discourse, define methodological standards, and enable the global research community to engage in continuous, evidence-based dialogue.

Acknowledgements As corresponding Guest Editor, I wish to extend my most profound appreciation to all members of the Organizing and Scientific Committees, whose sustained efforts and scientific leadership made the 2024 conference series possible. My special thanks go to Profs. Drs. Miguel Minhalma and Ana Charas from the Instituto Superior de Engenharia de Lisboa (ISEL) and the Instituto de Telecomunicações (IT) de Lisboa, whose commitment, scientific expertise, and collaboration were fundamental throughout the coordination of this Special Issue. We also express our gratitude to the Instituto Politécnico de Lisboa (IPL) for sponsoring these events.

My gratitude extends further to Mr. Javier L. and the entire Technical Secretariat team at Sciknowledge Education, whose professionalism, operational efficiency, and attention to detail were indispensable to the success of the events. I also acknowledge the contributions of all authors, whose research enriches this volume; the invited speakers, for their visionary insights; the reviewers, for their thorough and constructive evaluations; and the institutional sponsors, whose support strengthens the continuity and impact of these conferences.

I also wish to express my sincere appreciation to Prof. Dr Philippe Garrigues, Editor-in-Chief of ESPR, for his steadfast support, commitment to scientific quality, and trust in the significance of this Special Issue. My gratitude extends to Ms. Florence Delavaud as well, whose exemplary editorial assistance and professionalism ensured the seamless progression of the publication process. Without their guidance and collaboration, this Special Issue would not have reached its present form.

Looking ahead

As we move forward, it is clear that the challenges confronting environmental science will grow in scope and complexity. The interconnected crises of climate instability, ecological degradation, chemical pollution, and resource scarcity demand multidisciplinary approaches grounded in rigorous science, innovation, and international collaboration. Conferences such as WWEM, GreenChem, and GEET—and journals such as ESPR—will continue to play essential roles in shaping this evolving landscape.

We therefore look forward to the subsequent editions of these conferences, scheduled for 22 to 29 July 2026 in the Canary Islands, Spain, with optimism and renewed commitment. We anticipate that they will once again gather the global scientific community to share new knowledge, forge collaborations, and catalyse the development of sustainable technologies that protect and restore the environment.

With my highest regards,
 Prof. Dr Joaquin R. Dominguez
 Full Professor of Chemical Engineering,
 Department of Chemical Engineering,
 University of Extremadura,
 Avda. de Elvas s/n, 06006 Badajoz, Spain.
 Email: jrdoming@unex.es.

Publisher's Note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.



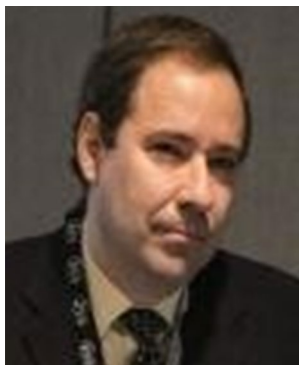
Joaquin R. Dominguez Has a degree (1996) and a PhD (2000) in Chemistry from the University of Extremadura, Spain, both with honours and obtaining the research excellence prize of the University in 2001. In 1997–2000, he held a MEC FPU Pre-doctoral Fellowship with Pre-doctoral and Post-doctoral stays at the "Instituto Superior Tecnico", Lisbon (Portugal). In 2001 he became an Assistant Lecturer in the Department of Chemical Engineering at the University of Extremadura (Spain). In Decem-

ber 2007, he became an Associate Professor in the Department, and in 2023, Dr Dominguez reached a Full Professor position. His research interests focus on water and wastewater treatment, removal of micropollutants and emerging contaminants from water using advanced oxidation processes, AOPs, (ozone, Fenton's reagent, hydrogen peroxide, persulphate, UV and VIS radiation, and their possible combinations). Without leaving this research line, from 2007, he centred his efforts on a new line of electrochemical treatment (anodic electrooxidation of pollutants using boron-doped electrodes) that has been genuinely fruitful. In the last three years, Dr Dominguez added a new line of sonochemical oxidation by ultrasonic waves at the MHz range (Sono-oxidation of contaminants at high frequency). Regarding his experience, Prof. Dominguez has actively participated in 24 research projects in Environment Engineering, specifically in water and wastewater treatment and removing micropollutants from water. He is the Chairman of the biannual "International Conference on Water, Waste and Energy Management (WWEM)" from 2015 to the present. Dr Domínguez has co-authored about 80 papers, 9 book chapters, and 6 scientific books about his research, obtaining an h-index = 35 (WoS). He has directed or co-directed 45 advanced research works, including 20 B.Sc. and 5 Ph.D. Theses. He has also presented 85 Communications at National and International Scientific Congresses.



Helder Gomes is Coordinator Professor at the Polytechnic Institute of Bragança (IPB), Portugal, and Coordinator of the Group “Sustainable Processes and Products” of the Mountain Research Center (CIMO). He graduated in Chemical Engineering from the Faculty of Engineering of the University of Porto (FEUP), Portugal in 1997. In 2002, and also at FEUP, he obtained the PhD degree in Chemical Engineering in the area of Heterogeneous Catalysis applied to Wastewater Treat-

ment. He joined the Department of Chemical and Biological Technology of IPB, in 2001, being Chair of his Department until 2025. Between 2016 and 2018 he was President of the Catalysis and Porous Materials Division of the Portuguese Chemical Society and, between 2018 and 2022, was Vice-President of the Iberoamerican Federation of Catalysis Societies (FISoCat), being president of FISoCat since 2024. Its main research interests are focused on the synthesis and characterization of heterogeneous carbon-based materials for environmental, biomedical and bioenergy applications, the valorization of industrial and agro-industrial wastes into materials and fuels, and the development of water/wastewater treatment solutions based on advanced oxidation processes. He has published more than 130 ISI articles and more than 300 communications at international/national congresses. Participated in 73 projects and networks, 15 as coordinator. Acts as project evaluator in several national and international agencies.



Paulo Augusto Is since 2011 an Associate Professor (Senior Lecturer) at the Faculty of Chemical Sciences and at the Faculty of Agronomy and Environmental Sciences at the University of Salamanca, Spain. Since 1998, he held Assistant Professor and other Academic and Research positions in other Universities, among others, the University of Porto in Portugal, the Health Institute of Porto and The University of Manchester (UK). Since 1994 he has been involved in research mainly in the area of

Magnetic Separation and Magnetic Classification but also in Magnetism, Electromagnetism, Cryogenics, Superconducting Magnets and Nanotechnology and Nanomaterials. In the last decade he has increased his involvement in Environmental Protection and Remediation,

Biotechnology and Chemical Processing areas. He graduated in Chemical Engineering from the University of Porto, where he also obtained his PhD in the same area, in 2001, after several stays in the University of Manchester. His PhD involved the development and design of the first Magnetic Separator and Classifier including the design of the Superconducting Magnet, Cryogenic System, Magnetic Shielding, etc. He has been involved in several national and international projects, either as coordinator or as a team member, totaling over 15 million euros, among which it may be pointed out the highly financed MAG-PRO2LIFE European Project. He has published over 60 book chapters and papers in top level international scientific media, filed 10 patents and has presented scientific works in more than 100 conferences and congresses. He has given several invited lectures in conferences and acted as co-chairman of some of them. He has been the supervisor of dozens of Post-Doctoral works and PhD, Master and Graduate Thesis. He works as a regular referee of several top scientific journals, and also has regular experience (more than 300 reviews) as an expert of European, National and International Projects as well as Graduation courses. He has been also acting as an international expert in review panels of French Universities, and has several publications and projects regarding pedagogical innovation in teaching. He was awarded with an Environmental Protection Prize by the European Commission, due to its work in Magnetic Classification and the Environment and was also awarded by the Jose Castillejo Programme.



Juan García Professor at the Department of Chemical Engineering and Materials, Faculty of Chemistry, University of Complutense de Madrid (Spain), since 2002. He has carried out research stays in Chile, Portugal, United Kingdom. Since 2002 he has belonged to CyPS (UCM) research group, first member and then director in 2022. He is the author of more than 139 articles in international SCI journals, of which more than 85 are first-quartile SCI articles (Q1) of the JCR epigraph. He has an h-index

of 46 (6900 citations). He has participated in over 40 research projects, has been leading research projects since 2003 and has co-supervised nine PhD Theses. His research interests have focused on synthesising and characterising carbon materials with enhanced properties and their catalytic application in adsorption, environmental catalysis, and biomass valorization. He is leader-researcher of several active projects related to wastewater treatment and waste valorisation from WWTPs. Prof. Garcia has four six-year research periods recognised, is a regular assessor for AEI (State Research Agency) and other international bodies.



Gassan Hodaifa is a Food Engineer (Univ. de Al-baath, Syria), Chemical Engineer (Univ. of Granada, Spain) and Dr. by the University of Jaén (Spain). He works in the research areas of Microalgae, wastewater treatment, Chemical Oxidation, Membrane Technology, Adsorption, Pesticide Removal, Olive Oil Processing, Enzyme Biotechnology, and Nematode Biotechnology. He participated in 32 National, European, International, and Company Research Projects. He held two contracts

as an Adviser for the mega Japanese Company, “Asahi Kasei Corporation”. As a result of his research work, 84 articles were published. 2 patents for water purification of olive oil mill wastewater, 5 books, 62 book chapters in prestigious publishers such as Academic Press (Elsevier), CRC Press, Taylor and Francis Group, Springer International Publishing AG, etc. He published as Editor 10 Special Issues and two Topics in Journals from JCR. He has participated in more than 127 Congresses and 52 International Conferences. He is currently Editor-in-Chief of Laboratories (MDPI journal), a member of 15 Editorial Boards of International Journals, such as Catalysts. Member of 9 Organizing Committees in International Congresses and Conferences, and Member of 27 Scientific-Technical Committees of International Congresses and Conferences. He has participated in the organization of 4 Congresses and 4 Conferences at the International level. He has received several awards, such as the Chemical Engineering Journal Award for the most cited article. Evaluator of European Projects (as MSCA-PF for different years, etc.), Projects of the United Arab Emirates University, National Projects from Argentina, National Romanian Project, Croatian National Project, Italian National Projects, etc. He is a member of the Spanish National Association of Chemists, the Official School of Chemists of Murcia, and the Society of Chemical Industry (SCI). Currently, he works as a Professor at Pablo de Olavide University.



Silvia Álvarez-Torrellas Professor at the Department of Chemical Engineering and Materials, Faculty of Chemistry, University Complutense of Madrid (Spain), since 2017. He undertook four-stay research (Concepción University, Chile; Autónoma University, Spain; Vila Real University, Portugal; and Polytechnic Institute of Bragança, Portugal). Currently, she is Associate Professor in Chemical Engineering at Complutense University in Madrid. Her research focuses on synthesising

and characterising carbon materials with enhanced properties and their application in Adsorption, Environmental Catalysis and Biomass Valorization. She has written over 81 scientific articles and several book and book chapters on these subjects in international journals and participated in more than 17 research projects supported by public and private institutions. She has supervised four Ph.D Thesis (International Mention) and currently co-directs three Ph.D, one of which is an industrial PhD in collaboration with the company Ecolotum. She has an H-index of 35 and more than 4500 citations. She is Editor of Chemical

Engineering Science Journal (Elsevier), and Secretary of the Working Party on Fluid Separations Association (EFCE).



José Alcides Peres is Associate Professor with Habilitation at University of Trás-os-Montes and Alto Douro (UTAD), Vila Real, Portugal. He graduated in Chemical Engineering at University of Coimbra (Portugal), received PhD in Chemistry (2002) at UTAD. He was director of Department of Chemistry (2017-2021), director of the PhD course in Chemical and Biological Sciences (2021-2023) at UTAD. Presently is member of the Scientific Council of ECVA (“Escola de Ciências da Vida e do Ambiente”) and the principal investigator of Environmental Chemistry Research Group of the Chemistry Centre of Vila Real.

He is author and co-author of more than 300 scientific publications, including more than 100 papers published in SCI journals, which received more than 5100 citations (h-index = 36, Scopus). Has been involved in 20 research projects and 7 enterprise projects. Has/is also supervised/supervising 7 post-doctoral researchers, 6 PhD students and 38 master students. He was the Chair Conference of 6th International Conference on Green Chemistry and Sustainable Engineering (GreenChem-24) which took place in Lisbon (Portugal) from 24 to 26 July 2024. He has been working for 25 years in the development of Advanced Oxidation Processes (AOPs), such as Fenton reagent, homogeneous and heterogeneous photo-Fenton, H₂O₂/UV, ozonation, O₃/UV, ferrioxalate/solar radiation, and heterogeneous photocatalysis, for industrial wastewater treatment, water disinfection, and the degradation of chemical contaminants. He also studied combined treatments (physical-chemical and biological), particularly for agro-industrial wastewater.



Miguel Minhalm is an Adjunct Professor of ISEL/IPL from 2005 until present. Has a PhD in Chemical Engineering from IST/UTL. “Synthesis and optimization of industrial wastewater recovery processes with integration of ultrafiltration and nanofiltration”, 2002; and a Degree in Chemical Engineering, Processes and Industry branch, by IST/UTL, 1994. He is an Integrated researcher in Center of Physics and Engineering of Advanced Materials (CeFEMA), IST. He is the Coordinator of the

Graduation Course in Biomedical Engineering, ISEL, from 2023. Member of the Coordinating Committee of the Master’s in Biomedical Engineering, ISE from 2015. Responsible for the Environmental Engineering Laboratory, ISEL, from 2008.

Author of 29 papers in international journals with referee. H index = 14; Author of 3 book chapters. Supervisor of 1 PhD thesis and 9 MSc thesis. Coordinated one research project and participated in other 10 research projects, using membrane technology in areas such as process integration, treatment and valorization of wastewaters, production/purification of bioactive compounds and development of mixed matrix membranes for hemodialysis.



Ana Charas Was graduated in Chemical Engineering (5 years) at Instituto Superior Técnico, in Lisbon, Portugal. She then completed a Master in Engineer of Materials in 1998 and, in 2002, a PhD in Chemical Engineering also by Instituto Superior Técnico/Univerisdade de Lisboa, Portugal

In 2004 she was post-doc in the Dyson Perrins Laboratory in Oxford University (UK). She was Assistant Researcher in Instituto de Telecomunicações from 2002 to 2016 and and from

2013 she is Principal Investigator in Instituto de Telecomunicações, at the Organic Electronics group. From 2022 to 2024 she was invited professor at University of Lisbon, Instituto Superior Técnico. She also

lectured the course "Nanotechnology and Biosensors" as invited professor in "Universidade Católica Portuguesa" from 2013 to 2014 and in Instituto Superior de Engenharia de Lisboa from 2015 to 2016. She has published 85 articles in ISI indexed peer-reviewed journals in the field of organic electronics, 8 articles in peer-reviewed conferences, and 2 book chapters. Her h-index is 24 (Web of Knowledge). She has supervised or co-supervised 7 PhD thesis, 10 Master thesis and 12 young researchers. She has coordinated (as Principal investigator) 7 national funded projects and participated in 11 more projects., including international projects. She is member of the Editorial Board of Polymers (MDPI) and has served as Guest Editor of several special issues in "Materials" and "Polymers" journals. She was member of the executive boards of the Portuguese Society of Chemistry (Sociedade Portuguesa de Química) and of the "Chemistry and Energy" Division of European Chemical Society (EuChemS). Her research interests are on Organic electronics; conjugated polymers and small molecules; organic conductors; solar cells; organic electronic devices; organic synthesis; nanotechnology; thin films; charge transport; Materials Science and Engineering - Nanomaterials and Devices.