

IOCE
2026
Conference

The 1st International Online Conference on Environments

2–4 March 2026 | Online



Program and Abstract Book

Organizers



environments

Sponsors



sustainability



diversity



resources



energies



学术会议云
ALLCONFERENCES

The 1st International Online Conference on Environments

2–4 March 2026 | Online



Organizing Committee

Conference Chair

Prof. Dr. Sergio Ulgiati

Session Chairs

Dr. Amalia Zucaro
Dr. Gabriella Fiorentino
Dr. Gianniantonio Petruzzelli
Dr. Remo Santagata
Dr. Silvio Viglia
Dr. Stefania Romano
Prof. Claudio Agnisola
Prof. Gaetana Napolitano

Prof. Dr. Brian D. Fath
Prof. Dr. Francesca Spigarelli
Prof. Dr. Kalavrouziotis Ioannis
Prof. Dr. Meirong Su
Prof. Dr. Milena Horvat
Prof. Dr. Walter Alberto Pengue
Prof. Dr. Xi Ji

Scientific Committee

Dr. Alessia Di Gilio
Dr. Alexandra Solomou
Dr. Angelo Riccio
Dr. Carlos Afonso Teixeira
Dr. Eduarda Marques da Costa
Dr. Elias Afif Khouri
Dr. Eng. Anca Becze
Dr. Ernesto Alfaro-Moreno
Dr. Gabriella Fiorentino
Dr. Gbadebo Oladosu
Dr. Gonalo Rodrigues
Dr. Haider A. Khwaja
Dr. Isabela Maria Simion
Dr. Jen-Yi Huang
Dr. Keshav Bhattarai
Dr. Marco Casazza
Dr. Maria Teresa Sebastia Frasquet
Dr. Martellos Stefano
Dr. Mihaela Simionescu
Dr. Petros Tsioras
Dr. Roberto M.R. Di Martino
Dr. Sofia Maria Muscarella
Dr. Steven McCutcheon
Dr. Teresa Rocha-Santos

Dr. Tommaso Caloiero
Dr. Valerio Paolini
Dr. Vasilis Fthenakis
Dr. Viktoria Voronova
Dr. Weronika Kruszelnicka
Dr. Yari Vecchio
Dr. Zane Vincēviča-Gaile
Professor Wojciech Czekala
Professor Angela Daniela La Rosa
Professor Jacopo Gaspari
Professor Ana Maria Antão-Geraldes
Professor Daniele Cespi
Professor Isabel Pestana Paixão Cansado
Professor Mordechai Shechter
Prof. Dr. Bruno Lemos Batista
Prof. Dr. Francesco Dondero
Prof. Dr. Gabriel Gasco Guerrero
Prof. Dr. Maria De Lurdes Dinis
Prof. Dr. Maria Laura Parisi
Prof. Dr. Phoebe Koundouri
Prof. Dr. Simone Varandas
Prof. Dr. Vera Amicarelli
Prof. Dr. Vitor João Pereira Domingues Martinho



2–4 March 2026
Online

The 1st International Online Conference
on Environments

Organised by



Conference Secretariat

Email: ioce2026@mdpi.com

Table of Contents

Welcome from the Chair.....	1
Keynote Speakers.....	4
Invited Speakers	6
Program at a Glance	7
IOCE 2026 Program.....	8
Session 1. Environmental Assessment Methods and Management Technologies.....	18
Session 2. Environmental Impact and Risk Assessment	69
Session 3. Terrestrial and Marine Biodiversity and Habitat Loss Prevention	133
Session 4. Urban Systems and Ecosystems: Dynamics and Functioning	158
Session 5. Shared Responsibility in Resource Use and Impact Generation.....	175
Session 6. Ecological, Environmental and Circular Economics.....	189

Welcome from the Chair

We are pleased to announce the **1st International Online Conference on *Environments* (IOCE 2026)-Environmental understanding, managing, restoring and policy-making**, which will be held online on 2–4 March, 2026, and promoted by the open access MDPI journal *Environments* (ISSN: 2076-3298, **Impact Factor: 3.7 (2024)**).

The biosphere, as the habitat of all species (including humans), and its self-organization to provide deep interactions and support biodiversity require full understanding and appropriate environmental policy making. *Environments*, with its final “s”, clearly refers to the multiplicity and diversity of environmental systems and species, linked to each other, all together contributing to create a symphony of colors, sounds, habits, habitats, and production and consumption patterns, from which every species benefits and to which every species contributes, in terms of sustainability and quality of existence. Humans, at the top of the evolutionary hierarchy, should not consider Nature and its diversity as a market from which to withdraw without limits, but instead as a living community to be understood in its dynamics and boundaries, protected in its abundance, enjoyed in its richness. *Environments* and its large research network have already highlighted and investigated the environmental systems, their pulsing cycles and species interactions and, most of all, the role of human species: its environmental impacts, its Earth management as a shared house according to rigorous rules for each species survival.

The scientific community grown around *Environments* is likely to contribute to increased environmental system knowledge, species interaction understanding, and nature-based solution implementation. When talking of “solutions”, we mean addressing problems related to the survival of species, improving the quality of the habitat in which these species live (including humans) and increasing the environmental services to meet some of their needs, in so preventing biodiversity loss due to environmental degradation. Environmental systems most often jointly suffer from the same environmental degradation problems (e.g., climate change, loss of biodiversity, population increase, impacts of mineral extraction, soil erosion, deforestation, etc.), which cannot be dealt with separately, but need an integrated picture, integrated monitoring and assessment, a clear investigation of the impacts of human activities and their mutual links. This deeper and integrated investigation, most welcome in the pages of *Environments*, may be the basis for appropriate environmental policy making and nature-based solutions.

The journal *Environments* was launched 10 years ago to promote a full understanding of environmental systems dynamics, species interaction and survival as well as the commitment of humans to protect and restore ecosystems and species at risk. Due to the tremendous efforts of its Editorial Board and Editorial Office Members, *Environments* has published a large number of papers and Special Issues that have contributed to environmental knowledge, policy making and well-being. We must continue to share and promote high-level research and results.

We invite researchers from different environmental sectors to contribute original findings, novel ideas, scientific concepts, as well as new technologies, experiences and policy-making strategies to understand, monitor, restore, and protect environmental systems and their biodiversity.

The following sessions will take place at the conference:

- S1. Environmental Assessment Methods and Management Technologies;
- S2. Environmental Impact and Risk Assessment;
- S3. Terrestrial and Marine Biodiversity and Habitat Loss Prevention;
- S4. Urban Systems and Ecosystems: Dynamics and Functioning;
- S5. Shared Responsibility in Resource Use and Impact Generation;
- S6. Ecological, Environmental and Circular Economy.

This conference will be organized as an online event in order to enable participation from all over the world, with no restrictions related to travel effort and expenditure. Furthermore, active participation and attendance in this online conference are free of charge. We extend our warmest welcome to you as participants or attendees of this virtual conference. We hope you can share this enthusiasm and help us to make this first *Environments* online conference a success.



Prof. Dr. Sergio Ulgiati
Conference Chair

Department of Science and Technology,
Parthenope University of Napoli, Napoli, Italy,
School of Environment, Beijing Normal
University, Beijing, China



environments

an Open Access Journal by MDPI

Environments (ISSN 2076-3298) is an international, cross-disciplinary, open access journal focusing on advances, issues and challenges related to environmental systems. Our aim is to provide an open space for scientists and engineers to publish and discuss their experimental, theoretical, and novel practical results in a variety of areas, with particular focus on shared responsibility and sustainable approaches to resource use and ecosystem management. Key research areas include environmental conservation; environmental technologies; ecosystems and ecosystem services; risk assessment; monitoring and modeling of environmental systems; policymaking and governance for stakeholder engagement and decision support. The biosphere, as the shared habitat of all species, including humans, requires a full understanding and appropriate environmental policymaking to ensure safe interactions, prevent biodiversity loss, and promote long-term sustainability.

There is no restriction on the maximum length in words of submissions. The full experimental details must be provided with the basic QA so that the results can be reproduced. For details on the calculation or experimental procedure that cannot be fully described in the main manuscript (Word/LaTeX format), electronic files and software can be deposited as supplementary electronic material.

Impact Factor: 3.7 (2024); **5-Year Impact Factor:** 3.7 (2024)

Keynote Speakers



Professor Hrisi Karapanagioti

Department of Chemistry, University of Patras, Patras, Greece

Hrisi K. Karapanagioti is a Professor of Environmental Chemistry at the Department of Chemistry in the University of Patras. She has been studying microplastics since 2004. She has co-edited two books related to plastic and microplastic pollution (from IWA and Springer Nature Publishers), co-authored several papers (Google Scholar >9000 citations, Stanford list of 2% World's Top Scientists) and co-organized and presented as invited speaker in several conference sessions with GESAMP, UNEP, G20, IAEA, EGU, NOAA, British Council, European Parliament, etc. Her research interests include the degradation of plastics to microplastics and microplastic interaction with microbes and organic pollutants.



Dr. Meri Barbafieri

Institute of Research on Terrestrial Ecosystem, National Research Council, Pisa, Italy

Meri Barbafieri is a Senior Research Scientist at the National Research Council of Italy (CNR), Institute of Research on Terrestrial Ecosystems (IRET). She has over 25 years of experience in soil chemistry, contaminated land management and phytoremediation. Her research focuses on Nature-Based Solutions, digital plant phenotyping, plant-microorganism interactions, rare earth elements in soils, and innovative remediation technologies. She has coordinated national and international research projects within EU Framework Programmes and NATO initiatives, collaborates with public and industrial stakeholders, and holds international patents. Her work integrates plant processes with applied soil science to support sustainable remediation technologies.



Prof. Dr. Walter Alberto Pengue

**Department of Ecological Economics and Agroecology, National University of General Sarmiento, Los Polvorines, Argentina;
Faculty of Architecture, Design and Urbanism of Buenos Aires University, Buenos Aires, Argentina**

Prof. Dr. Walter Alberto Pengue is an Agricultural Engineer, master in Environmental and Territorial Policies and Doctor in Agroecology. Full Professor of Ecological Economics and Agroecology at the National University General Sarmiento (UNGS) and Director of the Landscape and Environmental Ecology Group (GEPAMA) at the University of Buenos Aires (FADU UBA). Reviewer, lead author and coordinator of the Intergovernmental Platform on Biodiversity and Ecosystem Services IPBES (since 2019) and the United Nations Environmental Resource Panel (2007 to 2015). He was lead author of IPCC Round 6 (2019/2022). He is currently Coordinating Leading author in the IPBES NEXUS project (2021 to 2025), which conducts thematic analyses of the interrelationship between food systems, biodiversity, health, water and climate change.



Prof. Dr. Mengyao Han

Institute of Geographic Sciences and Natural Resources Research (IGSNRR), Chinese Academy of Sciences, Beijing, China

Mengyao Han, an Associate Professor of the Institute of Geographic Sciences and Natural Resources Research (IGSNRR), Chinese Academy of Sciences (CAS), a Fellow of the Cambridge Centre for Environment, Energy and Natural Resource Governance, a Fellow of the Royal Geographical Society, a Committee Member of the Energy Geographies Research Group, and a Council Member of China's Energy and Climate Finance Association. The main research interests include energy geographies, low-carbon transition, and sustainable development, especially focusing on the complexity and resilience of multi-regional supply networks towards renewable energy transition.



Mr. Alexander Müller

TMG Think Tank for Sustainability, Berlin, Germany

Alexander Müller is a sociologist by training. He began his public service as City Councilor for Social and Environmental Affairs in Marburg and later served as a Member of Parliament in Hessen. He held State Secretary roles both in Hessen and in Germany's Ministry for Consumer Protection, Food and Agriculture, and was Assistant Director-General of FAO. He led key FAO food security summits, chaired the United Nations System Standing Committee on Nutrition, advised the UN Secretary-General on energy and climate, and directed the TEEBAgriFood initiative on the "The Economics of Ecosystems and Biodiversity for Agriculture and Food". Since 2016 he is founder and Managing Director of TMG – Thinktank for Sustainability in Berlin/Germany.



Dr. Michael Mehaffy

Sustasis Foundation, Portland, OR, USA

Michael W. Mehaffy, Ph.D., is a researcher, author, educator, urban planner, designer, and strategic development consultant with an international practice. In addition to his work as an instructor at ASU since 2011, he is currently Executive Director of the Sustasis Foundation, an urban sustainability think tank in Portland, Oregon; Executive Director of the International Making Cities Livable conference series; and President of Structura Naturalis Inc., his consultancy. He has held teaching and/or research appointments at ten graduate institutions in eight countries, and he is on the editorial boards of two international journals of urban design. He is noted for his books, book chapters, research articles and professional articles on urban morphology, urban self-organization, architecture, computer science, and philosophy. He was a consultant to UN-Habitat for the Habitat III conference and its outcome document, The New Urban Agenda, and he has consulted for governments, businesses and NGOs on its implementation and related topics. Among his many leading urban-scale projects was Orenco Station, a pioneering transit-oriented development in the Portland region, for which he served as project manager and co-designer for the master developer. After graduate work in architecture, public policy, management and philosophy of science at UC Berkeley and the University of Texas at Austin, he received his Ph.D. in architecture, with a focus on urban planning and design, at Delft University of Technology in the Netherlands.



Prof. Dr. Meirong Su

School of Ecology, Environment and Resources, Guangdong University of Technology, Guangzhou, China

Prof. Dr. Meirong Su is a distinguished professor and doctoral supervisor at the School of Ecology, Environment and Resources, Guangdong University of Technology. She is a "Hundred Talents Plan" appointee, a German Humboldt Scholar, and has been awarded prestigious honors including the National Excellent Youth Science Fund, Guangdong Province Distinguished Youth Science Fund, and the Youth Pearl River Scholar. Her research focuses on urban and regional ecological planning and management, and she has led over ten national-level research projects funded by the National Key R&D Program and the National Natural Science Foundation of China. Professor Su has published over 200 academic papers in high-impact journals such as Nature Food, Nature Cities, Environmental Science & Technology, and Water Research, and serves as founding Associate Editor of Environmental and Sustainability Indicators. She has received multiple major science and technology awards, including the State Scientific and Technological Progress Award and the Ministry of Ecology and Environment Science and Technology Award.

Invited Speakers



Prof. Dr. Vítor Martinho
Polytechnic Institute of Viseu,
Viseu, Portugal



Dr. Gayantonia Franzè
Institute of Marine Research,
Norway-Plankton Research
Group, Bergen, Norway



Dr. Marco Casazza
Department of Medicine,
Surgery and Dentistry “Scuola
Medica Salernitana”, University
of Salerno, Baronissi, Italy



Professor Xiaofang Wu
School of Economics,
Zhongnan University of
Economics and Law,
Wuhan, China

Program at a Glance

	Day 1		Day 2		Day 3	
Morning	Session 2. Environmental Impact and Risk Assessment (Part 1)		Session 4. Urban Systems and Ecosystems: Dynamics and Functioning		Session 5. Shared Responsibility in Resource Use and Impact Generation	Session 3. Terrestrial and Marine Biodiversity and Habitat Loss Prevention
					Parallel Sessions	
Afternoon	Session 2. Environmental Impact and Risk Assessment (Part 2)	Session 1. Environmental Assessment Methods and Management Technologies (Part 1)	Session 6. Ecological, Environmental and Circular Economics	Session 1. Environmental Assessment Methods and Management Technologies (Part 2)	Flash Poster Session	
	Parallel Sessions		Parallel Sessions			

IOCE 2026 Program

2 March 2026 (Monday)

Session 2. Environmental Impact and Risk Assessment Part 1

Time: 09:00 (CET, Basel) | 03:00 (EST, New York) | 16:00 (CST Asia, Beijing)

CET Time	Speaker	Title
9:00–9:10	Prof. Dr. Sergio Ulgiati Conference Chair	<i>Welcome from the Conference Chair</i>
9:10–9:20	Dr. Gianniantonio Petruzzelli Session Chair	<i>Welcome from the Session Chair</i>
9:20–9:45	Dr. Meri Barbafieri Keynote Speaker	The Future of Ecological Restoration: How Digital Plant Phenotyping Strengthens Nature-Based Solutions, with phytoremediation as a key application
9:45–10:00	Eliud Kiprop Selected Oral Speaker	Techno-Economic Optimization of Solar Photovoltaic Systems for Industrial Sustainability: A Case Study of the Kenyan Tea Sector
10:00–10:15	Szymon Pelczar Selected Oral Speaker	Land Use Intensity, Power Density, and Energy Density of Photovoltaic Power Plants
10:15–10:30	Mariachiara Galati Selected Oral Speaker	The Double Face of Gadolinium, a Rare-Earth Element (REE): A Winning Strategy for Human Health or a Potential Defeat for Non-Target Organisms?
10:30–10:45	Jana Rammal Selected Oral Speaker	The High-Temperature Crisis: Regional Vulnerabilities, Environmental Impacts, and Adaptive Imperatives
10:45–11:00	Marilda Osmani Selected Oral Speaker	Assessment of Atmospheric Pollutants and Environmental Parameters in an Industrial Urban Area of Albania
11:00–11:15	Viacheslav Muratov Selected Oral Speaker	Computational Toxicogenomic Assessment of Inhalation Risks from Titanium Dioxide Sanding-Dust Particulate Emissions
11:15–11:30	Pelin Yapicioğlu Selected Oral Speaker	Greywater footprint reduction by agro-industrial biochar for brewery wastewater treatment: A data-driven parametric model
11:30–11:45	Roberto Di Martino Selected Oral Speaker	Tracing Anthropogenic and Volcanic CO ₂ Emissions through Isotopic Monitoring: Insights from Mediterranean Urban and Volcanic Environments
11:45–12:00	Manuela Piccardo Selected Oral Speaker	Index-based environmental risk assessment of micro- and nanoplastics: handbook for conscious, accurate, and standardized use
12:00–12:15	Antonio Peña-Fernández Selected Oral Speaker	Distribution and Environmental Risk of Rhodium (Rh) in Urban and Garden Soils: Evidence from Alcalá de Henares, Spain.
12:15–12:30	Pedro Brito Selected Oral Speaker	Tracing Anthropogenic Gadolinium in Portugal: Baseline Survey Across Five Transition Aquatic Systems
12:30–14:00	Break	

Session 2. Environmental Impact and Risk Assessment Part 2
Time: 14:00 (CET, Basel) | 08:00 (EST, New York) | 21:00 (CST Asia, Beijing)

CET Time	Speaker	Title
14:00–14:10	Prof. Kalavrouziotis Ioannis Session Chair	<i>Welcome from the Session Chair</i>
14:10–14:35	Prof. Hrisi K. Karapanagioti Keynote Speaker	Microplastic Pollution of the Environment: Emerging Issues
14:35–14:50	Michele Turco Selected Oral Speaker	Evaluating the Initial Nutrient Content in Green-System Porous Media Through Aqueous Extraction
14:50–15:05	Rodeta Pllumi Selected Oral Speaker	Presence and Assessment of Riparian Flora Along the Middle Course of the Shkumbin River near the Miraka Area
15:05–15:20	Christina Pourani Selected Oral Speaker	Military Pollutant Emissions
15:20–15:35	Benedetta Sgangarella Valvano Selected Oral Speaker	Effect of Di-n-butyl Phthalate (DBP) on the Prostate Gland and Adipogenesis: Possible Connections Between Metabolic Syndrome and Male Infertility
15:35–15:50	Yesica Pallavicini Selected Oral Speaker	Influence of Electrode Material on the Electroflocculation Treatment Efficiency of Swine Wastewater
15:50–16:05	Lorenzo Riccio Selected Oral Speaker	Stray Dogs as Sentinels for Male Infertility: AI-Based Assessment of testicular diseases linked to environmental pollution in the Campania region
16:05–16:20	Giuseppe De Marco Selected Oral Speaker	Dexamethasone: a potential hazard for aquatic organisms? Assessment of neurotoxic effects on mussel gills using a multi-biomarker approach
16:20–16:35	Simona Di Marino Selected Oral Speaker	Investigating the Effects of Psychoactive Emerging Contaminants in Early Frog Life Stages
16:35–16:50	Stefania Boccia Selected Oral Speaker	Cocaine as an Emerging Environmental Contaminant: CB1 and Barrier Function Alterations in Intestinal Human Cells
16:50–17:05	Nihad Chakri Selected Oral Speaker	Environmental Impact Assessment of Industrial and Urban Discharges on Groundwater and Surface Water in the Commune of Dar Bouazza
17:05–17:20	Ifreke Udofia Selected Oral Speaker	Appraising the water quality of Eto-anen stream in Ibotio, Mkpato Enin Local Government Area, Akwa Ibom State, Nigeria, using pollution, ecological and human health risk approach

Session 1. Environmental Assessment Methods and Management Technologies Part 1**Time: 14:00 (CET, Basel) | 08:00 (EST, New York) | 21:00 (CST Asia, Beijing)**

CET Time	Speaker	Title
14:00–14:10	Dr. Gabriella Fiorentino & Dr. Amalia Zucaro Session Chairs	<i>Welcome from the Session Chairs</i>
14:10–14:25	Maria Bairaktari Selected Oral Presenter	Life Cycle Assessment (LCA) of Circular Economy Pathways for the Valorization of Dairy By-products
14:25–14:40	Milica Vidić Selected Oral Presenter	Green extraction of <i>Satureja horvatii</i> Šilić (Lamiaceae): Preliminary chemical analysis and antioxidant evaluation using natural deep eutectic solvents
14:40–14:55	Paolo Blecich Selected Oral Presenter	Energy, Economic, and Environmental (Triple-E) Analysis of Energy Recovery from Sewage Sludge in Municipal Wastewater Treatment Plants
14:55–15:10	Lakshmi Gopakumar Selected Oral Presenter	Seasonal Dynamics of Earthworm and Microarthropod Communities in rural Home Garden agroecosystems: Linking Soil Properties to Biological Soil Quality
15:10–15:25	Nour El Imene Brahmi Selected Oral Presenter	A Dual Technical and Environmental Assessment of the Transition from Grey to Green Hydrogen in the Haber–Bosch Process: A Modelling and Simulation Approach
15:25–15:40	Kawtar Ezzahi Selected Oral Presenter	Eco-Friendly Wastewater Treatment Using Biochar Adsorbents: Removal of Tyrosol and Hydroxytyrosol and Life Cycle Assessment
15:40–15:55	Wagd Ajeeb Selected Oral Presenter	Renewable Biofuel Production from Green Hydrogen and Waste Vegetable Oil: Environmental Assessment for Sustainable Management
15:55–16:10	Ana Maria Antão-Geraldes Selected Oral Presenter	Towards sustainable reservoir management: linking ecosystem-based management, ecological integrity, and urban water efficiency in Serra Serrada (NE Portugal)
16:10–16:25	Xinyu Li Selected Oral Presenter	Spatio-temporal Evolution of Carbon Emissions from Energy Consumption in Jiangsu Province Based on Nighttime Light Data

3 March 2026 (Tuesday)

Session 4. Urban Systems and Ecosystems: Dynamics and Functioning

Time: 09:00 (CET, Basel) | 03:00 (EST, New York) | 16:00 (CST Asia, Beijing)

CET Time	Speaker	Title
9:00–9:10	Prof. Dr. Brian D. Fath & Prof. Meirong Su Session Chairs	<i>Welcome from the Session Chairs</i>
9:10–9:35	Prof. Meirong Su Keynote Speaker	Exploring Urban Ecology in the Context of Climate Change: Insights from Preliminary Research
9:35–10:00	Dr. Marco Casazza Invited Speaker	From Structures to Ecosystem Services: An Ecophysical One-Health Framework for Immovable Cultural Heritage
10:00–10:25	Dr. Michael Mehaffy Keynote Speaker	The Ecology of the City: Urban Systems as Biospheric Infrastructure
10:25–10:40	Bayu Maulana Selected Oral Speaker	Decoupling Traffic Growth and Air Pollution: Evidence-Based Strategies for Sustainable Urban Mobility in Jakarta
10:40–10:55	Lin Sun Selected Oral Speaker	Moderating Mechanism of Green Space Patterns on Urban Heat Island Effect under the Background of Urban Intensification: A Case Study of Nanjing
10:55–11:10	Jakub Kadlec Selected Oral Speaker	Ten-Year Dynamics of Water Surface and land use in La Marjal de Gandia (2015–2025) Using Sentinel-2 Satellite Imagery and Google Earth Engine
11:10–11:25	Rania Ajmi Selected Oral Speaker	Towards a Green City in the Face of Climate Change: Biodiversity Restoration of an Urban Park in a North African Mediterranean Context
11:25–11:40	Chayasmita Deka Selected Oral Speaker	Stated choice for sustainable mobility at different stages of behavior: A vignette stated choice experiment based on mental accounting interventions
11:40–11:55	Milena V. Sokolova Selected Oral Speaker	Carbon Storage Assessment of Urban Street Trees Using Terrestrial LIDAR and Satellite-Based Remote Sensing Data
11:55–12:10	Giulia Catania Selected Oral Speaker	Predictive Urban Ecologies: Integrating AI, Environmental Sensing and Adaptive resilience strategies
12:10–12:25	Ana Rita Martins Selected Oral Speaker	Can Phytoremediation Mitigate Eutrophication in Urban Streams? Insights from Costa-Couros Stream
12:25–12:40	Elham Sedighi Selected Oral Speaker	Building Shared Futures: Scenario Planning for Transboundary WEF Governance in the Tigris–Euphrates Basin
12:40–14:00	Break	

Session 6. Ecological, Environmental and Circular Economics
Time: 14:00 (CET, Basel) | 08:00 (EST, New York) | 21:00 (CST Asia, Beijing)

CET Time	Speaker	Title
14:00–14:10	Prof. Walter Pengue Session Chair	<i>Welcome from the Session Chair</i>
14:10–14:35	Alexander Müller Keynote Speaker	Assessing Sustainability of Eco-Agri-Food Systems with True Cost Accounting
14:35–15:00	Prof. Walter Pengue Keynote Speaker	Ecological Economics, Natural Resources and Food Systems: A Nexus Approach
15:00–15:15	Josephine Niangue Selected Oral Speaker	Linking spatial convergence and circular economy transitions: evidence from waste-sector emissions in Sub-Saharan Africa
15:15–15:30	Greta Grikštaitė-Prapiestė Selected Oral Speaker	Valorization of Strawberry (<i>Fragaria × ananassa</i> Duch) cv. 'Malwina' by-products: A Source of Phenolics and Antioxidants for Sustainable Applications
15:30–15:45	Mohamed Sharaf Selected Oral Speaker	Sustainable Stabilization of Expansive Soils Using Lime Sludge and Sodium Chloride: A Circular Economy Approach
15:45–16:00	Patryk Leda Selected Oral Speaker	Life Cycle Evaluation of Next-Generation Photovoltaic Systems with Emphasis on Material Flows and Circular Economy
16:00–16:15	Ailin Rasaie Selected Oral Speaker	Influence of the harvesting season on the yield and composition of biofuels from microalgae cultivated in raceway mode
16:15–16:30	Eugenio Geremia Selected Oral Speaker	Circular Approaches in Aquaculture: Fishmeal Replacement and Algal Bioremediation
16:30–16:45	Yaseen Selected Oral Speaker	Challenges and Strategies for Implementing the Circular Economy in Modular Construction: Evidence from Germany
16:45–17:00	Abdelouahab Sahli Selected Oral Speaker	Regeneration and Conservation Challenges of <i>Alnus glutinosa</i> (L.) Gaertn in riparian forests
17:00–17:15	Rosa Llerena Selected Oral Speaker	Dynamic perspective of the evolution of the environmental Kuznets curve in Ecuador and Mexico
17:15–17:30	Kaouther Kerboua Selected Oral Speaker	Carbon footprint related to municipal solid waste management in upper middle-income countries: a multi-factorial study based on composition, operations and management strategies

Session 1. Environmental Assessment Methods and Management Technologies Part 2**Time: 14:00 (CET, Basel) | 08:00 (EST, New York) | 21:00 (CST Asia, Beijing)**

CET Time	Speaker	Title
14:00–14:10	Dr. Silvio Viglia & Dr. Remo Santagata Session Chairs	<i>Welcome from the Session Chairs</i>
14:10–14:25	Indishe Senanayake Selected Oral Speaker	Application of Landform Evolution Models to Assess Long-Term Contour Bank Stability in Constructed Post-Mining Landforms
14:25–14:40	Sunil Nepali Selected Oral Speaker	AI-Enhanced Monitoring of Mangrove Restoration Using UAV and Satellite Data Fusion
14:40–14:55	Rahinatu Abdul-Rahman Selected Oral Speaker	Hydrogeochemical Characterization and Gold Mining Impacts on Groundwater Quality in the Ayanfuri Mining Enclave, Ghana: Implications for Sustainable Environmental Management
14:55–15:10	Yonis Khalif Elmi Selected Oral Speaker	Climatic Variability and Urban Heat Stress Assessment in Mogadishu, Somalia, from 2001 to 2025
15:10–15:25	Yury Erofeev Selected Oral Speaker	Life-Cycle GHG of SAF in Real Flights: Empirical WTW Accounting and Reconciliation with TIM, DEFRA, and Base Empreinte
15:25–15:40	Ezekiel Tobiloba Ogungbemi Selected Oral Speaker	Environmental Impact Assessment of Quarry Impact (Land Loss and Air Quality) in Akure, Nigeria
15:40–15:55	Bruna Pane Selected Oral Speaker	Life Cycle Assessment of composite materials from recycled carbon fibers
15:55–16:10	Aminu Ahmad Haliru Selected Oral Speaker	Integrating Vernacular Architectural Wisdom into Climate-Resilient Urban Development: A Sustainable Pathway for Environmental Management in Northern Nigeria
16:10–16:25	Ludovica Martinisi Selected Oral Speaker	Microbially Induced Carbonate Precipitation (MICP) for Cadmium Removal: Sustainable Applications for Ecosystem Protection
16:25–16:40	Jeremias Gorosito Selected Oral Speaker	Simulation Framework for Environmental Remediation: Monte Carlo Estimation of Mass Transfer in Nickel Bioadsorption

4 March 2026 (Wednesday)

Session 5. Shared Responsibility in Resource Use and Impact Generation**Time: 09:00 (CET, Basel) | 03:00 (EST, New York) | 16:00 (CST Asia, Beijing)**

CET Time	Speaker	Title
9:00–9:10	Prof. Dr. Francesca Spigarelli & Dr. Stefania Romano Session Chairs	<i>Welcome from the Session Chairs</i>
9:10–9:35	Prof. Dr. Mengyao Han Keynote Speaker	Deploying Renewables: Trends, Overlaps and Impacts
9:35–10:00	Prof. Dr. Xiaofang Wu Invited Speaker	The Impact of Domestic Market Integration on Carbon Emission Transfers: An Empirical Analysis Based on Input-Output Tables of Chinese Cities
10:00–10:25	Prof. Dr. Vitor Martinho Invited Speaker	One planet, diverse demands and concerns in times of scarcity: Gaps, trends and directions for the future
10:25–10:40	Yanxin Liu Selected Oral Speaker	Responsibility allocation to producers and users in the global industry and trade chain "energy-minerals-electric vehicles". An Emergy Accounting approach
10:40–10:55	Mohammed Islam Selected Oral Speaker	Life as a Race of Survival in the Environment: Balancing Human Progress, Ecological Interdependence and Human Health
10:55–11:10	Flora Silva Selected Oral Speaker	Hydrological and Economic Benefits of Sustainable Urban Drainage in an Allotment from Northeastern Portugal
11:10–11:25	Hina Shaikh Selected Oral Speaker	From Degradation to Restoration: Nature-Based Solutions for Environmental Recovery
11:25–11:40	Giuseppe Tagarelli Selected Oral Speaker	Spatiotemporal dynamics and drivers of an Italian reclamation landscape: the Piana di Sibari (Calabria, Italy)
11:40–11:55	Shefali Vinod Ramteke Selected Oral Speaker	From Kyoto to Paris: Evolving Legal Regimes and the Role of Emerging Technologies in Climate Adaptation
11:55–12:10	Luis Eduardo Ferrari Irisarri Selected Oral Speaker	Nueva Esperanza rural settlement: Challenges of a public policy for environmental and territorial Development in the peri-urban area of Neuquén (1993–2018), Argentina
12:10–14:00	Break	

Session 3. Terrestrial and Marine Biodiversity and Habitat Loss Prevention**Time: 14:00 (CET, Basel) | 08:00 (EST, New York) | 21:00 (CST Asia, Beijing)**

CET Time	Speaker	Title
9:00–9:10	Prof. Claudio Agnisola & Prof. Gaetana Napolitano Session Chairs	<i>Welcome from the Session Chairs</i>
9:10–9:35	Dr. Gayantonia Franzè Keynote Speaker	Darkening Coastal Waters Reshape Plankton Communities and Coastal Food Webs
9:35–9:50	Jinhui Wei Selected Oral Speaker	Climate-Driven Vulnerability of Island Ecosystems: Quantitative Evidence of Precipitation Decline Leading to Mammoth Extinction on St. Paul Island
9:50–10:05	Maria Carolina Martone Selected Oral Speaker	Trace Metal Bioaccumulation and Redox Imbalance in <i>Mytilus galloprovincialis</i> from the Gulf of Pozzuoli (Italy)
10:05–10:20	Sara Esposito Marroccella Selected Oral Speaker	Redox State and Metabolic Changes in Gill and Muscle Tissues of the Invasive Alien Species <i>Pinctada Radiata</i> from Heat-Impacted Environments
10:20–10:35	Alessia Caferro Selected Oral Speaker	Time-dependent response of the animal model <i>Mytilus galloprovincialis</i> to water hypoxia: oxidative status and antioxidant enzymes modulation
10:35–10:50	Francesco Bolinesi Selected Oral Speaker	Phytoplankton Community Shifts in a Mediterranean Lagoon Under Combined Shellfish Farming and Climate Pressure
10:50–11:05	Jesús Fernández-Gutiérrez Selected Oral Speaker	How could environmental conditions shape the outcome of a mitigation strategy? A short-term study in marinas of the NW Iberian Peninsula
11:05–11:20	Laís Souto Lira Selected Oral Speaker	Limnological characterization and phytoplankton structure in a stone tank located on an inselberg in the semiarid region of Paraíba, Brazil
11:20–11:35	Juan Esteban Trinidad Huerta Selected Oral Speaker	Characterization and Sampling of Local Plant Species from the Puruándiro Region (Mexico) as Options for the Restoration of the Local Agroecosystem

Flash Poster Session**Time: 14:00 (CET, Basel) | 08:00 (EST, New York) | 21:00 (CST Asia, Beijing)**

CET Time	Speaker	Title
14:00–14:05	Youngwook Kim Poster Presenter	Developing a tool to monitor water use efficiency and vegetation greenness in hyper-arid desert using multiple satellite remote sensing data records
14:05–14:10	Mithila Mattoo Poster Presenter	Quantifying Dignity in Urban Ecosystems: A Framework for Inclusive and Sustainable Aging in Indian Cities
14:10–14:15	Hafiz Muhammad Safdar Khan Poster Presenter	Agricultural Resource Management Through Shared Responsibility: Combining Technology, Policy, and Community Initiatives to Reduce Transboundary SMOG Across the Indo-Pak Border Region
14:15–14:20	Tewodros Nigatu Bitaw Poster Presenter	Transforming local waste into value: Activated carbon from brewery sludge for sustainable phosphate removal
14:20–14:25	Isabela Simion Poster Presenter	From gray water to green solutions: Life Cycle Sustainability Assessment of heavy metals removal using inactive yeast
14:25–14:30	Konstantinos Stefanidis Poster Presenter	Freshwater quillworts of Greece: Updated distribution patterns and conservation threats
14:30–14:35	Musaida Mercy Poster Presenter	The impacts of producing bio briquettes made from organic waste as an alternative source of fuel
14:35–14:40	Chahid Sadiki Poster Presenter	The Evolution and Challenges of Water Governance in Morocco
14:40–14:45	Adjlane Nouredine Poster Presenter	Biodiversity Protection and Pollinator Conservation: An Integrated Approach of the Medibeas Project
14:45–14:50	Dimitra Rapti Poster Presenter	Natural and anthropogenic contamination processes in the sediments of the Sacca di Goro lagoon (Po River delta, northern Italy)
14:50–14:55	Valentina Bernarello Poster Presenter	Changes in the macrozoobenthic community across coastal lagoons in the Po River Delta (Northern Adriatic Sea, Italy) during the outbreak years of the blue crab <i>Callinectes sapidus</i> (Rathbun, 1896)
14:55–15:00	Emilia Konowat Poster Presenter	Valorization of lignin for the development of sustainable amphiphilic modifiers with high surface activity for environmentally responsible cement systems
15:00–15:05	Cinthya Costa Lopes Poster Presenter	Toxic, Essential, and Rare Earth Element Exposure from Chocolate: A Human Health Risk Assessment

15:05–15:10	Isabella Alvares Fernandes Poster Presenter	Local implementation pathways of the European Green Deal: integration between environmental monitoring and community-driven policy mechanisms.
15:10–15:15	Thiago Allain Martins Siqueira Moura Poster Presenter	Phenological and Aesthetic Dynamics of Urban Trees: Implications for Landscape Planning
15:15–15:20	Emanuel Rodrigo Silva Poster Presenter	Reserve Areas in Public Agrarian Reform Settlements as a Potential for Carbon Credit in the State of Pernambuco, Northeastern Brazil
15:20–15:25	Edwin Villagran Poster Presenter	Transitions Toward a Circular Economy in Protected Agriculture Across the Americas: A Bibliometric Analysis of Trends, Approaches, and Research Gaps
15:25–15:30	Nelda Martínez-Galero Poster Presenter	Agro-industrial waste from pineapple (<i>Ananas comosus</i> L. Merr) in the Papaloapan basin: enzymes, a link in the value chain
15:30–15:35	Gennaro Trancone Poster Presenter	Advancing Low-Cost Biosorbent Engineering: Optimized Alkaline Activation of Agro-Industrial Biomass for Enhanced Removal of Cationic Dyes
15:35–15:40	Dorcas Adejunmobi Poster Presenter	Life Cycle Assessment (LCA) of a Metal Scrap Shredder Facility
15:40–15:45	Hadj Boumedien Rahmoun Poster Presenter	Adsorptive Removal of Synthetic Textile Dyes Using Raw Almond Shells: A Sustainable Approach to Wastewater Treatment
15:45–16:00	Prof. Dr. Sergio Ulgiati Event Chair	<i>Closing Ceremony</i>

Session 1. Environmental Assessment Methods and Management Technologies

sciforum-160015: Advancing Environmental Policy Studies With Pluralist Epistemology

Gilbert Michaud

School of Environmental Sustainability, Loyola University Chicago, Chicago 60660, USA

This paper examines how universities could offer more integrative curricula to enhance students' skills. While many have historically narrowed the study of environmental policy to a mix of economics, ethics, and politics, this paper extends beyond these boundaries to advance the discipline towards greater knowledge and effectiveness. In particular, a literature review with a theory-building approach was employed to identify the policy's central perspectives of economics, ethics, and politics, juxtaposed with an investigation of more peripheral perspectives. These perspectives are synthesized, and tangible examples of how to pursue pluralism are provided. Overall, while environmental policy has several common traits ingrained in its literature and practice, integrating additional perspectives, such as post-structuralist and psychoanalytic, can enhance disciplinary cognition and ultimately spur virtuous policymaking. Referred to as 'pluralist epistemology', this approach is identified as a strategy that develops more innovative environmental leaders. Pluralist epistemology can enrich environmental policy education by blending mainstream and alternative perspectives to support critical thinking (e.g., through collaborative simulations or integrative policy labs) and by fostering better policymaking by challenging dominant assumptions and embracing complexity. This type of critical thinking can be fundamental as institutions of higher education continue to seek dynamic ways to meet the evolving academic demands of the 21st century.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-149265: Arsenic in Urban Soils and Mushrooms from Leicestershire: Exposure Risks and Biomonitoring Strategies

Gurminderjeet S Jagdev¹, Mark D. Evans^{1,*} and Antonio Peña-Fernández^{1,2}

¹ Leicester School of Allied Health Sciences, De Montfort University, Leicester, LE1 9BH, UK

² Department of Surgery, Medical and Social Sciences, Faculty of Medicine and Health Sciences, University of Alcalá, Ctra. Madrid-Barcelona, Km. 33.600, 28871 Alcalá de Henares, Madrid, Spain

Arsenic (As) is a naturally occurring metalloid that can pose serious health risks through chronic environmental exposure, particularly when associated with contaminated soils or edible fungi. This study evaluated As concentrations in 850 surface soil samples and 106 wild mushrooms collected across urban Leicester and rural Bradgate Park (Leicestershire, UK) using ICP-MS. Arsenic was detected in 78.9% of soil samples and 34.9% of mushrooms, with significantly higher concentrations at urban sites, particularly in areas with known historical industrial activity and high traffic density. Median As concentrations were 8.4 µg/g in soil and 0.212 µg/g dry weight in mushrooms. Although bioconcentration factors (BCFs) calculated for As were relatively low (median BCF 0.02), they varied between fungal species, suggesting differential uptake dynamics. Human health risk assessments for children and adults exposed via soil ingestion, dermal contact, and inhalation indicated that total hazard indices remained below the safety threshold of 1. However, ingestion accounted for the largest proportion of exposure across all groups, particularly among young children. The findings highlight the utility of combining soils and wild mushrooms as complementary matrices in urban environmental monitoring. However, current exposure levels do not pose immediate health risks; the persistence and potential carcinogenicity of arsenic support the need for routine surveillance in urban ecosystems and increased public awareness regarding foraging and home gardening. The study underscores the importance of integrated biomonitoring approaches to inform evidence-based public health strategies in contaminated or transitional urban landscapes.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-149262: Geospatial Distribution of Emerging Elements (Ag, Pd, Rh, Sb, Co, Pt) in Alcalá de Henares Topsoils: Insights from Gis Mapping

Antonio Peña-Fernández ¹, Gevorg Tepanosyan ^{2,*}, Manuel Higuera ³
and Maria de Carmen Lobo-Bedmar ⁴

¹ Department of Surgery, Medical and Social Sciences, Faculty of Medicine and Health Sciences, University of Alcalá, Ctra. Madrid-Barcelona, Km. 33.600, 28871 Alcalá de Henares, Madrid, Spain

² The Centre for Ecological-Noosphere Studies, National Academy of Sciences, Abovian-68, Yerevan 0025, Armenia

³ Scientific Computation Research Institute (SCRIUR), University of La Rioja, 26006 Logroño, Spain

⁴ Department of Agro-Environmental Research, Madrid Institute for Rural, Agricultural and Food Research and Development (IMIDRA), "El Encín" Estate, Madrid-Barcelona Road Km 38.2, 28800 Alcalá de Henares, Madrid, Spain

Emerging contaminants such as platinum group elements (Pt, Pd, Rh), silver (Ag), antimony (Sb), and cobalt (Co) are increasingly reported in urban soils, yet their spatial distribution and environmental behaviour remain insufficiently characterised. We applied a geographic information system (GIS)-based approach to evaluate the spatial variability of Ag, Co, Pt, Rh, Sb, and Pd (inferred, not directly measured) in 137 surface soil samples (0–3 cm) collected across urban, industrial, and garden areas of Alcalá de Henares, Spain. Spatial interpolation using inverse distance weighting (IDW; power = 2, 12 neighbours), based on commonly applied parameters in urban soil mapping, revealed distinct patterns for each element. Ag and Co showed heterogeneous distributions, with higher concentrations in garden and industrial soils (Ag: up to approx. 0.9 mg/kg; Co: up to approx. 19 mg/kg), likely influenced by biosolids application and historical industrial activity. Pt and Rh were elevated near major traffic routes, consistent with vehicular emissions as dominant sources. Sb exhibited marked urban hotspots associated with brake wear and industrial legacy inputs. Although Pd was not analysed, its likely co-occurrence was inferred from the spatial congruence of Pt–Rh and shared emission sources. Correlation analysis supported the spatial findings, highlighting an anthropogenic Rh–Sb–Mo cluster (Mo included as part of the correlation dataset) and a mixed geogenic–anthropogenic profile for Co. Overall, the integration of spatial mapping and multivariate statistics demonstrates the utility of GIS for identifying contamination hotspots, supporting source apportionment and informing soil surveillance and biomonitoring strategies. Our results emphasise the need to consider less-monitored elements in regulatory frameworks to better protect vulnerable populations in complex urban environments.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-158328: A Sustainability-Driven Digital Twin for Optimizing Component Delivery in Piece-Type Manufacturing

Matevž Resman *, Mihael Debevec and Niko Herakovič

Faculty of Mechanical Engineering, University of Ljubljana, Ljubljana SI-1000, Slovenia

Sustainable logistics has become a cornerstone of modern manufacturing, with companies seeking to minimise energy use, CO₂ emissions, and resource inefficiencies throughout the supply chain. This manuscript examines component delivery as a critical aspect of inbound logistics and introduces a digital twin framework to improve its organisation, transparency, and sustainability. The proposed model enables simulation of various delivery scenarios to assess vehicle capacity, fuel consumption, delivery frequency, and warehouse utilisation, providing a comprehensive decision-support tool for balancing economic and environmental objectives.

The digital twin integrates real production data, customer orders, and logistical parameters across various transport vehicles (van, lorry, and lorry with trailer) to generate real-time, data-driven insights (the data are refreshed after each completed shift). The methodology for developing the digital twin uses a previously developed five-stage procedure with integrated algorithms for automatic recognition of the transport vehicle type, automatic detection of the production part type, automatic control of delivered parts, etc. This enables users to perform detailed “what-if” analyses without disrupting actual operations, identifying the most efficient and sustainable delivery configurations. Results from simulated test cases show that larger transport vehicles reduce total fuel consumption by more than 50% and consequently also reduce emissions (Tank-to-Wheel), but increase temporary storage requirements and external warehouse costs. Conversely, smaller vehicles offer greater delivery flexibility but result in higher energy intensity and transport frequency. Validation and verification of the digital twin were conducted using a diverse set of test data designed to reflect typical operational variations and quantity fluctuations, enabling a reliable assessment of the digital twin’s accuracy and robustness for the manuscript.

The findings show that digital twins can be practical enablers of the green and digital transition in manufacturing, linking operational excellence with ecological responsibility.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-162579: Microbially Induced Carbonate Precipitation (MICP) for Cadmium Removal: Sustainable Applications for Ecosystem Protection

Ludovica Martinisi *, Vincenzo Pasquale and Valeria Di Onofrio

International PhD Programme/UNESCO Chair “Environment, Resources and Sustainable Development”, Department of Sciences and Technologies, University of Naples “Parthenope” Naples, 80143, Italy

Introduction

Heavy-metal pollution represents a critical threat to environmental and public health due to the persistence, non-biodegradability, and bioaccumulative nature of these elements. Contaminated waters used for agriculture, drinking, or discharged as urban wastewater constitute major exposure routes for humans and ecosystems. In recent years, nature-based bioremediation strategies employing non-pathogenic microorganisms have gained attention for the selective removal of dissolved metals. Among these, bacterially induced bioprecipitation has emerged as a promising approach due to its efficiency, specificity, and operational sustainability.

Methods

This study evaluated the capacity of selected non-pathogenic ureolytic bacteria to induce co-precipitation of Cd^{2+} as a carbonate mineral phase. Two microbial strains, *Vibrio harveyi* and *Glutamicibacter bergerei*, known for catalyzing ureolysis-driven increases in pH and carbonate alkalinity, were tested. Cultures were grown in defined liquid media supplemented with urea and NaCl under controlled laboratory conditions (30 °C, initial pH 7.0, continuous aeration). Cadmium was introduced at an initial concentration of 50 ppm in synthetic contaminated-water matrices. Incubations were carried out for 8 days, with periodic sampling for quantitative analysis of residual metal concentrations using standard chemical methods. Statistical analyses were applied to assess strain-dependent differences and the significance of operational variables.

Results

Both bacterial strains demonstrated notable Cd^{2+} removal through microbially induced carbonate precipitation, forming predominantly insoluble metal-carbonate compounds. Removal efficiencies approached 80%, highlighting the strong potential of ureolytic bioprecipitation for application in contaminated-water treatment.

Conclusion

The proposed biotechnology offers an environmentally sustainable remediation option, generating no toxic by-products and enabling in-situ deployment without chemical additives. These findings provide a scientific basis for further optimization and pilot-scale implementation. The study presenting a solid nature-based strategy for mitigating heavy-metal contamination in aquatic systems.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-158349: Public Perceptions and Adaptive Capacity to Climate-Related Risk in Greece: Evidence from a Nationwide Dataset

Maria Vasiliki Kanellaki ¹, Eleni Kritidou ², Alexandra Aspioti ³, Stergios Emmanouil ⁴, Anastasios Perdios ⁵, Maria Margarita Ntona ¹, Maria Nefeli Georgaki ⁶, Maria Papailiopoulou ⁷ and Athanasios Vasileios Serafeim ^{3,*}

¹ Department of Geology, Aristotle University of Thessaloniki, Thessaloniki, 54636, Greece

² Department of Geography, University of Zurich, Zurich, 8057, Switzerland

³ Department of Civil Engineering, University of the Peloponnese, Patras, 26334, Greece

⁴ Department of Civil, Environmental and Construction Engineering, University of Central Florida, Florida, FL 32816, USA

⁵ Department of Civil Engineering, University of Patras, Patras, 26500, Greece

⁶ Department of Chemical Engineering, Aristotle University of Thessaloniki, 54124 Thessaloniki, Greece

⁷ Department of Geology, University of Patras, Patras, 26504, Greece

The Mediterranean region is recognised as a hotspot for the climate crisis. Natural hazards such as storms, droughts, fires, and heat waves, combined with an area's vulnerability, can cause severe impacts and damage to property, ecosystems, crops, and human life.

Understanding public perceptions of climate-related risks is critical, as they shape not only the individual and collective responses to climate challenges but also the effectiveness of adaptation strategies. Despite growing pressure, comprehensive nationwide research on public attitudes and adaptive capacity regarding climate change is lacking in Greece.

The present study builds on the previous work of Perdios et al. (2025) and extends their analysis using a published dataset with over 1,000 responses from the Greek population; see Serafeim et al. (2025). Specifically, the questionnaire aims to capture four key dimensions of adaptive capacity: (a) the magnitude of information and awareness about climate-related risk, (b) personal experiences with extreme weather events, (c) readiness to adopt more sustainable practices, and (d) perceptions of local interventions to address the climate crisis.

Key results highlight regional disparities in both awareness and preparedness, and socio-demographic variables such as education and income are important determinants. By identifying patterns of readiness and risk perception across populations, this work contributes to a more informed understanding of society and resilience to climate change in the Mediterranean region.

References

Perdios, A. et al. (2025). Adapting to the Escalating Climate Crisis in the Mediterranean Region: The case of Greece, EGU General Assembly 2025, Vienna, Austria, 27 Apr–2 May 2025, EGU25-9003, <https://doi.org/10.5194/egusphere-egu25-9003>, 2025.

Serafeim, A. V. et al. (2025). National survey-based investigation of climate risk perceptions and adaptation readiness in Greece [Dataset]. Dryad. <https://doi.org/10.5061/dryad.t1g1jwgt1>



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-153187: Determinants of Climate-Smart Agriculture Technology Adoption Among women Farmers in Oyo state, Nigeria

Oluwaseyi Adenike Idowu * and Munyaradzi Chitakira

Department of Environmental science, University of South Africa (Florida Campus), Johannesburg, South Africa

This study explores the factors shaping the adoption of Climate-Smart Agriculture (CSA) practices among women farmers in Oyo State, Nigeria. The research objectives were to profile respondents' socio-demographic characteristics, identify the main determinants of CSA uptake, and propose strategies to strengthen adoption pathways and enhance resilience.

A multistage random sampling approach was employed to select 260 women farmers. Primary data were collected through structured questionnaires and analyzed using descriptive statistics and logistic regression to examine the influence of socioeconomic and institutional variables on CSA adoption. The analysis also examined respondents' perceptions of the benefits and challenges of CSA in the local agricultural context.

The results indicate that 27.8% of respondents were aged 50 years or younger, 22.7% had received formal education, and 23.8% reported extensive experience in farming. Regression analysis identified farm size, age, education, technology costs, extension contact, credit access, and perceived benefits of CSA as significant predictors of adoption. These findings highlight the importance of enabling environments, particularly improved access to credit and extension services, while addressing structural and socio-cultural barriers that restrict women's participation in climate-smart farming. The study provides practical insights for policymakers, extension agents, and development stakeholders seeking to promote the adoption of gender-responsive CSA and to strengthen agricultural resilience to climate change.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-161807: A Dual Technical and Environmental Assessment of the Transition from Grey to Green Hydrogen in the Haber–Bosch Process: A Modelling and Simulation Approach

Nour El Imene Brahmi ^{1,*} and Kaouther Kerboua ^{1,2}

¹ Department of Process and Energy Engineering, National Higher School of Technology and Engineering, 23005 Annaba, Algeria

² Laboratory of Mining, Metallurgy and Materials L3M, National Higher School of Technology and Engineering, Annaba, Algeria

The transition from fossil-derived (grey) hydrogen to electrolytic (green) hydrogen in Haber-Bosch ammonia synthesis introduces substantial technical, energetic, and environmental challenges at the process level. This study provides an integrated technical and environmental assessment per 1 ton of NH₃, combining detailed process simulation with system-level mass, energy, and emission accounting. Methodologically, the novelty lies in the coupled modelling framework that links electrolyser dynamics (including purity variations and intermittency) with the closed-loop behaviour of the ammonia synthesis section, allowing the quantification of stability limits and integration requirements under variable renewable operation. The approach further introduces a unified per-ton NH₃ indicator set that simultaneously evaluates electrical demand, compression duty, CO₂ intensity, and water consumption.

Stoichiometrically, the process requires 0.177 ton H₂/ton NH₃. Using proton-exchange-membrane electrolysis at 50 MWh/ton H₂ results in an electrolytic demand of 8.85 MWh/ton NH₃, and including a representative compression penalty of 1.5 MWh/ton H₂ yields a total electrical requirement of about 9.12 MWh/ton NH₃. From an environmental perspective, conventional SMR hydrogen (8.5 to 9.5 ton CO₂/ton H₂) corresponds to 1.50 to 1.68 ton CO₂/ton NH₃, whereas renewable energy-based electrolysis cuts direct process CO₂ emissions by >95%, contingent on the grid carbon factor for upstream electricity. Water use, quantified at around 9 to 10 kg H₂O per kg H₂, implies 1.6 to 1.8 m³ of deionized water per ton NH₃.

Simulation results show that hydrogen purity fluctuations and pulsating electrolyser output significantly affect loop conversion, recycle duty, and process stability, and that heat-integration and storage strategies are required to maintain steady operation under renewable intermittency. The unified performance indicators and dynamic-integration results generated in this work provide new design benchmarks for retrofitting existing plants and deploying next-generation low-carbon ammonia production systems.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-155842: Adsorptive Removal of Methylene Blue Using HCl-Activated Cactus Biomass: Box–Behnken Design Optimization

Fouzia Ouazani *, Assia Bensedjad and Khedidja Benouis

Laboratory of Process Engineering, Materials and Environment, Faculty of Technology, University of Djillali Liabes, PO Box 89, Sidi Bel Abbas 22000, Algeria

This work examines the generation and optimization of activated carbon from cactus biomass via chemical activation with hydrochloric acid (HCl) to assess its efficacy and sustainability as an adsorbent for removing methylene blue from aqueous solutions. The preparation procedure involved two primary steps: carbonization of the cactus biomass at a regulated temperature, followed by chemical activation with HCl to augment the material's porosity, surface area, and active functional groups. The resulting adsorbent was characterized and used in methylene blue adsorption experiments

A Box–Behnken experimental design was employed to optimize the process and assess the effects of critical operating factors. The effects of solution pH, initial dye concentration, and adsorbent dose, as well as their interactions, were systematically examined. Statistical analysis revealed that all parameters significantly influenced the adsorption capacity. The experimental data conformed well to a quadratic model, yielding a high coefficient of determination ($R^2 = 0.97$), thereby affirming the model's robustness and predictive accuracy. Under optimal conditions, the cactus-derived activated carbon exhibited exceptional methylene blue removal efficiency, indicating robust adsorption capacity.

To evaluate the environmental and economic advantages of the proposed adsorbent, the study conducted comparative analyses of precursor availability, energy requirements during carbonization, chemical consumption during activation, and estimated production cost per unit mass of activated carbon. Life-cycle considerations, including the renewability of cactus biomass and its reduced environmental footprint relative to conventional activated carbon derived from non-renewable sources, were also assessed. These methodological approaches helped quantify reductions in waste generation, energy input, and overall treatment cost.

These findings underscore the efficacy of cactus biomass as an economical, renewable precursor for the manufacture of activated carbon. The study emphasizes its environmental and economic advantages, suggesting its promising application in wastewater treatment processes for the removal of synthetic dyes and other persistent organic contaminants



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-158289: Adsorptive Removal of Synthetic Textile Dyes Using Raw Almond Shells: A Sustainable Approach to Wastewater Treatment

Hadj Boumedien Rahmoun ^{1,*}, Maamar Boumediene ² and Eduardo Ferreira Da Silva ³

¹ Water and Structures in Their Environment (EOLE) Laboratory, Department of Hydraulics, Faculty of Technology, University of Tlemcen, Tlemcen 13000, Algeria

² Promotion of Water, Mineral and Soil Resources: Environmental Legislation and Technological Choices Laboratory, Department of Hydraulics, Faculty of Technology, University of Tlemcen, Tlemcen 13000, Algeria

³ GeoBioTec Research Unit, Department of Geosciences, Campus de Santiago, University of Aveiro, 3810-193 Aveiro, Portugal

The adsorption capacity of raw almond shells (RASs) was evaluated for the removal of two synthetic textile dyes, Bemacron Blue RS 01 (BB-RS01) and Bemacid Marine N-5R (BM-N5R), from aqueous solutions. Prior to adsorption tests, RAS was characterized using Fourier-transform infrared spectroscopy (FTIR), scanning electron microscopy (SEM-EDX), Brunauer–Emmett–Teller (BET) surface analysis, thermogravimetric/differential thermal analysis (TGA/DTA), and point of zero charge (pHpzc) determination to assess its physicochemical properties relevant to adsorption. Batch adsorption experiments were then conducted under varying operational parameters, including contact time, dye concentration, biosorbent dosage, particle size, pH, and temperature. Rapid dye uptake occurred within the first 30 minutes, reaching equilibrium after two hours. Maximum dye removal efficiencies of 90% for BB-RS01 and 80% for BM-N5R were achieved at acidic pH (2–4) and low initial concentrations (15 mg.L⁻¹). Increasing biosorbent dosage and decreasing particle size enhanced adsorption efficiency. The adsorption process exhibited endothermic behavior, with optimal performance at 35 °C. Kinetic data were best fit by a pseudo-second-order model, suggesting chemisorption as the controlling mechanism. Equilibrium data followed the Langmuir model for BB-RS01 ($R^2 = 0.995$) and the Freundlich model for BM-N5R ($R^2 = 0.850$), indicating monolayer and heterogeneous multilayer adsorption, respectively. The maximum adsorption capacities were 208.33 mg.g⁻¹ for BB-RS01 and 243.90 mg.g⁻¹ for BM-N5R. Regeneration studies showed stable adsorption performance for up to four reuse cycles. These findings confirm that RAS is a promising, sustainable, and low-cost biosorbent for the treatment of dye-contaminated wastewater, supporting circular economy and green chemistry principles.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-161986: Advancing Low-Cost Biosorbent Engineering: Optimized Alkaline Activation of Agro-Industrial Biomass for Enhanced Removal of Cationic Dyes

Gennaro Trancone

Department of Civil, Architectural and Environmental Engineering, University of Naples "Federico II", Via Claudio 21, 80125 Naples, Italy

The growing need for sustainable and affordable technologies for wastewater treatment has driven the development of biosorbents derived from agricultural residues. This work investigates the optimization of alkaline chemical activation applied to two widespread biomasses—spent coffee grounds (SCG) and date pits (DP)—to enhance their capacity to remove methylene blue (MB) from aqueous solutions. Using a two-level full factorial design, the impact of NaOH concentration, activation time, and activation temperature on sorbent performance was assessed.

Among the tested materials, SCG demonstrated a strong response to chemical activation, whereas DP presented limited improvement. The optimal operating conditions for SCG (0.2 M NaOH, 5.5 h activation, and 22 °C) yielded the highest adsorption capacity (140.23 mg g⁻¹), confirming the key role of activation time and temperature in shaping surface reactivity. Textural and spectroscopic analyses (BET, SEM, and FTIR) revealed a mesoporous structure (37.44 m² g⁻¹; pore diameter 4.39 nm) and the presence of functional groups (O–H, C=O, and C–O) actively involved in dye uptake. The point of zero charge (pHpzc = 5.42) indicated enhanced surface acidity following NaOH treatment.

Adsorption performance was strongly influenced by pH, dosage, and temperature, with higher pH and moderate dosages favoring MB removal. Kinetic modeling identified the pseudo-second-order model as the most suitable ($R^2 = 0.96$), supported by intraparticle diffusion analysis indicating multi-step mass transfer. Equilibrium data were best represented by the Sips isotherm ($R^2 = 0.99$), predicting a maximum capacity of 145.59 mg g⁻¹. Thermodynamic parameters revealed a spontaneous, exothermic, and entropy-driven process.

Overall, this study demonstrates that statistically optimized alkaline activation significantly enhances the adsorption performance of SCG, validating its potential as an efficient, low-cost biosorbent for treating dye-polluted wastewater, while contributing to the valorization of agro-industrial residues within circular economy frameworks.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-162730: AI-Enhanced Monitoring of Mangrove Restoration Using UAV and Satellite Data Fusion

Sunil Nepali *, Pawita Boonrat and Veeranun Songsom

Faculty of Environment and Technology, Prince of Songkla University, Phuket, Thailand

Mangrove forests play a vital role in coastal ecosystems by mitigating climate change, protecting shorelines, and supporting biodiversity. However, these critical habitats are declining globally due to encroachment, deforestation, urbanization, and aquaculture expansion. Regular and detailed monitoring is essential for effective conservation and restoration efforts. While freely available satellite imagery, such as from Sentinel-2, provides broad coverage, its coarse spatial resolution limits its usefulness for detailed mangrove monitoring. To address this gap, this study develops an unmanned aerial vehicle (UAV)-assisted super-resolution framework to reconstruct high-resolution historical imagery for monitoring mangrove restoration at Saphan Hin, Phuket, Thailand. We acquired high-resolution UAV imagery in 2024 to calculate precise vegetation indices and canopy cover metrics. These UAV-derived products are used to train a super-resolution deep learning algorithm. The trained model is then applied to upscale historical satellite imagery from Landsat and Sentinel-2 archives (2004–2024), creating an enhanced temporal series. From this reconstructed data, we extract key indicators of restoration trajectories, including canopy density and phenological patterns. This approach enables a direct, high-resolution comparison of ecosystem development between actively restored areas and zones of natural recovery. The primary goal of this study is to demonstrate a practical, scalable workflow that leverages AI to transform low-resolution satellite data into actionable, site-specific insights. By reconstructing past canopy dynamics in the absence of historical high-resolution data, this framework provides a powerful, non-invasive tool for long-term monitoring. It holds significant potential to improve the management of coastal restoration projects, enhance the accuracy of blue carbon accounting, and support the valuation of ecosystem services in vulnerable coastal regions.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-150175: Application of Landform Evolution Models to Assess Long-Term Contour Bank Stability in Constructed Post-Mining Landforms

Indishe P Senanayake * and Gregory R Hancock

School of Engineering, The University of Newcastle, Callaghan, NSW 2308, Australia

In the mining industry, once valuable minerals are extracted, waste rock dumps are piled at designated sites. These dumps are capped with topsoil, and the hillslopes are seeded with pasture species. The constructed post-mining landscapes are expected to gradually integrate with the surrounding natural terrain. However, due to the physical and chemical properties of the waste material, limited vegetation cover, and hillslope geometries, these landforms are susceptible to rill and gully erosion. Ensuring their long-term erosional stability is therefore a primary challenge. Contour banks are occasionally constructed across rehabilitated slopes to mitigate erosion, yet predicting their long-term effectiveness at each site remains challenging. In this study, we evaluated the stability of contour banks using a physics-based landform evolution model (LEM). A LiDAR-derived digital elevation model (DEM) of a unique hillslope, with one section containing contour banks and another without, served as the study site. The State Space Soil Production and Assessment Model (SSSPAM) was applied over a 100-year simulation period with annual time steps, parameterised for site-specific conditions. The model results indicate that contour banks at this site gradually erode, and that after 100 years, average erosion rates were comparable between slopes with and without contour banks. These findings are consistent with short-term visible observations, showing early signs of contour bank erosion. The study highlights the utility of LEMs for assessing the long-term sustainability of erosion-control measures, such as contour banks, in post-mining landscapes. The insights generated from LEMs provide valuable guidance for mine rehabilitation planning and broader land management applications, including terraced landscapes.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-154899: Assessment of Atmospheric Heavy Metal Deposition in the Karabakh Region of Azerbaijan Using *Leucobryum glaucum* as a Bioindicator

Murad Maharram ^{1*}, Timur Mustafazade ¹ and Rana Khankishiyeva ²

¹ International School of Azerbaijan (TISA), Baku, AZ1070, Azerbaijan

² Institute of Radiation Problems of the Ministry of Science and Education of the Republic of Azerbaijan, Baku, AZ1143, Azerbaijan

Mosses are well-established bioindicators for atmospheric pollution due to their remarkable capacity to accumulate airborne contaminants. This study evaluates atmospheric heavy metal deposition in the Karabakh region (Azerbaijan) using *Leucobryum glaucum* as a bioindicator species. Two complementary biomonitoring approaches were applied: (A) passive sampling with native moss and (B) active moss bag exposure using commercially sourced material. Sampling was conducted across eight locations: Shusha, Karkijahan, Khankendi, Khojali, Asgaran, Vang, Kalbajar, and Agdere. Concentrations of Pb, Cd, Cu, As, and Zn were determined by inductively coupled plasma mass spectrometry (ICP-MS) following a 59-day exposure period.

The results revealed consistently higher heavy metal accumulation in native moss compared to moss bags, indicating its superior efficiency for long-term atmospheric monitoring. Elevated arsenic levels were observed in Karkijahan (3.50 mg kg⁻¹), while lead concentrations peaked in Agdere (0.82 mg kg⁻¹). Zinc and copper were notably higher in Shusha (89.6 mg kg⁻¹ and 378.5 mg kg⁻¹, respectively), identifying potential local pollution hotspots. These spatial variations likely reflect differences in emission sources, atmospheric transport, and local environmental conditions.

The study demonstrates the effectiveness of moss-based biomonitoring in assessing regional air quality and detecting heavy metal gradients. Such approaches provide an essential, cost-efficient tool for environmental surveillance and sustainable regional management. Future investigations should integrate long-term monitoring and species-specific calibration to improve quantitative accuracy and ecological interpretation.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-156431: Assessment of Flash Flood in the Dharali Region of Uttarkashi using Sentinel-1A and Sentinel-1C SAR data

Aditya Bhalekar ^{1,*}, Varun Gowda ¹, Neeraj Parekh ¹, Ashish Itolika ² and Vaishali Wangikar ³

¹ Department of Electrical and Electronics Engineering, MIT Academy of Engineering, Alandi, Pune, Maharashtra 412105, India

² Department of Humanities and Engineering Sciences, MIT Academy of Engineering, Alandi Road, Pune, 412105 (MS), India

³ Department of Computer Engineering, MIT Academy of Engineering, Alandi Road, Pune, 412105 (MS), India

Floods are among the most devastating natural disasters, causing widespread damage to life, property, and infrastructure. Rapid and accurate flood detection and mapping are essential for effective emergency response and mitigation. Synthetic Aperture Radar (SAR) data, with its ability to penetrate cloud cover and operate in all weather conditions, plays a crucial role in real-time flood assessment and management. The present study uses Synthetic Aperture Radar (SAR) Sentinel-1A and Sentinel-1C (10 M resolution) datasets provided by the European Space Agency (ESA) to assess the extent of flooding in the Dharali Region of Uttarkashi, Uttarakhand, India. During the flood event, extensive cloud cover limits the applicability of optical imagery; therefore, microwave SAR data are used in the present investigation. The flood-affected zone in the Dharali region is relatively small, making change detection using 10-meter-resolution SAR data challenging. The challenges posed by comparatively low-resolution data can be addressed using threshold-based band-filtering techniques and RGB composites. The present study uses Sentinel-1A and Sentinel-1C data to detect changes in the flooded area before and after the event. The data are preprocessed using an orbit file application, geometric correction, radiometric calibration, speckle noise reduction, and terrain correction, all of which are essential for accurate geospatial analysis. A threshold-based band-filtering technique and RGB composite images are employed to detect change. This study provides useful data for rapid response in disaster management and flood mapping in the Dharali region of Uttarkashi, Uttarakhand, India, during the flash floods that occurred on 5th August 2025.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-156350: Biochar-assisted nanoclay adsorption process for industrial wastewater reclamation: A data-driven green economic model

Pelin Soyertaş Yapicioğlu * and Fatma Elisa

Department of Environmental Engineering, Harran University, Sanliurfa 63050, Turkey

The European Union (EU) Urban Water Reuse Legislation outlines the important challenges to obtaining a green environment. Biochar-assisted treatment processes combined with green substances could be a beneficial option in order to deal with the challenges in EU water reuse legislation. Biochar alone might not be sufficient for achieving higher quality reclaimed water. Even so, a modification of biochar should be carried out by adding an efficient green material such as nanoclay to ensure quaternary treatment is achieved. Nanoclay substances have attracted attention recently owing to their many environmentally friendly advantages for wastewater treatment. The combination of biochar and nanoclay could be an efficient adsorber by the intercalation of the properties of both biochar and nanoclay. From this point of view, this study mainly aimed to investigate the effects of nanoclay addition on malt-dust-derived biochar for wastewater reclamation. Then, a new green improvement index (GII) was developed to determine the effect of nanoclay addition on the biochar adsorption process for wastewater reclamation. This study presented two new biochar-based mechanistic models: a data-driven sensitivity analysis and an uncertainty analysis by Monte Carlo simulation. According to the multivariate statistical analysis, the mixing ratio of malt-dust-derived biochar and nanoclay (bentonite) was 1:2 for the maximum pollutant removal efficiency from brewery industry wastewater. The green improvement index (GII) was in the range of 0.255–0.317, so the nanoclay addition improved the overall wastewater quality by 25.5–31.7%. At the end of the biochar-assisted nanoclay adsorption, Class-A-quality reclaimed water from brewery wastewater was achieved. Also, a virtual benefit-cost analysis was performed, where the economic amendment was ensured by reclaimed water use achieved by the biochar-assisted nanoclay process instead of freshwater reuse.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-158072: Climatic Variability and Urban Heat Stress Assessment in Mogadishu, Somalia, from 2001 to 2025

Yonis Khalif Elmi ^{1,2,*} and Khalid Abukar ²

¹ Department of Electrical and Electronic Engineering, Jamhuriya University of Science and Technology, Mogadishu, Somalia

² Engineering and Technical Services Division, Solpremier Energy Solution, Mogadishu, Somalia

Understanding long-term temperature behavior is essential for sustainable urban and environmental management in Somalia. Mogadishu, as a rapidly expanding coastal city, faces growing exposure to extreme heat events that threaten human comfort, health, and urban resilience. Yet, limited continuous environmental monitoring has constrained policy development. This study provides a comprehensive examination of historical temperature records from 2001 to 2025, offering new insights into climatic variability and thermal stress conditions in the Somali capital. Hourly temperature data were analyzed through time-series and statistical trend assessment methods. The Mann–Kendall test and Sen's slope estimator were applied to determine the direction and magnitude of climatic trends. Heat-stress indicators, including the Heat Index and Discomfort Index, were used to classify thermal comfort levels. Seasonal and diurnal variations were visualized using anomaly and frequency plots. The analysis reveals a clear warming pattern over the 25 years, with an average temperature increase of approximately 1.2 °C and a noticeable increase in the frequency of hours exceeding 35 °C. The results show intensified heat stress conditions after 2015, particularly during the March–April season. The Discomfort Index indicates a substantial shift from the comfortable to the caution and danger categories, implying greater vulnerability among urban populations. These findings underscore the urgent need for climate-adaptive urban design, vegetation restoration, and reflective-surface technologies to mitigate rising thermal stress in Mogadishu.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-158313: Coupled AOPs as a mitigation strategy for synergetic environmental remediation in small scale environments: the case of sono-galvano-Fenton technique against recalcitrant pollutant in water

Gasmi Intissar^{1,*}, Kaouther Kerboua^{2,3} and Naoufel Haddour⁴

¹ Environmental Research Center, 23000, Annaba, Algeria

² Department of Process and Energy Engineering, National Higher School of Technology and Engineering, 23005 Annaba, Algeria

³ Laboratory of Mining, Metallurgy and Materials L3M, National Higher School of Technology and Engineering, Annaba, Algeria

⁴ AMPERE Laboratory, H9 Building, École Centrale de Lyon (Lyon Central School), UMR CNRS 5005, 36 Avenue Guy de Collongue, 69134 Ecully Cedex, France

The Sono-Galvano-Fenton is a hybrid advanced oxidation process designed to harness the advantages of each process, namely the *in-situ* production of the Fe^{2+} catalyst (through the Galvano-Fenton process) and hydrogen peroxide (H_2O_2 ; through sonochemistry), as well as the plausible synergetic production of the hydroxyl radical ($\text{HO}^\bullet$). In the present study, the hybrid technique is applied to the degradation of Malachite Green using different coupling strategies, at an acoustic frequency of 600 kHz and an acoustic power of 120 W, with a pre-optimized electrochemical configuration of 1 anode to 6 cathodes. A numerical model is also applied to assess the role of sonication at both microscopic and macroscopic scales. The experimental results revealed an extended residence time of the emerging pollutant within the 300 mL reactor in batch mode when both techniques are coupled in series, offering an advanced purely sonochemical degradation of the extent of Fenton reagent H_2O_2 production. The process is then engineered in continuous mode with recirculation of the treated solution to overcome this limit. The numerical model of sonolysis in an air atmosphere at the reactor scale demonstrated apicomolar production of hydrogen peroxide and hydroxyl radicals at 200 kHz, suggesting a frequency shift toward this value to enhance both processes' coupling.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-161717: Degradation of Sulfamethazine and Trimethoprim in Aquaculture Wastewaters: Kinetics, Pathogen Inactivation, and Toxicity Assessment

Alexandra A. Ioannidi ^{1,2,*}, Dionissios Mantzavinos ¹ and Maria Antonopoulou ²

¹ Department of Chemical Engineering, University of Patras, Caratheodory 1, University Campus, GR-26504 Patras, Greece

² Department of Sustainable Agriculture, University of Patras, 30131 Agrinio, Greece

Antibiotics like sulfamethazine (SMZ) and trimethoprim (TMP) are widely used in aquaculture to treat bacterial infections in farmed fish. Their extensive use results in continuous release into wastewater, where they persist as micropollutants. Both compounds show low biodegradability and can accumulate in water bodies. Their presence in aquaculture effluents raises concerns about antimicrobial resistance, ecotoxicity to aquatic organisms, and potential human exposure through water reuse and seafood consumption.

Because of their persistence, advanced oxidation processes such as UVC/H₂O₂, solar/persulfate, and ozone are increasingly examined to efficiently degrade these antibiotics and minimize toxic transformation products. In this study, to the best of our knowledge, the degradation of an SMZ-TMP mixture in aquaculture influents and effluents from two different farms was investigated by UVC/H₂O₂ for the first time. Experiments were conducted in a 150 mL batch reactor using a low-pressure UVC lamp at 8 W and a temperature of 25 °C. SMZ and TMP concentrations were monitored using high-performance liquid chromatography (HPLC, Waters Alliance 2695, Milford, MA, USA). All water samples exhibited TSS and TOC below 6 and 3 mg/L, respectively, with pH 7.7–7.9 and conductivity of 350–430 µS/cm.

Preliminary experiments show very promising results. Specifically, photolysis experiments showed that UVC alone cannot degrade TMP, achieving less than 15% removal at 10 min, while SMZ exhibited a removal of ~50% at the same time. Remarkably, in the presence of 7 mg/L H₂O₂, the UVC/H₂O₂ process achieved more than 50% TMP and 90% SMZ removal at 15 min. The next steps include simultaneous antibiotic removal and pathogen inactivation, and toxicity assessment of the treated effluents using freshwater (*Chlorococcum* sp.) and saltwater (*Tisochrysis lutea*) microalgae species.

Acknowledgements

The research project is implemented in the framework of H.F.R.I call "3rd Call for H.F.R.I.'s Research Projects to Support Faculty Members & Researchers" (H.F.R.I. Project Number: 26141).



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-162521: Eco-Friendly Wastewater Treatment Using Biochar Adsorbents: Removal of Tyrosol and Hydroxytyrosol and Life Cycle Assessment

Kawtar Ezzahi^{1,*}, Imad Rabichi², Francesca Demichelis³, Nabil Rochdi⁴, Rachid Idouhli², Mohamed Hafidi¹, Debora Fino⁵ and Loubna El Fels¹

¹ Laboratory of Water Sciences, Faculty of Sciences Semlalia, Cadi Ayyad University, Marrakech 40000, Morocco

² Laboratory of Applied Chemistry and Biomass, Faculty of Sciences Semlalia, Cadi Ayyad University, Marrakech 40000, Morocco

³ Department of Applied Science and Technology (DISAT), Politecnico di Torino, Torino, Italy

⁴ Laboratory of Innovative Materials, Energy and Sustainable Development (IMED-Lab), Cadi Ayyad University, PO Box 549, Marrakesh 40000, Morocco

⁵ Department of Applied Science and Technology (DISAT), Politecnico di Torino, Italy

Olive mill wastewater (OMWW), a major by-product of olive oil production, is generated in large volumes throughout the Mediterranean region and contains high concentrations of phenolic compounds, notably tyrosol (TY) and hydroxytyrosol (HT). Owing to their high mobility and toxicity toward microorganisms and aquatic ecosystems, these compounds can disrupt soil processes and pose significant environmental challenges. In this study, olive stone-derived biochar was evaluated as a sustainable and low-cost adsorbent for the removal of TY and HT from aqueous solutions, with performance benchmarked against commercial activated carbon (AC). Comprehensive physicochemical characterization showed that the biochar possesses a high specific surface area (258 m²/g), well-developed porosity, and abundant surface functional groups favorable for phenolic adsorption. Batch adsorption experiments were conducted under controlled conditions (initial phenolic concentration of 50 mg L⁻¹, contact time of 1 h, and neutral pH) to investigate adsorption equilibrium, kinetics, and thermodynamics. Adsorption behavior was described using pseudo-first-order, pseudo-second-order, and Elovich kinetic models, as well as Langmuir and Freundlich isotherms. Regeneration experiments demonstrated the reusability of the biochar over multiple adsorption-desorption cycles. A life cycle assessment (LCA) was performed following a cradle-to-grave approach, encompassing biomass collection, biochar production, adsorption application, and regeneration/recovery stages. The environmental impact was evaluated using the global warming potential over a 100-year time horizon (GWP100, kg CO₂-eq). The environmental performance of olive stone biochar was compared with that of a commercial activated carbon subjected to identical adsorption experiments, enabling a consistent and fair comparison. Under the tested conditions, olive stone biochar achieved removal efficiencies of 87% for TY and 91% for HT, comparable to those obtained with AC. Overall, these findings highlight the strong potential of olive stone-derived biochar as an eco-friendly and high-performance alternative for sustainable OMWW treatment, with potential for phenolic recovery and clear relevance to circular economy strategies.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-162892: Effects of electrooxidation vs photoelectrooxidation on bentazone ecotoxicity for different supporting electrolytes

Teresa Girona-Albuixech *, Montserrat García-Gabaldón, Carlos Domingo-Torner, Valentín Pérez-Herranz and Maria Teresa Montañés

IEC Group, ISIRYM, Universitat Politècnica de València, Camí de Vera s/n, 46022, València, P.O. Box 22012, E-46071, Spain

Introduction

Directive (EU) 2024/3019 on the treatment of urban wastewater mandates using quaternary treatments for reducing both the concentration and toxicity of micropollutants. In this work the effectiveness of electrooxidation and photoelectrooxidation processes to eliminate bentazone (BTZ) was studied. BTZ is a micropollutant detected in the Albufera lake (Spain).

Methods

A new ceramic anode made of Sb-SnO₂ and coated with a Bi₂WO₆ photocatalyst was used. Three supporting electrolytes were tested: 1.65 g L⁻¹ of NaCl; 2 g L⁻¹ of Na₂SO₄; and a mixture of 0.46 g L⁻¹ of NaCl and 1.3 g L⁻¹ of Na₂SO₄ (this last being similar to Albufera lake conditions). The initial concentration of BTZ was 100 mg L⁻¹. Two current intensities (0.2 and 0.6 A) were applied, both in the absence and presence of light provided by a xenon lamp. After 4 h, the degradation and mineralization percentages were determined. Ecotoxicity was determined using *Lactuca sativa* seeds according to US EPA OPPTS 850.4200 standard, after adjusting the pH between 5.5-8, if necessary.

Results

The degradation and mineralization degrees achieved using the mixed electrolyte show intermediate values between those achieved with pure electrolytes. Applying 0.6 A, they are very close to the maximum values achieved with pure NaCl. Moreover, the final effluents toxicity is significantly lower, especially when light is applied. Therefore, the photoelectrooxidation process applying 0.6 A with the mixed electrolyte is the most effective technique from the combined point of view of final degradation (90.9%), mineralization (62.4%) and toxicity (elongation of 47.4% compared to control, p-value 0.05). Furthermore, the degradation achieved is greater than 80%, minimum value required by Directive (EU) 2024/3019 (Table 3, Annex I) to reduce the micropollutants concentration.

Conclusions

Photoelectrooxidation is a good option as quaternary treatment in wastewater treatment plants with the following additional advantages. It does not need the addition of chemicals, and energy consumption could be supplied by alternative sources, especially in small communities.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-162065: Energy, Economic, and Environmental (Triple-E) Analysis of Energy Recovery from Sewage Sludge in Municipal Wastewater Treatment Plants

Paolo Blecich ^{1,*}, Dinko Đurđević ² and Igor Wolf ¹

¹ Department of Thermodynamics and Energy Engineering, Faculty of Engineering, University of Rijeka, Rijeka, Croatia

² Green Sustainable Solutions d.o.o., 10255, Donji Stupnik, Croatia

Wastewater treatment plants (WWTPs) generate large amounts of sewage sludge, and managing this sludge is both energy- and cost-intensive. The organic fraction contains recoverable chemical energy that can be converted into biogas, heat, electricity, or upgraded biomethane. This paper presents a triple-E (energy, economic, environmental) assessment of sludge-to-energy options in municipal WWTPs. The analysis is based on a reference WWTP of 200,000 PE, supported by data from the literature, and includes sludge treatment, anaerobic digestion (AD), combined heat and power (CHP) generation, and optional mono-incineration of solar-dried sludge. Mono-incineration is increasingly adopted in Europe because it is publicly accepted, substantially reduces sludge volume and mass, and enables the recovery of phosphorus from ash.

For a sludge production rate of 50 gDS/(PE·day), the corresponding biogas yield is 300 Nm³/tDS. Biogas-fired CHP systems generate about 15 kWh/(PE·year) of electricity and 20 kWh/(PE·year) of thermal energy, meeting approximately 30% of the electrical demand and up to 80% of the thermal demand in WWTPs. Energy autonomy can be further increased by recovering 100–150 kWh/tDS from the mono-incineration of solar-dried sludge.

The specific investment cost of WWTP energy-recovery systems ranges between 400 and 1,000 EUR/PE, with annual operating costs of 40–75 EUR/PE and energy-related costs of 4–8 EUR/PE. Mono-incineration involves average disposal and processing costs of EUR 350 per tonne of dry solids and can be combined with phosphorus recovery, though this introduces additional costs. Under these conditions, AD+CHP typically achieves a payback period of around 10 years, whereas mono-incineration is more capital-intensive and generally results in longer payback periods.

From an environmental perspective, replacing grid electricity with biogas-derived power reduces greenhouse gases emissions by roughly 60%, assuming an EU-27 average grid intensity of 210 gCO₂eq/kWh. Overall, energy-oriented sludge management improves the triple-E performance of municipal WWTPs, provided that the higher costs of mono-incineration are balanced by the value of recovered phosphorus.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-158340: Enhanced Photocatalytic Degradation of Tetracycline by Mg, Co, Cu, and Fe-Doped Versus Undoped Nickel Aluminate: Comparative Mechanism and Efficiency Study

Pavithra G *, Anitha G and Geetha D

Madras Institute of Technology, Anna University, Chennai, India

The degradation of tetracycline, a persistent antibiotic pollutant, was systematically investigated using Mg-doped nickel aluminate(90.19%), Co-doped nickel aluminate (74.35%), Cu-doped nickel aluminate (81.63%), Fe-doped nickel aluminate (64.28%), and undoped nickel aluminate (62.68%) photocatalysts. In each experiment, 12.5 mg of tetracycline and 25 mg of the corresponding catalyst were added to 100 mL of distilled water, and the reaction was monitored for 120 minutes under visible light. SEM analysis revealed distinct dopant-dependent morphologies, ranging from agglomerated particles to well-defined layered structures, which influence surface adsorption and catalytic activity. The particle size of all nickel aluminate catalysts was found to range from 50 to 180nm. Photoluminescence (PL) spectra showed that Mg-doped nickel aluminate exhibited lower PL intensity than Cu- and Co-doped samples, indicating more efficient suppression of electron-hole recombination. The structural and optical characteristics of the corresponding nickel aluminates were directly correlated with the observed enhanced tetracycline removal rates, particularly for the doped catalysts. Kinetic studies confirmed pseudo-first-order behavior, and the degradation efficiency and the resulting mechanistic pathway were comprehensively evaluated for Tetracycline degradation. Overall, the combined evidence demonstrates that metal doping substantially improves the photocatalytic performance of nickel aluminate, primarily through optimized surface morphology and more efficient charge-carrier dynamics, offering a promising approach for tetracycline remediation in contaminated water systems.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-155704: Environmental Flow Assessment of the Old Brahmaputra River Under Climate Change Scenarios Using HEC-HMS

Md. Jubayer Ahamed *, Sujoy Dey and K. M. Ahtesham Hossain Raju

Department of Water Resources Engineering, Bangladesh University of Engineering and Technology, Dhaka 1000, Bangladesh

The Old Brahmaputra River is a vital water resource in Bangladesh, which faces numerous difficulties because of natural variability, human activity, and climate change. This study uses the Hydrologic Engineering Center-Hydrologic Modeling System (HEC-HMS) to evaluate the environmental flow requirements (EFR) of the Old Brahmaputra River under historical and future climate change scenarios. Three hydrological techniques are used in the study to assess the EFR for both low-flow and high-flow seasons: the Tennant Method, the Flow Duration Curve (FDC) Method, and the Constant Yield Method (CYM). Using CMIP6 climate models (ACCESS-ESM1-5, BCC-CSM2-MR, and MRI-ESM2-0) under the SSP5-8.5 scenario, future projections were made for the 2030s, 2050s, and 2080s based on historical data from 1994 to 2024. The findings show notable seasonal fluctuations in flow, with the river suffering from severe ecological degradation during the low-flow period, especially in March. The FDC and CYM methods offer more precise, month-by-month estimates, whereas the Tennant Method recommends an EFR of 62.22 cumecs for the low-flow season. The ACCESS-ESM1-5 model predicts considerable increases in monsoon flows in the future, which could result in more frequent and severe flooding. Future projections show growing flow variability. On the other hand, the MRI-ESM2-0 model projects lower future flows, indicating potential water scarcity. In order to meet the challenges brought on by climate change, the study shows the importance of adaptive water resource management strategies, such as preserving minimum flows during the low-flow season. The results highlight the necessity of integrated water resource management to maintain the Old Brahmaputra River's ecological sustainability and sustain the livelihoods of the communities that depend on it.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-155487: Environmental Impact Assessment of Quarry Impact (Land Loss and Air Quality) in Akure, Nigeria

Ezekiel Tobiloba Ogungbemi * and Suleiman Abdul-Azeez Adegboyega

Remote Sensing and Geoscience Information System, School of Earth and Mineral Sciences, The Federal University of Technology Akure, Akure 340252, Ondo, Nigeria

Quarrying drives infrastructure and economic growth but poses significant environmental challenges in urbanizing areas like Akure North, Ondo State, Nigeria. This study conducted an Environmental Impact Assessment (EIA) focusing on air quality and quarry site expansion by integrating remote sensing and GIS techniques. Multi-temporal satellite imagery (2014–2024) from Landsat 8/9 and Google Earth Pro was processed via GEE for LULC classification and change detection. Air quality data for PM_{2.5} and PM₁₀ (2021–2024) was obtained from the OpenWeatherMap API and analyzed using Empirical Bayesian Kriging interpolation in ArcGIS Pro. LULC results revealed vegetation cover declination by 67.34%, bareland expansion by 102.73%, and water body surge by 4150% due to quarry-induced craters. The NDVI decreased from 0.064–0.408 to 0.030–0.406, and Land Surface Temperature (LST) increased from 29.23–40.72°C to 31.12–42.62°C. Air quality analysis showed that PM_{2.5} ranged from 4.91 to 10.34 µg/m³ and PM₁₀ from 10.24 to 17.03 µg/m³, remaining consistently below their respective WHO annual thresholds (10 µg/m³ and 20 µg/m³, respectively). Proximity analysis using buffer zones (500m, 1000m, and 1500m) revealed significant human exposure, with 447 buildings identified within the 500m zone. Critically, this proximity indicates non-compliance with international benchmarks, such as the Code of Pollution Control (NEA Singapore) recommendation for a 3-kilometer protective buffer between quarries and residential areas. As part of the standard EIA framework, this study further recommends yearly environmental checks for environmental impact, teamwork with the government in city planning and safety zone control, quarry land restoration and recovery planning, and better community involvement and complaint systems. This study successfully integrated remote sensing and geospatial techniques to provide quantitative evidence of significant landscape transformation, vegetation loss, and thermal stress for EIA assessment for quarrying activities.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-156529: Green extraction of *Satureja horvatii* Šilić (Lamiaceae): Preliminary chemical analysis and antioxidant evaluation using natural deep eutectic solvents

Milica Vidić *, Nevena Grujić-Letić, Branislava Teofilović and Emilia Gligorić

Department of Pharmacy, Faculty of Medicine, University of Novi Sad, Hajduk Veljkova 3, 21000 Novi Sad, Serbia

Phenolic compounds, secondary metabolites in the herb of the endemic species *Satureja horvatii* Šilić (Lamiaceae), exhibit antioxidant activity, highlighting the medicinal value of this species. Natural deep eutectic solvents (NADES) represent a new generation of environmentally friendly and sustainable solvents, developed in accordance with green chemistry principles. These solvents are gaining attention as alternatives to conventional solvents. This study aimed to assess the effect of various NADES, combined with the green microwave-assisted extraction (MAE), on the preliminary chemical composition and antioxidant potential of extracts from *S. horvatii* herb. The effectiveness of NADES was also evaluated in comparison with conventional solvents, including ethanol and water. Four types of NADES were prepared through a combined heating–stirring technique, employing choline chloride, lactic acid, malic acid, glucose, and glycerol as components, in appropriate molar ratios. Six extracts of *S. horvatii* were produced through MAE, utilizing NADES, ethanol, and water as extraction media. Extraction was conducted in three 5-second cycles. Spectrophotometric techniques were used to determine the total phenolic content (TPC) and the total flavonoid content (TFC) of the extracts. The antioxidant potential of the extracts was assessed using the 2,2-diphenyl-1-picrylhydrazyl (DPPH) radical scavenging method and the cupric reducing antioxidant capacity (CUPRAC) assay. The glycerol–lactic acid NADES enabled the extraction of the highest TPC, while the choline chloride–lactic acid and glycerol–lactic acid NADES exhibited the strongest antioxidant activity in the CUPRAC assay. The application of the MAE–ethanol combination yielded extracts with the highest TFC and the most potent DPPH radical scavenging activity. Lactic acid-based NADES represent an efficient and sustainable alternative to conventional solvents, providing extracts with TPC, TFC, and antioxidant activity, comparable to or exceeding those of ethanol and water.

Acknowledgments

This work was supported by the Provincial Secretariat for Higher Education and Scientific Research, Province of Vojvodina (Grant No. 142-451-3474/2023).



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-159889: Hydrogeochemical Characterization and Gold Mining Impacts on Groundwater Quality in the Ayanfuri Mining Enclave, Ghana: Implications for Sustainable Environmental Management

Rahinatu Abdul-Rahman ^{1,*} and Emmanuel Daanoba Sunkari ^{1,2}

¹ Department of Mining Engineering, Faculty of Integrated and Advanced Technology, Sir Padampat Singhania University, N.H. 76, Bhatewar, Udaipur-313 601, Rajasthan State, India

² Department of Chemical Sciences, Faculty of Science, University of Johannesburg, P.O. Box 524, Auckland Park 2006, Johannesburg, South Africa

Intensive gold mining activities in Ghana's Ayanfuri enclave pose a significant threat to groundwater quality. To evaluate this impact, a hydrogeochemical assessment was conducted on 59 groundwater samples from community boreholes (n = 22), observation boreholes (n = 13), tailings storage facility (TSF) boreholes (n = 18), and embankments (n = 6). Analytical techniques included Piper diagrams, Gibbs plots, bivariate diagrams, Ficklin diagrams, geochemical modeling, and Net Acid Production Potential (NAPP) computations to characterize hydrogeochemical facies and dominant processes. The prevailing water type is Na-Mg-HCO₃, accounting for approximately 17% of all samples. Groundwater pH is generally below seven at all sampling sites, with the highest acidity in observation boreholes, likely due to hydromorphic dispersion of metal effluents. The groundwater samples consistently exhibited negative NAPP values, indicating that they can neutralize acidity and therefore pose a low risk of acid mine drainage (AMD). Approximately 93% of the samples fall within the Near-neutral Low-metal range on the Ficklin diagram, indicating stable water chemistry and further supporting a low AMD risk. However, 7% of the samples from sites located behind the TSF embankments and observation boreholes, with pH 5.2–5.9 and elevated potentially toxic elements (up to 18.1 ppm), fall within the Colorado AMD and Acid Low Metal zones, implying that sulfide oxidation outpaces neutralization at these sites. These areas pose a higher risk of generating acidic, metal-rich drainage, potentially mobilizing harmful elements, and degrading water quality. Ion exchange and silicate weathering dominate solute acquisition, while lithology and anthropogenic inputs influence spatial variability. This study underscores aquifer vulnerability in mining regions and calls for policy interventions integrating hydrogeochemical risk assessments into mining legislation and water governance. Continuous monitoring, community-based protection, and strict regulatory enforcement are recommended to safeguard groundwater for domestic and agricultural use.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-158237: Hydrogeochemical Processes and Evolution of Groundwater in the Voltaian Aquifer of Krachi East Municipality, Oti Region, Ghana

Harriet Naa Larteley Yeboah¹, Joseph Ndago Amoldago^{2*}, Emmanuel Daanoba Sunkari^{2,3} and Moses Boakye Okyere⁴

¹ Department of Geological Engineering, Faculty of Geosciences, University of Mines and Technology, P.O. Box 237, Tarkwa, Ghana

² Department of Mining Engineering, Faculty of Integrated and Advanced Technology, Sir Padampat Singhanian University, N.H. 76, Bhatewar, Udaipur-313 601, Rajasthan State, India

³ Department of Chemical Sciences, Faculty of Science, University of Johannesburg, P.O. Box 524, Auckland Park 2006, Johannesburg, South Africa

⁴ Department of Geology, Faculty of Science, University of Johannesburg, P.O. Box 524, Auckland Park 2006, Johannesburg, South Africa

Groundwater from the Voltaian aquifer serves as a vital resource for the rapidly growing Krachi East Municipality in Ghana. Despite its significance, detailed insights into its hydrogeochemical evolution remain limited. This study adopts an integrated approach, combining hydrochemical analysis, multivariate statistics, and spatial mapping to characterize groundwater quality, identify the processes controlling its chemistry, and evaluate its suitability for domestic and agricultural purposes, using sixteen samples. Major ions and physicochemical parameters were analyzed, and interpretation employed graphical methods, saturation index calculation, and multivariate statistical techniques, including Factor Analysis and Hierarchical Cluster Analysis on centred log-ratio transformed data. Water Quality Index was computed for drinking suitability, while irrigation suitability was assessed using Sodium Adsorption Ratio (SAR), Electrical Conductivity (EC), Sodium Percentage (Na%), and Magnesium Ratio (MR). Results indicate that groundwater is generally fresh (mean TDS: 363.19 mg/L; mean EC: 488.81 $\mu\text{S}/\text{cm}$) and dominated by a Na-HCO₃ facies (81.25% of samples). Gibbs plots suggest water-rock interaction, particularly silicate and carbonate weathering and ion exchange as the primary control on hydrochemistry. Four principal factors, explaining 92.84% of total variance, highlight contributions from both geogenic processes and anthropogenic influences. WQI classification shows 87.5% of samples fall under the “Excellent” category for drinking, meeting WHO standards. However, irrigation assessment reveals potential risks: although salinity hazards are low (EC 750 $\mu\text{S}/\text{cm}$), most samples exhibit high sodicity (mean Na% $\approx$ 81.6%; 50% unsuitable) and magnesium hazards (mean MR $\approx$ 61.2%; 75% above recommended limits). Overall, the Voltaian aquifer provides groundwater of excellent quality for domestic use, but elevated sodicity and magnesium pose long-term threats to soil health and agricultural sustainability. These findings emphasize the need for integrating water quality indices into local management strategies and adopting mitigation measure such as gypsum application and optimized irrigation scheduling to safeguard socioeconomic and environmental well-being.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-162330: Hydrophobic Menthol–Dodecanoic Acid Deep Eutectic Solvent as a Sustainable Extractant for Phenolic Compounds from Lamiaceae Herbal Drugs

Branislava Teofilović^{1,*}, Snežena Papović², Nevena Grujić-Letić¹, Ivana Đuran³, Emilia Gligorić¹, Milica Vidić¹ and Milan Vraneš²

¹ Department of Pharmacy, Faculty of Medicine, University of Novi Sad, Hajduk Veljkova 3, 21000 Novi Sad, Serbia

² Faculty of Science, University of Novi Sad, Trg Dositeja Obradovica 3, 21000 Novi Sad, Serbia

³ Clinic of Nephrology and Clinical Immunology, University Clinical Centre of Vojvodina, Novi Sad, Serbia

Introduction

Green extraction techniques are essential for reducing the environmental impact of natural product isolation and advancing circular bioeconomy strategies. Hydrophobic deep eutectic solvents (DESs), particularly menthol-based systems, have emerged as biodegradable, low-toxicity alternatives to conventional organic solvents. This study evaluates a menthol–dodecanoic acid DES as a sustainable medium for extracting phenolic acids and flavonoids from commonly used Lamiaceae herbal drugs.

Methods

Ten monocomponent herbal drug samples (basil, thyme, savory, oregano, sage, mint, lavender, rosemary, lemon balm, and an additional thyme sample) produced at the Institute for Medicinal Plant Research “Dr Josif Pančić” were examined. Extractions were carried out using a hydrophobic DES composed of menthol and dodecanoic acid (2:1). Phenolic profiles were determined by high-performance liquid chromatography (HPLC), focusing on representative phenolic acids and flavonoids.

Results

The DES demonstrated effective solubilization of compounds with different structural characteristics. Coumaric acid was detected in concentrations ranging from 0.0244 to 0.0308 mg/g drug, quercetin from 0.1189 to 0.2025 mg/g drug, and naringenin from 0.2912 to 0.3483 mg/g drug. In lavender extract, cinnamic acid was additionally quantified at 0.0177 mg/g drug. These findings confirm that the menthol–dodecanoic acid DES enables successful extraction of both phenolic acids and flavonoids without relying on volatile or hazardous solvents.

Conclusions

The menthol–dodecanoic acid DES represents an environmentally friendly, economical, and efficient extractant for selected phytochemicals from Lamiaceae plants. Its performance supports broader implementation of hydrophobic DES within sustainable extraction platforms aimed at reducing ecological burden and improving the selectivity and safety of natural product processing.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-155270: Integrating Vernacular Architectural Wisdom into Climate-Resilient Urban Development: A Sustainable Pathway for Environmental Management in Northern Nigeria

Aminu Ahmad Haliru ^{1,*} and Aishat Ja'afar Abdullahi ²

¹ Department of Architecture, Federal University Birnin Kebbi, Birnin Kebbi 840000, Nigeria

² Department of Educational Foundation, Sokoto State University, Sokoto 9600000, Nigeria

Urbanization in Northern Nigeria has resulted in the proliferation of modern architectural typologies that often overlook the region's environmental conditions and cultural traditions. This study investigates the integration of vernacular architectural wisdom into climate-resilient urban development, focusing on Sokoto, Katsina, and Kano as case study cities. The study employed a mixed-methods approach, including field measurements, structured interviews, simulation analysis, and policy review, to assess the thermal performance, spatial configuration, and material sustainability of vernacular and modern buildings. The results show that traditional Hausa architecture achieves a mean indoor temperature drop of 4–6°C relative to outdoor ambient conditions, principally due to its courtyard orientation, thick earthen walls, and passive ventilation systems. Comparative life-cycle assessments reveal that vernacular materials possess 60–75% less embodied energy than modern counterparts. The findings further show that residents link vernacular dwellings with cultural identity, comfort, and ecological balance. However, current urban policies remain fragmented, and there are no frameworks that encourage passive design and indigenous material use. This paper proposes an integrative model combining passive-vernacular and modern technologies with educational and policy interventions. Finally, the study demonstrates that incorporating vernacular principles into Nigeria's urban design codes can improve environmental management, cultural continuity, and resistance to climate change, all of which are consistent with the United Nations Sustainable Development Goals (SDGs 11 and 13).



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-162220: Leveraging Machine Learning for Early Detection and Monitoring of *Xylella fastidiosa* in Olive Cultivation: Implications for Technological Diffusion

P. Barciela *, A. Perez-Vazquez, M. Carpena and M. A. Prieto

Instituto de Agroecoloxía e Alimentación (IAA), Universidade de Vigo, Nutrition and Food Group (NuFoG), Campus Auga, 32004 Ourense, Spain

Introduction

Xylella fastidiosa subsp. *pauca* (*Xfp*) has caused significant economic losses in European agriculture. *Xfp* triggers olive quick decline syndrome (OQDS), disrupting the flow of ecosystems, biodiversity, and economic stability. To control *Xfp*, the EU has implemented quarantine protocols, including eradicating infected plants, vector suppression, and restriction of trade barriers in plant material. In this context, using Machine Learning (ML) technologies can help control pest pressures, while Deep Learning (DL) algorithms can detect spectral signatures in leaf reflectance caused by infection with over 90% accuracy.

Aim and Methodology

This systematic review analyzes the application of ML for the early detection of *Xfp*. Academic databases (Scopus, PubMed, and ScienceDirect) were searched using keywords such as “*Xylella fastidiosa*,” “plant disease,” and “machine learning.” Only peer-reviewed studies published between 2015 and 2022 discussing the use of ML for *Xfp* or OQDS diagnosis in olives were selected. Those focused exclusively on unrelated pests or generic Artificial Intelligence (AI) applications were excluded. A total of 17 studies satisfied the inclusion criteria.

Results

ML enables an adaptive, data-driven, and efficient method of farming. The major input here is a review-based study that uses hyperspectral imagery technology and thermal data from Unmanned Aerial Vehicles and satellites. The most popular models applied are supervised ML algorithms and DL architectures. Yet, these analyses were conducted with small datasets or under controlled laboratory conditions without adequate validation at a large scale in the field, thus impacting the generalization of the results. Further barriers to entry include cost of data acquisition, farmer uptake, regulatory obstacles, and interoperability issues.

Conclusion

ML-enabled sensing technologies complement and supplement existing phytosanitary measures with precision agriculture support for crop health, water use, and *Xfp* detection. The success factors are early detection and strong field validation involving regulatory and farm-level decision-making frameworks.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-158125: Life Cycle Assessment (LCA) of a Metal Scrap Shredder Facility

Dorcas Adeola Adejunmobi ^{1,*}, Sabrina Sorlini ¹, Alessandro Abba ¹ and Angela Daniela La Rosa ²

¹ Department of Civil, Environmental, Architectural Engineering and Mathematics (DICATAM), University of Brescia, Brescia, 25123, Italy

² Department of Manufacturing and Civil Engineering, Norwegian University of Science and Technology (NTNU), Gjøvik 2815, Norway

Introduction

Metal scrap recycling plays a role in the circular economy, reducing reliance on primary metal production, which uses more energy; recycled metal requires only 5% of the energy. Mechanical sorting at shredder facilities recovers ferrous and non-ferrous metals from mixed scrap, conserving resources. To achieve circular economy objectives, the waste (SR) from these processes needs to be recovered. SR, a mix of metals, plastics, rubber, and other materials, poses a challenge in achieving a circular economy in scrap recycling. The sustainability of scrap recycling depends not only on metal recovery but also on alternative SR treatment. This study applies LCA to assess the environmental performance of mechanical sorting.

Method

LCA was performed on a shredder facility processing 7 kt annually. Using SimaPro with the CML-IA Baseline method and a 1-tonne functional unit, system boundaries included energy, emissions, and waste treatment, with recycling credits for avoided virgin production. Four scenarios were modelled: (S1) metal recovered, residues landfilled; (S2) metal and plastic recovered, remaining residues landfilled; (S3) metal recovered, residue incinerated; (S4) metal and plastic recovered, residue incinerated for energy.

Result

Metal recovery greatly reduces the environmental impacts of sorting, and the scenarios showed clear differences across the indicators. For Global Warming Potential, S1 had the highest impact at 8.77 kg CO₂-eq, while S4 performed best at -17.34 kg CO₂-eq due to avoided virgin production and energy substitution. The Human Toxicity indicator followed the same trend, with S1 showing the highest impact at -29.25 kg 1,4DBeq and S4 the lowest at -91.78 kg 1,4DBeq. Acidification showed the best performance in S2 at -0.19 kg SO₂-eq and the highest impact in S3 at -18.14 kg SO₂-eq. For Fossil Fuel Depletion, S2 performed best at -147.28 MJ, while S3 showed the highest impact at -114.01 MJ.

Conclusions

The results demonstrate that combining material recovery with appropriate residue treatment significantly enhances environmental benefits compared to landfill-only.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-158074: Life Cycle Assessment (LCA) of Circular Economy Pathways for the Valorization of Dairy By-products

Maria Bairaktari ^{1,2,*}, Nikolaos Karountzos ^{2,3}

¹ Department of Nutritional Science and Dietetics, School of Health Sciences, University of the Peloponnese, Antikalamos, 24100, Kalamata, Greece

² Sustainability Management, Green Metrics, Piraeus, 18543, Greece

³ Department of Digital Systems, School of Economics and Technology, University of the Peloponnese, Valioti's building, Kladas, 23100, Sparta, Greece

Introduction

Global dairy production has expanded significantly in recent decades, leading to increased generation of dairy by-products and highlighting the need for sustainable management solutions. Life Cycle Assessment (LCA) is attracting increasing amounts of attention as a key tool for evaluating environmental performance and supporting circular economy strategies. This study aims to assess and compare alternative valorization pathways for dairy by-products, focusing on environmental impacts and circularity performance to identify resource-efficient and sustainable options.

Methods

LCA was applied to multiple valorization strategies using a functional unit of 1 kg of processed raw milk to ensure a consistent comparison across scenarios. The examined pathways included (i) direct disposal (baseline), (ii) protein recovery via energy-intensive technologies, (iii) production of functional foods from whey, (iv) biogas generation with residue utilization, and (v) an integrated approach combining functional food production, biogas, and material recovery. The environmental impact categories comprised global warming potential, cumulative energy demand, water footprint, and eutrophication potential. Circularity assessment encompassed recovery rates and the Material Circularity Indicator (MCI).

Results

The results showed that protein recovery and functional food production enhanced circularity and reduced waste compared to the baseline, though some technologies increased the energy demand. The integrated approach demonstrated the most balanced performance, achieving both lower environmental impacts and higher circularity.

Conclusions

In conclusion, the proposed LCA framework provides a holistic evaluation of valorization pathways and supports informed decision-making for sustainable dairy by-product management. Further case studies are recommended to refine the methodology and validate its applicability across diverse production systems.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-158176: Life Cycle Assessment and Exergetic Performance of Solar Agricultural Dryers: Scientific Trends, Technological Niches, and Transitions Toward Sustainable Postharvest Systems

Jader Rodriguez Cortina ^{1*}, Andres Sarmiento ¹, John Javier Espitia ¹ and Edwin Villagran ²

¹ Colombian Corporation for Agricultural Research—Agrosavia, Tibaitatá Research Center, Km 14, Mosquera–Bogotá, Mosquera 250040, Colombia

² Colombian Corporation for Agricultural Research—Agrosavia, Central Headquarters, Km 14, Mosquera–Bogotá, Mosquera 250040, Colombia

Life Cycle Assessment (LCA) applied to solar agricultural drying technologies has become a critical research area for quantifying postharvest sustainability and informing climate mitigation policies. Based on 42 documents indexed in *Scopus* (1999–2025), this bibliometric study integrates keyword co-occurrence (VOSviewer) and strategic thematic mapping (Bibliometrix) to identify research evolution, conceptual cores, and emerging opportunities in this field. Scientific production has intensified since 2020, with a 300% increase, driven by Asia (India 43%, followed by Bangladesh, China, and Egypt) and an emerging presence in the Americas and Europe. Results indicate increasing convergence among energy efficiency, environmental impact, and economic feasibility, with 4E approaches (Energy–Exergy–Environment–Economics) becoming the prevailing framework for comprehensive system evaluation. The co-occurrence network reveals four technological domains: (i) exergetic efficiency and thermal energy storage (heat storage, PCM, phase change materials), (ii) environmental analysis and carbon footprint (LCA, carbon dioxide, environmental impact), (iii) energy hybridization (hybrid solar–biomass dryers, photovoltaic/thermal systems), and (iv) agro-industrial applications (fruits, vegetables, high-value crops). The thematic map positions the *solar dryers–environmental impact–drying* cluster as the motor theme of current research, while *life cycle–biogas–carbon dioxide* constitutes an emerging niche associated with advanced environmental modeling. The scientific trend points toward multicriteria design and digitalization of solar drying systems, integrating LCA, thermoeconomics, and exergy analysis to optimize materials, geometry, and thermal flow behavior. Future research must strengthen dynamic and comparative LCA methodologies, AI-assisted control and adaptive optimization, and circular models of energy and material flow that transform agricultural drying into a low-carbon, measurable, and environmentally restorative process aligned with the goals of sustainable food systems and renewable energy transitions.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-162895: Life Cycle Assessment of composite materials from recycled carbon fibers

Bruna Pane ^{1,*}, Amalia Zucaro ², Marco Tammaro ², Serena Righi ¹ and Gabriella Fiorentino ²

¹ Interdepartmental Centre for Research in Environmental Sciences, University of Bologna, Via S. Alberto 163, 48123 Ravenna, Italy

² ENEA, Department for Sustainability, Laboratory of Technologies for Waste and Secondary Raw Materials, Research Centre of Portici, P.le E Fermi 1, 80055 Portici (NA), Italy

In recent decades, the use of carbon fiber-reinforced polymers (CFRPs) in the automotive and aerospace sectors has increased significantly. This trend has led to a corresponding rise in global demand for carbon fibers, as well as a growth in end-of-life composite products and manufacturing waste, with associated environmental challenges. Given the high cost of carbon fibers, the development of innovative recycling solutions represents a clear win-win strategy for improving the life cycle of these materials and enhancing overall environmental and economic sustainability, in line with European standards for the transition toward a circular economy.

This study aims to assess the environmental performance of the production system for consolidated laminates obtained from recycled composite materials from a cradle-to-gate life cycle perspective. The production system is analyzed using the Life Cycle Assessment (LCA) methodology, based on primary data provided by an engineering and manufacturing company within the framework of the Italian MARiS project, funded by the Ministry of Enterprises and Made in Italy.

Environmental impacts are evaluated using SimaPro v.9.6 coupled with the Environmental Footprint 3.1 impact assessment method, with reference to the functional unit of 1 kg of consolidated laminate produced with recycled carbon fibers. The LCA methodology, recognized as a standardized tool for assessing the environmental impacts of products, services, or processes throughout their life cycle, is adopted to identify the main hotspots along the value chain and to explore circular improvement options. The environmental benefits associated with replacing virgin carbon fibers through CFRP recycling are highlighted by comparing the environmental performance of the innovative product (recycling scenario) with that of the conventional product (Business-as-Usual scenario).



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-160567: Life-Cycle GHG of SAF in Real Flights: Empirical WTW Accounting and Reconciliation with TIM, DEFRA, and Base Empreinte

Yury Erofeev^{1,2,*}, Stefan Majer³, Daniela Thrän^{1,4} and Finn McFall⁵

¹ Faculty of Economics and Management Science, Leipzig University, Institutsgebäude, Grimmaische Straße 12, 04109 Leipzig, Germany

² SQUAKE.earth GmbH, Brunnenstraße 19-21, 10119 Berlin, Germany

³ DBFZ German Biomass Research Center gGmbH, Torgauer Str. 116, 04347 Leipzig, Germany

⁴ Departmentleiterin Systemanalyse und Nachhaltigkeitsbewertung, UFZ / Helmholtz Centre for Environmental Research GmbH, Permoserstraße 15, 04318 Leipzig, Germany

⁵ Centre for Environment and Sustainability, University of Surrey, Guildford, Surrey, UK

The growing deployment of Sustainable Aviation Fuels (SAFs) collides with an aviation greenhouse gas (GHG) accounting landscape that remains largely fossil-baseline- and tank-to-wake (TTW)-focused. Operational calculators used for corporate reporting and disclosure—such as Google's Travel Impact Model, IATA CO₂ Connect, the ICAO Carbon Emissions Calculator, ATP-DEC and the UK DEFRA factors—generally assume 100% conventional jet fuel and offer little structural treatment of SAF. This study quantifies well-to-wake (WTW) CO₂-equivalent emissions for ten commercial flights operated with certified SAF blends and documented pathways, including hydroprocessed esters and fatty acids (HEFAs), Fischer-Tropsch fuels and power-to-liquid e-fuels. Using flight-specific fuel uplift, blend share and aircraft data combined with ISO 14067/14083-consistent life-cycle assessment, the analysis derives WTW intensities per flight, per seat-kilometre and per passenger-kilometre. These empirical results are then compared with estimates from the above calculators, each run under its native distance uplift, passenger-and-cargo allocation and non-CO₂ conventions. The comparison decomposes discrepancies into contributions from the TTW versus WTW scope, treatment of SAF, non-CO₂ assumptions and allocation rules. In addition to climate change impact, the work screens a limited set of further impact categories (such as land-use change, eutrophication potential and water use) to explore trade-offs for SAF produced from dedicated biomass versus waste-based feedstocks. Building on the findings, the paper proposes a minimal, auditable protocol for integrating SAF into existing tools—explicit TTW/WTW disclosure, transparent non-CO₂ options, pathway- and blend-specific WTW factors and book-and-claim rules compatible with SAF certificates—aimed at making SAF deployment visible, comparable and verifiable in Scope 3.6 business-travel accounting.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-162884: Local implementation pathways of the European Green Deal: integration between environmental monitoring and community-driven policy mechanisms

Isabella Alvares Fernandes

Department of Law, Catholic University of Santos, São Paulo, Brazil

The European Green Deal (EGD) defines an ambitious pathway for the achievement of climate neutrality, pollution reduction and ecosystem restoration by 2050, with high-level goals, representing a clear challenge for effective local action. This study assesses how cities can implement EGD initiatives by integrating high-resolution environmental monitoring systems with community-driven policy mechanisms. Three European cities from different contexts (rural, coastal and urban) were chosen for a comparative evaluation: Lisbon, Aveiro and Évora.

The methods utilized were as follows: a multi-criteria evaluation framework aligned with EGD's goals, inspired by the European Innovation Scoreboard; engagement through digital platforms, interviews with specialist-technicians, local non-governmental organizations and the local population; and the placement and incorporation of air and water quality sensors and biodiversity and energy usage monitoring systems. Data collected identified gaps, relations between environmental and policy interventions, and local priorities. The timeframe (2019-2024) aligned with the launch of the European Green Deal, allowing an assessment of recent developments and initial effects on local implementation.

Results indicate that cities with integrated environmental monitoring systems and participatory mechanisms showed alignment with the goals and targets of the European Green Deal, especially in air quality (a reduction in air pollution), urban green planning, improving biodiversity and sustainable mobility policies. Community participation contributed to acceptance and effectiveness of environmental policies, reducing local conflicts and supporting evidence-based decisions. The study formed a Local EGD Readiness Index, capable of assisting cities in assessing their annual progress and comparing data and performance across different regions.

Findings suggest that the local implementation of the EGD depends on the combination of environmental data and modern governance models. This approach allows more transparency and is able to connect the European Union's ambitions to regional priorities in adaptive policymaking. The framework offers a scalable model for cities seeking to advance their climate neutrality and their environmental resilience.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-161563: Mechanistic Insights into Phenol Adsorption and Mass Transport on Multi-Walled Carbon Nanotubes

Thiago Ferro de Oliveira ^{1,2,3*} and Simoni Margareti Plentz Meneghetti ^{2,3}

¹ Institute of Mathematics, Federal University of Alagoas, Maceió 57072-970, AL, Brazil

² Postgraduate Program in Chemical Engineering, Federal University of Alagoas, Maceió 57072-970, AL, Brazil

³ Catalysis and Chemical Reactivity Group (GCAR), Chemistry Department, Federal University of Alagoas, Maceió 57072-970, AL, Brazil

Phenol remediation from contaminated effluents presents a critical industrial challenge due to its acute toxicity even at trace concentrations [1-3]. Multi-walled carbon nanotubes (MWCNTs) are promising adsorbents for this purpose, given their high adsorption capacity and ease of separation [4]. This work presents a phenomenological and numerical analysis of mass transport coupled to phenol adsorption on MWCNTs ($d_{\text{ext}} = 50 \text{ nm}$) parameterized with published experimental equilibrium data under neutral pH conditions at 298 K [1,4, 5]. The mathematical model incorporates effective pore diffusivity ($D_e = 4.82 \times 10^{-10} \text{ m}^2/\text{s}$) derived from pore structure parameters and describes three distinct scenarios: (1) pure physical adsorption via modified Fick's Second Law, (2) kinetics incorporating 0.5-order reaction kinetics, and (3) parametric analysis of particle size (1–100 nm) and concentration sensitivity (1–5 mg/L). Numerical solutions establish a Thiele modulus of $\phi \ll 1$ across the tested range, indicating kinetically controlled mass transfer with effectiveness factor $\eta = 1.0$, and validate the theoretical dependence $\phi \propto C_s^{0.25}$. During effluent polishing operations (reduction from 5 to 1 mg/L), relative diffusive resistance increases by 49.5%, necessitating proportional increases in contact time or adsorbent dosage. The nanoscale architecture of MWCNTs reduces diffusional limitations by approximately 10^6 compared to macroscopic granular adsorbents, enabling significantly reduced contact times. This phenomenological analysis provides fundamental mass transport insights for optimizing phenol remediation systems using nano-adsorbents.

References

1. <https://doi.org/10.1007/s11356-018-3450-8>
2. <https://doi.org/10.2166/wst.2021.433>
3. <https://doi.org/10.5132/eec.2015.01.05>
4. <https://doi.org/10.1016/j.jare.2014.06.001>
5. <https://doi.org/10.1021/jp1107075>



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-158447: Mitigating Antibiotic Contamination in Aquaculture Effluents Using UVC/H₂O₂ Advanced Oxidation Process

Anna Bilida * and Maria Antonopoulou

Department of Sustainable Agriculture, University of Patras, GR-30131 Agrinio, Greece

Aquaculture has proliferated globally, accompanied by the widespread use of antibiotics like sulfamethoxazole (SMX) and trimethoprim (TMP) to manage bacterial infections and improve productivity. These chemicals are often co-administered as a combination (co-trimoxazole), and their ongoing release into aquatic habitats has aroused considerable concern due to their persistence, bioaccumulation, and promotion of antimicrobial resistance. Residues may linger in sediments, affect non-target species, and pose threats to human health through food-chain transmission. Advanced Oxidative Processes (AOPs) provide a potential technique for degrading such persistent contaminants by generating highly reactive hydroxyl radicals.

This study used a UVC/H₂O₂ system to simultaneously remove SMX and TMP from various aquaculture influents and effluents. The influents and effluents were collected from different aquaculture facilities, spiked with environmentally relevant concentrations of both antibiotics, and treated with the UVC/H₂O₂ process under controlled laboratory conditions. The process efficiency was evaluated using a combination of chemical analytical techniques and toxicity assays. Preliminary results showed that the concentration of H₂O₂ significantly affected the process, with % removal up to about 90% for both antibiotics observed in aquaculture influents and effluents. In all cases, SMX was removed more rapidly. In conclusion, UVC/H₂O₂ process can effectively remove both antibiotics, underscoring the potential of AOPs as long-term and efficient treatment options for reducing antibiotic contamination in aquaculture systems.

Acknowledgements

"The research project is implemented in the framework of H.F.R.I. call "3rd Call for H.F.R.I.'s Research Projects to Support Faculty Members & Researchers" (H.F.R.I. Project Number: 26141).



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-158027: Recovery of ammonium crystals and water by condensation of the gases emitted during the solar drying of wastewater sludge

Lidia Nuño ^{1,2,*}, Virginia Perez ³ and Raúl Muñoz ^{2,4}

¹ Biomass Unit, Ceder-Ciemat, E-42290 Lubia, Soria, Spain

² Department of Chemical Engineering and Environmental Technology, University of Valladolid, Dr. Mergelina s/n., Valladolid, 47011, Spain

³ Thermal Conversion Process unit, Ceder-Ciemat, E-42290 Lubia, Soria, Spain

⁴ Institute of Sustainable Processes, University of Valladolid, Dr. Mergelina s/n., Valladolid, 47011, Spain

Ammonia recovery reduces contamination and provides a source of Nitrogen. Ammonia volatilization during solar drying of WWTP sludge ranged from 22% to 74%. A gas-permeable membrane has a short half-life, making it difficult to reuse. Here, we demonstrate the feasibility of ammonium recovery as ammonium sulfate crystals using the heat stored in the dryer, followed by water recovery through condensation. A laboratory-scale solar dryer was designed to use artificial solar light. In one set of experiments, water samples were recovered at their original pH throughout the condensation process. In another setup, an impinger containing sulfuric acid (impinger A) was placed inside the artificial solar dryer. Passing the gas produced during the drying of the sludge to impinger A and then to the condensation setup (a thermostatic bath to condense water vapor). The experiment was replicated, varying the oxygen rate, air recirculation, and artificial alkalization of sludge. Recovered water, ammonia crystals, and acidic residues were analysed for Total Nitrogen (ammonia and inorganic nitrogen), Total Carbon (organic and inorganic carbon), and short-chain carboxylic acids. The loss of ammonium and total nitrogen from fresh sludge during the solar drying prototype measurements was 2.103 g N - NH₄/kg dried sludge and 11.64 g N/kg dried sludge, respectively. Our laboratory setup recovered up to 3.3 g N - NH₄ / kg dried sludge in the form of (NH₄)₂SO₄ by mixing fresh and dried sludge, and 5.5 g N - NH₄ / kg dried sludge after sludge alkalization with ash sludge. The reuse of heat stored in the solar dryer, combined with an air-extraction and condensation system, enhances simultaneous recovery of elements such as ammonia and water. The system still has areas for improvement, such as reducing contamination from the acidic residues and determining an optimal extraction flow to prevent cross-contamination.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-163217: Renewable Biofuel Production from Green Hydrogen and Waste Vegetable Oil: Environmental Assessment for Sustainable Management

Wagd Ajeeb * and Rui Costa Neto

IN+ Center for Innovation, Technology and Policy Research, IST-ID - Associação do Instituto Superior Técnico para a Investigação e Desenvolvimento, University of Lisbon, 1049-001 Lisbon, Portugal

Rising energy demand and climate change pressures highlight the urgent need for sustainable strategies in the transport sector, not only to reduce greenhouse gas emissions but also to inform effective environmental management and policy decisions. Renewable biofuels produced from bio-hydrotreated oils have emerged as a promising alternative due to their compatibility with conventional diesel engines, lower pollutant emissions, and potential to support climate mitigation objectives. Using waste vegetable oils (WVO) as feedstock further enhances sustainability by valorizing waste streams, reducing dependence on virgin resources, and aligning with circular economy principles. Integrating green hydrogen in the production process improves environmental performance by providing a low-carbon hydrogen source for hydrotreatment. This study presents a comprehensive environmental assessment of renewable biofuel production in Portugal, using WVO feedstock and green hydrogen generated from a combined solar and wind electricity supply. The assessment encompasses the full production chain, including feedstock preprocessing, electricity supply and electrolyser operation, biofuel synthesis, transportation, and disposal. Environmental impacts are quantified across multiple categories, including global warming potential (GWP), human toxicity, acidification, eutrophication, ozone depletion, and resource depletion. The results indicate that producing renewable biofuel from WVO and green hydrogen powered by solar and wind energy reduces GWP by approximately 0.45 kg CO₂ per kg biofuel compared to conventional processes, with a value observed at 0.304 kg CO₂/ biofuel. Transportation of feedstocks contributes around 37% of total GWP, mainly due to fossil fuel use in trucks and ships. Feedstock choice and electricity source strongly influence overall environmental outcomes. These findings demonstrate that combining waste-derived feedstocks with green hydrogen and renewable electricity not only reduces the environmental footprint of renewable biofuel production but also provides actionable insights for environmental understanding, ecosystem restoration strategies, and informed policy-making aimed at promoting sustainable energy and transportation systems.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-162741: Seasonal Dynamics of Earthworm and Microarthropod Communities in rural Home Garden agroecosystems: Linking Soil Properties to Biological Soil Quality

Lakshmi Gopakumar

National Centre for Aquatic Animal Health, Cochin University of Science and Technology, Kochi 682016, India

Soil invertebrates like earthworms and soil microarthropods are key players in the soil ecosystem by maintaining soil structure, nutrient cycling, and biological fertility in home-garden agroecosystems. Even though short-term studies exist on these individual groups and their role in soil ecosystem functioning, long-term data from non-polluted reference sites are very scarce. This study was carried out in twenty-five home garden agroecosystems (two seasonal samplings per year for five years) from a non-polluted area (home gardens with no soil pollution and no input of chemical pesticides/insecticides or chemical manures) to evaluate temporal patterns of soil fauna and their relationships with soil physicochemical properties. Soil cores (10 x 10 x 10 cm) were collected from the home gardens in triplicate for microarthropod estimation, and earthworms were collected from the home gardens using the mustard water extraction method. Earthworm abundance, total microarthropod abundance, and QBS-ar scores were assessed along with soil temperature, pH, moisture, organic carbon, and electrical conductivity in each home garden. The total earthworm abundance showed clear seasonal dynamics and inter-annual variability, with higher densities generally associated with cooler, moister seasons and soils richer in organic carbon. Microarthropod abundance and QBS-ar scores also varied significantly among seasons and gardens and were moderately correlated with soil organic carbon and moisture, indicating a consistent link between soil biological and physicochemical soil quality. Mixed-effects modelling and multivariate ordination revealed that home garden age, season, and soil moisture were the main drivers of faunal abundance, while pH and EC exerted secondary but detectable effects. Together, these findings show that combined monitoring of earthworm abundance, microarthropod abundance, QBS-ar scores, and soil properties provides a robust, taxonomically simple framework for assessing soil quality and temporal stability in non-polluted tropical home gardens and offers a valuable reference for comparison with contaminated urban and industrial soils.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-153383: Simulation Framework for Environmental Remediation: Monte Carlo Estimation of Mass Transfer in Nickel Bioadsorption

Jeremias Gorosito, Maria Natalia Piol, Susana Boeykens and Maria Sol Ruiz *

Department of Chemistry, Faculty of Engineering, University of Buenos Aires, C1063ACV Buenos Aires, Argentina

Introduction

Toxic metal contamination in water is a critical environmental issue, and adsorption has emerged as a promising remediation technique due to its simplicity, efficiency, and cost-effectiveness. Beyond removal efficiency, the use of agricultural residues as bioadsorbents supports circular-economy strategies by valorizing low-cost biomass and reducing waste generation. Nickel removal using *Moringa oleifera* residues is particularly attractive due to their availability, sustainability, and contribution to cleaner production frameworks. A key challenge in adsorption modeling is the estimation of the internal mass transfer coefficient (k_s), which governs intraparticle diffusion and strongly influences process performance.

Methods

In this study, we developed a Monte Carlo (MC)-based simulation framework to estimate k_s in nickel bioadsorption using *Moringa oleifera* residues. The system was represented as a lattice where adsorption and desorption events occur probabilistically according to kinetic parameters. Simulations were performed on a 50×50 grid for up to 10^6 steps to ensure convergence. Surface coverage (θ) and mass transfer coefficients were obtained and compared with experimental values previously determined from fixed-bed column and batch experiments.

Results

The MC model successfully predicted an equilibrium surface coverage of $\theta_{MC}=0.5188$, in close agreement with the experimental value $\theta_{exp}=0.508$ (error: 1.34%). The estimated coefficient was $k_{s,MC}=0.0329$, deviating by 17.48% from the experimental reference $k_{s,exp}=0.028$, but remaining within the reported uncertainty. Simulations also revealed a decrease in adsorption efficiency with increasing temperature, consistent with the exothermic nature of the process. A cluster-based MC variant underestimated equilibrium coverage and overestimated k_s , indicating that independent-site adsorption is the most suitable representation for this system.

Conclusions

The proposed MC framework constitutes a valuable computational tool for evaluating adsorption-based remediation processes. By integrating stochastic simulation with experimental validation, the model supports the assessment and management of bioadsorption technologies, reduces experimental demand, and contributes to the design of sustainable water treatment strategies under the principles of circular economy.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-158484: Solar-Activated Chlorine Process for Efficient Degradation of Brominated Aromatic Pollutants

Alexandra Spyrou^{1,*}, Dimitris Vlastos², Dionissios Mantzavinos³ and Maria Antonopoulou¹

¹ Department of Sustainable Agriculture, University of Patras, GR-30131 Agrinio, Greece

² Department of Biology, Section of Genetics Cell Biology and Development, University of Patras, GR-26500, Patras, Greece

³ Department of Chemical Engineering, University of Patras, GR-26504, Patras, Greece

2,4,6-Tribromophenol (TBP) and its transformation product, 2,4,6-tribromoanisole (TBA), are characteristic brominated aromatic compounds frequently detected in various aquatic systems. Their presence in the aquatic environment is associated with the low efficiency of conventional treatment methods to remove them. It is well documented in the literature that they can cause several detrimental effects, including toxicity to aquatic microorganisms and the formation of unpleasant odours that deteriorate water quality. Therefore, the main aim of the present study is to investigate alternative methods for the removal of both compounds from different aqueous matrices. The solar/chlorine process is a representative advanced oxidation process (AOP) that has been studied in recent years due to its potential applicability compared with other methods in this category.

Accordingly, the solar/chlorine process was, for the first time, evaluated for its ability to simultaneously degrade both brominated aromatic compounds at environmentally relevant concentrations. To evaluate the efficiency of the process, a combination of analytical techniques and biological assays was employed. According to the results, the solar/chlorine process was effective for the simultaneous removal of both compounds. In particular, >80% removal was achieved in approximately 30–45 minutes. Moreover, no acute toxicity or genotoxic effects were observed at the end of the process against microalgae and human lymphocytes, respectively.

Acknowledgements

This paper has been financed by E.Y.D.A.P. within the framework of the IKY-EYDAP Scholarship program academic year 2022-23.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-162373: Spatio-temporal Evolution of Carbon Emissions from Energy Consumption in Jiangsu Province Based on Nighttime Light Data

Xinyu Li * and Ge Shi

School of Energy Science and Engineering, Nanjing Tech University, Nanjing 211816, China

Against the background of global warming, a scientific assessment of the spatiotemporal patterns of regional carbon emissions is crucial for achieving the "Dual Carbon" goals (carbon peak and carbon neutrality). Using counties in Jiangsu Province as a typical case study, a county-level carbon emission estimation model was constructed based on DMSP-OLS and NPP-VIIRS nighttime light data and the IPCC carbon emission coefficient method. The model was validated using energy consumption statistics from the China Carbon Accounting Database, showing a high goodness of fit ($R^2 = 0.966$) with statistical data and a mean relative error of 4.48%, indicating high reliability. On this basis, methods including spatial autocorrelation analysis and carbon emission economic contribution coefficient were employed to systematically reveal the spatiotemporal evolution characteristics of carbon emissions. Six indicators—Regional GDP, Industrial Structure, Total Population, Urbanization Rate, Energy Structure, and Energy Intensity—were selected to explore the driving factors of carbon emission expansion using the geographical detector technique, identifying both single-factor and interactive effects. The results demonstrate that between 2000 and 2019, carbon emissions in Jiangsu Province generally exhibited a spatial distribution pattern of "high in the south and low in the north," with high-value areas concentrated in the economic core zone of Southern Jiangsu, while the global spatial agglomeration effect showed a weakening trend. Analysis reveals that the level of economic development and industrial structure are the dominant factors driving the spatial heterogeneity of carbon emissions, with significant interactive enhancement effects observed between factors. Finally, considering the combined effects of market regulation and environmental policy, differentiated emission reduction strategies were proposed to provide a scientific basis for regional low-carbon transition and sustainable development.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-162520: Structural Modifications of Clinoptilolite-Type Zeolites Utilized for Ammonium Filtration in Standing Water Bodies

Dorina Simedru * and Anca Becze

INCDO-INOE2000, Subsidiary Research Institute for Analytical Instrumentation, Cluj-Napoca, Romania

Clinoptilolite-type zeolites were tested for their effectiveness in removing ammonium from standing water bodies. To enhance their retention efficiency to nearly 100% for ammonium ions, a thermal treatment at 50°C was identified as an effective method. To assess the changes in the zeolite structure resulting from this thermal treatment, both the original and thermally treated samples were analyzed using Scanning Electron Microscopy with Energy-Dispersive X-ray Spectroscopy (SEM-EDX). This advanced technique allows for an in-depth examination of the morphology, topography, and elemental distribution within the samples.

The findings indicated an increase in porosity in the thermally treated zeolite samples, accompanied by a reduction in particle size. This morphological enhancement is crucial for increasing ammonium filtration efficacy, as increased porosity can improve ion-exchange capacity. The elemental composition of both the original and thermally treated samples is O₂, Si, Al, Fe, K, Ca, Mg, and Na. Notably, the elemental composition of the zeolites and their concentration remained approximately the same throughout the thermal treatment process, suggesting that the thermal modifications primarily affected the physical structure rather than altering the inherent material properties. These results underscore the potential of thermally treated clinoptilolite-type zeolites as effective filtering agents for ammonium removal from aquatic environments, providing a promising approach for environmental remediation in standing waters.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-159379: Synergizing Intelligence-Led and Community-Oriented Policing for Environmental Sustainability: Evidence from Illegal Mining-Prone Regions in Ghana

Ernest Kwaku Agyei ^{1,2,*}, Emmanuel Daanoba Sunkari ^{3,4} and Prithvi Yadav ¹

¹ Faculty of Management, Sir Padampat Singhanian University, N.H. 76, Bhatewar, Udaipur-313 601, Rajasthan State, India

² Department of Procurement & Supply Chain Management, Faculty of Business, Kuamsi Technical University, P.O. Box 854, Kumasi, Ghana

³ Department of Mining Engineering, Faculty of Integrated and Advanced Technology, Sir Padampat Singhanian University, N.H. 76, Bhatewar, Udaipur-313 601, Rajasthan State, India

⁴ Department of Chemical Sciences, Faculty of Science, University of Johannesburg, P.O. Box 524, Auckland Park, 2006, Johannesburg, South Africa

This study examines how governance influences environmental sustainability in Ghana's mining supply chain, with particular emphasis on the strategic application of intelligence-led and community-oriented policing. Drawing on Institutional Theory and Routine Activity Theory (RAT), this study employed a cross-sectional design with 382 respondents from the regulatory and law enforcement sectors, as well as community leaders and residents of selected mining districts in Ghana. Findings from structural equation modelling (AMOS) and Hayes' PROCESS macro show that Institutional Coordination Practices ($\beta = 0.322$, $p = 0.002$) and Transparency and Accountability Practices ($\beta = 0.290$, $p = 0.002$) substantially contribute to improvements in environmental sustainability. Among the variables, Intelligence-Led Policing was the most robust positive predictor ($\beta = 0.391$, $p = 0.001$), thereby confirming the importance of an intelligence-based strategy in the enforcement of regulations on illegal mining. Furthermore, Community-Oriented Policing mediated the relationship between Institutional Coordination and environmental outcomes (indirect $\beta = 0.110$, $p = 0.001$). In addition, Community Trust Capital contributed to the Community-Oriented Policing and sustainability connection (interaction $\beta = 0.066$, $p = 0.006$), thus emphasizing the importance of trust in the community-police relationship. Considering that Regulatory Enforcement Capacity is statistically insignificant ($p = 0.367$) in conjunction with control variables, Community Trust Capital still positively contributes to the overall robustness of the model ($\beta = 0.184$, $p = 0.005$). This study theoretically reconceptualizes governance as a relational behavioural system whereby the environment is shaped by the synergetic alignment of institutional goals, community participation, and locally adaptive control. In practice, the results advocate the integration of Intelligence-Led Policing and Community-Oriented Policing within national mining policies, fostering interagency collaboration and building trust with communities to achieve sustainable mining. The model is proposed for replication in environments where enforcement resources are severely limited.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-157885: Synthesis of hydrogels derived from microalgae polysaccharides (extracted from *Spirulina platensis*) for β -blocker removal from wastewaters

Evangelos Tsintziras *, Despina A. Gkika, Pavlos Efthymiopoulos and George Z. Kyzas

Hephaestus Laboratory, School of Chemistry, Faculty of Sciences, Democritus University of Thrace, GR-65404 Kavala, Greece

Introduction

Wastewater purification from widely prescribed pharmaceuticals is a critical global priority. β -blockers used to treat cardiovascular diseases are frequently detected in wastewater and have been shown to exert toxic effects on various organisms. Adsorption onto green materials has emerged as an efficient, sustainable, and environmentally friendly technique for removing such contaminants from aquatic matrices.

Methods

Microalgae polysaccharides (MPs) have been extracted from *Spirulina platensis* biomass by a hot water extraction process. Sodium carboxymethyl cellulose (CMC) has been employed as a second hydrogel building block due to its mechanical robustness and its plethora of hydroxyl groups, which serve as potential crosslinking sites via esterification with citric acid. Thin MPS:CMC:CA (21:62:17 wt:wt:wt) films have been produced by water solution casting method followed by thermal curing at 80°C and characterized by FTIR and SEM. Batch adsorption experiments towards atenolol have been conducted.

Results

The successful synthesis of the hydrogel was confirmed. The optimum pH value was found to be 9, with a removal efficiency of 82% ($C_0 = 50$ mg/L, $dose = 1$ g/L, $T = 30$ °C). Adsorption exhibited rapid kinetics, with 69% atenolol removal within the first 15 min and an optimum time of 150 min; the pseudo-second-order model better described the process.

Conclusions

The results indicate that microalgal polysaccharide-based hydrogels, produced in accordance with Green Chemistry Principles #3, #5, #7, and #12, can efficiently and rapidly remove a model β -blocker drug from wastewater via a chemisorption-driven adsorption mechanism.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-157426: Towards sustainable reservoir management: linking ecosystem-based management, ecological integrity, and urban water efficiency in Serra Serrada (NE Portugal)

Ana Maria Antão-Geraldes ^{1,*} and Flora Silva ^{2,3}

¹ CIMO, LA SusTEC, Instituto Politécnico de Bragança, Campus de Santa Apolónia, 5300-253 Bragança, Portugal

² ESTiG, Instituto Politécnico de Bragança, Campus de Santa Apolónia, 5300-253 Bragança, Portugal

³ GICoS, Instituto Politécnico de Bragança, Campus de Santa Apolónia, 5300-253 Bragança, Portugal

In Mediterranean regions, reservoirs play a crucial role in securing urban water supply. Despite the large number of reservoirs in Portugal, their management still largely follows their primary designated use—public supply, irrigation, or hydropower—which limits progress towards achieving good ecological potential. This highlights the need for integrated, ecosystem-based management approaches. The Serra Serrada reservoir (41.886° N, -6.766° W), which supplies the city of Bragança (NE Portugal), exemplifies the importance of management strategies that stabilise water-level fluctuations and support good ecological potential in line with the Water Framework Directive. With a total storage capacity of 1,680,000 m³ and located within a Key Biodiversity Area, this reservoir was assessed through an environmental diagnosis conducted at five geographic levels: territory, catchment, reservoir surroundings, reservoir, and downstream territory. Field surveys, bibliographic data, and stakeholder consultations supported the assessment of pressures and the definition of mitigation measures. Proposed actions include the restoration of wetlands and riparian vegetation and the promotion of water efficiency in public buildings. Studies carried out in Bragança—covering schools, the municipal market, student residences, and the municipal swimming pool complex—report an annual water consumption of 324,239.62 m³. Estimated savings range from 12.4% to 75%, depending on building type and the efficiency measures applied. Improving water efficiency in these facilities represents a priority action, as it directly contributes to sustainable urban water use. The implementation of rainwater harvesting systems and nature-based solutions, such as green roofs, can further enhance water sustainability. Such measures in the urban water cycle can indirectly support higher and more stable water levels, improved water quality, and the overall ecological integrity of the Serra Serrada reservoir.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-162329: Water Governance in a Climate-Stressed Context: Benchmarking Morocco Against Four International Models

Chahid Sadiki *, Abdelkrim Bouasria, Rachid Boutafoust and Abdelmejid Rahimi

Geodynamics and Geomatics Laboratory, Faculty of Sciences, Chouaib Doukkali University, El Jadida, 24000, Morocco

Facing structural water stress exacerbated by climate change, Morocco must rethink its water governance model. This study proposes an international benchmarking analysis comparing the Moroccan system with four countries confronting similar climatic constraints: Spain, Australia, Tunisia, and Jordan. The benchmarking is conducted using a multi-criteria governance framework combining institutional, regulatory, and performance indicators, based on official national reports, international databases, and the peer-reviewed literature; the reference countries were selected due to comparable levels of water stress, arid or Mediterranean climates, and the implementation of documented water governance reforms. Despite undeniable achievements, such as an extensive dam policy and widespread access to drinking water (94% in rural areas), Moroccan governance reveals structural deficiencies, including the inactivity of the Supreme Water and Climate Council, limited autonomy of basin agencies, weak enforcement of Laws 10-95 and 36-15, and underutilization of non-conventional resources. The comparative analysis highlights improvement levers inspired by international best practices: Spain's autonomous Hydrographic Confederations coordinated by the Ministry for Ecological Transition; Australia's Murray-Darling Basin Authority and innovative water markets combining desalination with integrated demand management, with documented reductions in agricultural water consumption reaching up to 35–40% in certain sub-basins; Tunisia's National Water Observatory and demand control through the National Water-Saving Program in Irrigation; and Jordan's Ministry of Water and Irrigation framework for cooperative transboundary water resource management. The results indicate a substantial potential for additional water mobilization in Morocco through ten priority recommendations: revitalizing the Supreme Water and Climate Council, strengthening the autonomy of basin agencies, updating legislative frameworks (Laws 10-95 and 36-15), diversifying resources through desalination and wastewater reuse, deploying water-saving technologies at scale, enforcing the polluter-pays principle, promoting public-private partnerships, adopting progressive tariff systems, and strengthening climate resilience mechanisms.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

Session 2. Environmental Impact and Risk Assessment

sciforum-149261: Distribution and Environmental Risk of Rhodium (Rh) in Urban and Garden Soils: Evidence from Alcalá De Henares, Spain

Antonio Peña-Fernández ^{1,*}, Manuel Higuera ² and María del Carmen Lobo-Bedmar ³

¹ Department of Surgery, Medical and Social Sciences, Faculty of Medicine and Health Sciences, University of Alcalá, Ctra. Madrid-Barcelona, Km. 33.600, 28871 Alcalá de Henares, Madrid, Spain

² Scientific Computation Research Institute (SCRIUR), University of La Rioja, 26006 Logroño, Spain

³ Department of Agro-Environmental Research, Madrid Institute for Rural, Agricultural and Food Research and Development (IMIDRA), "El Encín" Estate, Madrid-Barcelona Road Km 38.2, 28800 Alcalá de Henares, Madrid, Spain

Rhodium (Rh) is a platinum group element (PGE) increasingly found in urban environments due to traffic-related emissions. In this study, Rh was quantified via ICP-MS in 137 topsoil samples from urban, industrial and garden areas in Alcalá de Henares (Spain). Despite being below detection limits in 15.5% of urban samples, Rh concentrations were significantly higher in garden soils (median: 0.168 mg/kg) than in urban parks (0.084 mg/kg; p-value 0.05). Principal component and cluster analyses grouped Rh with molybdenum (Mo) and antimony (Sb), suggesting shared anthropogenic origins, likely related to vehicle emissions and industrial activities. Rh levels showed substantial spatial variability, with high coefficients of variation and skewed distributions that point to localised hotspots. Notably, Rh concentrations were strongly associated with sand and silt fractions, indicating its potential mobility and influence of soil texture. Toxicological characterisation could not be performed due to the absence of US EPA reference values (RfDo/RfCi). Nonetheless, given Rh's increasing environmental prevalence, potential for human exposure via resuspended particles, and growing use in industrial processes, its monitoring is essential. This study highlights a regulatory and research gap surrounding Rh, emphasising the need for its inclusion in environmental assessments. Further research is warranted to elucidate its toxicokinetics, environmental persistence, and possible health effects, especially in vulnerable populations exposed to urban garden soils.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-157031: Biochar Modulates Zinc Uptake and Lettuce Performance at Agronomic and Excessive Zinc Levels

Natalia M Escobar-Marulanda ^{1,*}, Gabriel Gascó ², Ana M Mendez ¹ and Patricia Almendros ³

¹ Department of Geological and Mining Engineering, Mines and Energy School, Universidad Politécnica de Madrid, Madrid, 28003, Spain

² Department of Agricultural Production, Agronomic, Food and Biosystems Engineering School, Universidad Politécnica de Madrid, 28040 Madrid, Spain

³ Department of Chemistry and Food Technology, Agronomic, Food and Biosystems Engineering School, Research Centre for the Management of Agricultural and Environmental Risks (CEIGRAM), Universidad Politécnica de Madrid, 28040 Madrid, Spain

Biochar can improve nutrient retention and influence metal availability in soils. This study assessed the combined effects of Zn source, dose, and biochar amendment on lettuce growth and Zn uptake in a Zn-deficient acidic soil. Treatments included ZnSO₄ and a chelated Zn-glycine-NH₃ complex applied at agronomic (2 mg·kg⁻¹) and high (20 mg·kg⁻¹) Zn doses. Each treatment was tested with and without 5% biochar prepared by pyrolysis at 500 °C of olive pruning waste. Biochar consistently enhanced lettuce fresh weight, particularly under high-dose Zn-glycine-NH₃ treatment, reaching increases of up to 79% compared to the corresponding soil-only treatment. High Zn fertilization did not negatively affect biomass, indicating tolerance of lettuce to elevated Zn inputs. In soil-only treatments, leaf Zn concentrations significantly increased at agronomic Zn doses—up to 293% above the control—whereas high Zn-glycine-NH₃ doses did not further enhance uptake. Conversely, in biochar-amended soils, Zn accumulation decreased markedly, with up to an 80% reduction under high chelate doses. These findings suggest that biochar improves plant growth by enhancing soil physical and chemical properties but may adsorb or immobilize Zn at high concentrations, reducing its bioavailability. Overall, the interaction between Zn source, application rate, and biochar strongly influences nutrient dynamics. Properly managed biochar application can improve crop performance while mitigating excessive Zn accumulation and potential environmental risks. This research was funded by the Ministerio de Ciencia, Innovación y Universidades, Agencia Estatal de Investigación y Fondo Europeo de Desarrollo Regional (Project PID2023-149789OB-I00 funded by MCUI /AEI /10.13039/501100011033 / FEDER, UE).



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-161612: Computational Toxicogenomic Assessment of Inhalation Risks from Titanium Dioxide Sanding-Dust Particulate Emissions

Viacheslav Muratov *, Karolina Jagiello and Tomasz Puzyn

University of Gdansk, Faculty of Chemistry, Laboratory of Environmental Chemoinformatics, Wita Stwosza 63, Gdansk 80-308, Poland

Mechanical processing of titanium dioxide-containing coatings and composites generates airborne particulate emissions that contribute to occupational and near-field environmental exposure. Titanium dioxide nanoparticles (TiO₂-NPs) are widely used in industry, and their potential to cause adverse effects in the respiratory system raises concerns for both environmental impact and human health risk assessment. Importantly, new approach methodologies (NAM)-relevant computational toxicogenomic models for TiO₂-NPs are derived almost exclusively from studies of “free” nanoparticles in simplified media, whereas real-world scenarios involve complex sanding-dust (SD) mixtures. We investigated whether inhalation of TiO₂-NP SD produces lung transcriptomic responses comparable to those induced by free TiO₂-NPs, and whether existing transcriptomic biomarkers can serve as mechanistic monitoring tools for SD exposure.

We analyzed in vivo lung transcriptomic data for mice exposed to free TiO₂-NPs and SD emissions across multiple doses (54–486 µg/animal), post-exposure periods (1–28 days), and particle sizes (10–38 nm), yielding 649 differentially expressed genes across 54 exposure scenarios. Unsupervised machine learning methods (principal component analysis, hierarchical clustering, correlation analysis) were applied to identify global patterns and relate SD-induced signatures to established TiO₂-NP biomarkers.

Analyses showed that SD-induced profiles clustered closely with free TiO₂-NP exposures, indicating broadly comparable transcriptomic responses. We further observed that many key biomarkers previously perturbed after free TiO₂-NP inhalation (*Saa*, *Ccl*, *Cxcl*, *Il* families relevant to acute neutrophilic inflammation and chemokine-driven response) are strongly upregulated following SD inhalation at 1 day post-exposure, indicating a pronounced acute response to sanding-generated particulate matter relative to later time points. These findings support the extension of NAM-relevant computational toxicogenomic approaches and transcriptomic biomarkers from free TiO₂-NPs to more realistic particulate emissions, thereby strengthening mechanism-based environmental impact and regulatory-relevant health risk assessment of TiO₂-containing materials.

Funded via the Polish National Science Centre in the frame of the TransNANO project (UMO-2020/37/B/ST5/01894).



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-158218: Grain-Size And Magnetic Properties Of Surface Sediments From Huguangyan Maar Lake: An Integrated Assessment Of Controlling Factors And Implications For Recent Asian Monsoon Evolution

Huan Huan Peng ^{1,*}, Xiaodong Tan ² and Jinhui Wei ³

¹ Key Laboratory of Space Ocean Remote Sensing and Application, Ministry of Natural Resources, Guangdong Ocean University, Zhanjiang 524088, China

² Key Laboratory of Ocean and Marginal Sea Geology, South China Sea Institute of Oceanology, Chinese Academy of Sciences, Guangzhou 510301, China

³ Key Laboratory of Climate, Resources and Environment in Continental Shelf Sea and Deep Ocean, Guangdong Ocean University, Zhanjiang 524088, China

Huguangyan Maar Lake (HML) has long been recognized as a critical repository for reconstructing paleoenvironmental changes in southern China. However, interpretations regarding the dynamics of the Asian monsoon system derived from this site have been diverse and, at times, contradictory. To better understand the sediment source-to-sink processes and associated magnetic characteristics, this study investigates grain-size distributions and rock magnetic properties based on 56 lake surface sediments collected from varying water depths, as well as 23 topsoil and 4 volcanic rock samples obtained from the HML catchment. Our findings reveal that the lake sediments are predominantly sourced from the surrounding catchment and transported into the lake via surface runoff. Grain size generally decreases toward the center of the lake and is strongly influenced by water depth. Nevertheless, the relationship between grain-size and water depth is complex, with a threshold depth of approximately 5 meters marking the effective limit of wave-induced sediment reworking. Magnetic minerals in the lake sediments are primarily composed of stable single-domain and superparamagnetic magnetite, resembling those found in local topsoil and volcanic rocks but differing from the magnetic signature of aeolian dust transported by the winter monsoon. The concentration of magnetic minerals is largely source-dependent, with higher values observed near magnetite-rich coastal zones. Additionally, water depth exerts a notable influence on magnetic concentration, likely due to greater transport distance from source areas and the partial dissolution of magnetic particles under suboxic to anoxic conditions within the lake. The magnetic record preserved in HML sediments may reflect variations in the intensity of the Asian summer monsoon, which controls the supply of weathered material from the catchment, the accumulation of organic matter, and overall water depth.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-158051: Greywater footprint reduction by agro-industrial biochar for brewery wastewater treatment: A data-driven parametric model

Pelin Soyertaş Yapicioğlu

Department of Environmental Engineering, Engineering Faculty, Harran University, Sanliurfa, Turkey

In recent years, biochar has attracted considerable attention owing to its application in disposing a large range of organic and inorganic contaminants from industrial wastewater. In this context, one of the dual benefits from biochar application is greywater footprint reduction in industrial wastewater. The greywater footprint (GWF) is an important indicator tool for the determination of environmental impacts and risks in water pollution and scarcity to reduce climate change effects. The GWF is described as the quantity of fresh water required to dilute the contaminants to meet water quality standards. From this point of view, this study investigated GWF reduction by malt dust-derived biochar in terms of brewery wastewater treatment. The GWF was determined in terms of organic materials removal by considering the parameters of chemical oxygen demand (COD) and total suspended solid (TSS). A data-driven analysis was performed by using Monte Carlo simulation based on the achieved data of COD and TSS removal from brewery wastewater by the agro-industrial biochar adsorption process. At the end of the analysis, a new data-driven parametric index ($GWFI_{BP}$) was developed based on the basic GWF tool. A data-driven model based on the parameters of COD and TSS was designed and operated to determine the effect of the dual benefits of the biochar adsorption process compared to the conventional activated sludge process. This tool was used by considering the treatment efficiencies, allowable discharge limits, and legal water pollution procedure. The analysis showed that an average GWF reduction of 21.59% was ensured by using agro-industrial biochar. The highest GWF reduction was observed in terms of COD removal with a value of 30.19%. Also, the malt dust which was the feedstock of the biochar was the by-product of the brewery industry, so a waste reduction was dually achieved with GWF reduction in this study.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-158352: Life Cycle Assessment of 3D-printed Coir Pith/Poly-Lactic Acid Sustainable Composites for Automotive Interior Application

Darshan Dange ^{1,*}, Angela Daniela La Rosa ² and Gnanamoorthy R ¹

¹ Department of Mechanical Engineering, Indian Institute of Technology Madras, Chennai, Tamil Nadu, India

² Department of Manufacturing and Civil Engineering, Norwegian University of Science and Technology (NTNU), Gjøvik, Norway

The increasing awareness of sustainability and the use of sustainable materials is driving a shift toward natural particle- or fibre-reinforced bio-based polymer composites. Agricultural waste-based materials mostly end up in landfills, and their use for value-added applications will help minimise environmental pollution due to poor disposal. The personalised manufacturing using 3D printing leverages the desired orientation and selective distribution of materials to achieve the preferred design and ergonomics. Additionally, the use of customised interiors in automobiles is growing to satisfy customer needs, and 3D printing will help to achieve this economically. This study aims to evaluate the life cycle aspects of producing a coir-pith/PLA (polylactic acid) green composite using a personalised additive manufacturing technique. The background data needed are sourced from the Ecoinvent 3.11 database. The energy and resources used for material processing and manufacturing are estimated from industrial and laboratory-scale manufacturing machines. Cradle-to-gate analysis is carried out in these preliminary investigations. The single automotive interior part is considered the functional unit for this study. The unit processes for coir-pith/PLA composite include coir-pith extraction from coconut husks, composite filament extrusion using a filament extruder, and additive manufacturing using an FFF (Fused Filament Fabrication) printer. The different environmental impacts are compared and discussed.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-158116: Presence and Assessment of Riparian Flora Along the Middle Course of the Shkumbin River Near the Miraka Area

Rodeta Pllumi ^{1,*}, Ermelinda Gjeta ² and Alma Gjerani ¹

¹ Department of Biology, Faculty of Natural Sciences, "Aleksandër Xhuvani" University, Elbasan, Albania

² Research Centre of Flora and Fauna, Faculty of Natural Sciences, University of Tirana, Tirana, Albania

In its middle course, the Shkumbin River flows across Central Albania, traversing the urban centers of Librazhd, Elbasan, and Peqin, forming characteristic riparian habitats along its banks. The climate in these areas is Mediterranean, with irregular distribution of precipitation, alluvial soils, and fertile fields. These riparian areas are characterized by high floristic diversity and significant ecological value. The study was conducted along the middle course of the Shkumbin River, in riparian habitats mainly located near the Miraka area. To evaluate the floristic diversity of these riparian areas, we conducted fieldwork in spring and summer 2025. Overall, we collected 310 plant materials. For data evaluation and comparison, we highlight the plant taxa collected near the Miraka area to assess their biodiversity, current status, conservation priorities, and human impacts. The analysis of the floristic data showed that the most widespread families are *Poaceae*, *Fabaceae*, and *Compositae*, with the *Plantaginaceae* family exhibiting particularly high representation. The area's systematic composition highlights Mediterranean, Cosmopolitan, and Paleotemperate elements. The distribution of life forms indicates a Mediterranean influence, particularly evident in the dominance of hemicryptophytes, therophytes, and phanerophytes. The studied riparian areas exhibit significant anthropogenic influence, as reflected in their floristic composition compared to that of other sites along the river. Across the riparian environments, we found species such as *Papaver dubium* L., *Veronica polita* Fr., and *Trifolium resupinatum* L., which provide a different ecological perspective on the impact of human activities, given their synanthropic occurrence.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-141666: The High-Temperature Crisis: Regional Vulnerabilities, Environmental Impacts, and Adaptive Imperatives

Jana Rammal ^{1,*}, Ismail Hijazi ², Salem Darwich ³, Dalia El Badan ^{4,5}, Marwa Rammal ⁶ and Akram Hijazi ¹

¹ Environmental Sciences Research and Analysis Platform (EDST-PRASE), Beirut P.O. Box 6573/14, Lebanon

² Medical Laboratory Sciences, Al Maarif University, Beirut, Lebanon

³ Economic Agricultural Department, Faculty of Agronomy, Lebanese University, Beirut 2866, Lebanon

⁴ Department of Biological Sciences, Faculty of Science, Beirut Arab University, Beirut P.O. Box 11-5020, Lebanon

⁵ Botany and Microbiology Department, Faculty of Science, Alexandria University, Alexandria 21568, Egypt

⁶ Department of Food and Technology Studies, Faculty of Agronomy, Lebanese University, Beirut, Lebanon

The rising frequency and intensity of extreme heat events are now a defining feature of the global climate crisis, with profound effects on the ecological resilience and environmental sustainability of ecosystems. Here, the cascading impacts of rising temperatures on terrestrial and freshwater ecosystems are critically discussed, with a focus on novel emerging vulnerabilities in climate-affected regions. The nations of the Arab world, such as Iraq and Kuwait, have experienced record-high temperatures exceeding 50 °C in recent decades, resulting in extreme droughts, agricultural disruption, water shortages, and infrastructure collapse. Based on peer-reviewed literature syntheses and local climate data, the review identifies four principal ecological effects: reduced vegetation productivity and soil water storage, increased wildfire frequency, freshwater ecosystem stress, and marine ecosystem decline. Ocean warming has exacerbated coral bleaching, altered species migration, and reduced dissolved oxygen, threatening biodiversity and coastal livelihoods. These occur most vehemently in locations with low adaptive capacity, particularly in the Global South. Severe heat also accelerates the release of greenhouse gases through thawing permafrost and damaged carbon sinks, trapping dangerous climate feedback loops. Compared to other analyses of land or ocean systems in isolation, this review includes cross-ecosystem impacts to provide an end-to-end overview of thermal stress. To mitigate the risks posed by these threats, the study calls for urgent, science-informed adaptation measures, including climate-resilient agriculture, nature-based cooling, early warning systems, and interregional environmental cooperation. Special emphasis is put on hyper-arid regions in the Middle East, which are likely to experience more intense heatwaves in the coming decades.

This study contributes to the understanding of how extreme heat affects the environment. It highlights the need for equitable and practical solutions to protect both nature and communities as the planet continues to warm.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-157062: Zinc Oxide Nanoparticles and magneto-priming in *Triticale*: Environmental Behaviour, Biological Responses, and Risk Implications

Mónica Montoya ^{1,2,*}, José Álvarez ³, Marina de-Francisco ¹ and Patricia Almendros ^{1,2}

¹ Department of Chemistry and Food Technology, Agronomic, Food and Biosystems Engineering School, Universidad Politécnica de Madrid, 28040 Madrid, Spain

² Research Centre for the Management of Agricultural and Environmental Risks (CEIGRAM), Universidad Politécnica de Madrid (UPM), 28040 Madrid, Spain

³ Department of Agroforestry Engineering, Agronomic, Food and Biosystems Engineering School, Universidad Politécnica de Madrid, 28040 Madrid, Spain

The environmental implications of nanoparticle-based agricultural inputs remain insufficiently understood, particularly for zinc oxide nanoparticles (ZnO-NPs), which are increasingly incorporated into fertilizers and agrochemicals. To ensure their safe and sustainable use, it is essential to evaluate both their potential phytotoxic effects and strategies to mitigate them. Magneto-priming (MP) has recently gained attention as a non-chemical, eco-friendly approach capable of enhancing seed germination, stimulating plant metabolism, and improving stress tolerance. In this study, *Triticale* (X *Triticosecale* Wittmack) seeds were subjected to two experimental approaches: (i) direct priming with ZnO-NPs at 500 and 5000 mg Zn L⁻¹, with or without MP, and (ii) exposure to soil leachates obtained from an acidic soil previously treated with the same nanoparticle concentrations. Germination percentage, shoot and root length, root number, and the Seedling Vigor Index were evaluated to assess nanoparticle-induced phytotoxicity and the potential mitigating role of MP treatment. Results showed an average 17.5 % reduction in germination in seeds directly treated with ZnO-NPs, likely due to ion release and the high reactivity of nanoparticle surfaces, indicating short-term phytotoxic potential under direct exposure. In contrast, MP treatment enhanced seedling vigour by 28.8%, improving shoot and root elongation and suggesting a capacity to alleviate early stress responses. Seeds exposed to soil leachates showed negligible effects, reflecting a limited mobility and bioavailability of ZnO-NPs within the soil matrix. These findings suggest that under the conditions of our study, soil-applied ZnO-NPs represent a low environmental risk, whereas direct contact with seeds can induce localized phytotoxic effects. In addition, MP treatment appears to modulate plant responses, enhancing root system development and mitigating nanoparticle-induced stress. Overall, the study contributes to environmental impact assessment of nanomaterials, emphasizing the need to evaluate exposure pathways and mitigation strategies for safe nano-enabled fertilizer use.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-156304: Appraising the water quality of Eto-anen stream in Ibotio, Mkpato Enin Local Government Area, Akwa Ibom State, Nigeria, using pollution, ecological and human health risk approach

Ifreke Mfon Udofia *, Idongesit Bassey Anweting and Godwin Asukwo Ebong

Department of Chemistry, University of Uyo, P.M.B 1017, Uyo, Nigeria

Water, as an essential component of the ecosystem, is required in good condition for proper ecological and economic processes. Surface water samples were collected and analyzed in accordance with recommended standards. Metal concentrations were determined using an atomic absorption spectrophotometer. The physicochemical parameters, temperature, pH, turbidity, electrical conductivity, dissolved oxygen, total dissolved solids, total suspended solids, salinity as Cl^- , total hardness, total alkalinity, and bicarbonate, were 29°C , 5.86, 4.06NTU, $41.1\mu\text{S}/\text{cm}$, 3.65mg/L, 20.4mg/L, 0.064mg/L, 24.82mg/L, 90mg/L, 65mg/L, and 79.3mg/L accordingly. The water quality index (WQI) of 21.153, evaluated using physicochemical parameters, indicates excellent water quality. Values for heavy metals obtained in surface water were in the order $\text{HgCoAsMnNiCrPbCdCuZnFe}$. The results indicate that the concentrations of metals exceeded the recommended limits set by WHO and NSDWQ, except for Hg, Co, As, and Mn. Contamination index ranged from 0.167 to 701.66. The Nemerow integrated pollution index was 499.049. Pollution load index was 3.895, and the geoaccumulation index ranged from -3.170 to 8.870. The indices indicate that the metals had a moderate to very high degree of contamination, except for Mn, As, Co, and Hg. The average daily intake of the metals via ingestion, dermal contact, and inhalation ranged between $4.92\text{E}-13$ to $6.56\text{E}-05$ and $2.11\text{E}-13$ to $7.02\text{E}-06$ for children and adults, respectively. These values were lower than their corresponding estimated daily intake rates from the USEPA. Target hazard quotient for children ($3.94\text{E}-06$ to $2.69\text{E}-02$) and adults ($4.22\text{E}-07$ to $2.88\text{E}-03$), and the hazard index for children ($3.14\text{E}-02$) and adults ($3.37\text{E}-03$) were 1, depicting no health risk. Incremental lifetime cancer risk for children ($2.89\text{E}-08$ to $3.45\text{E}-05$) and adults ($3.42\text{E}-09$ to $5.80\text{E}-06$), and the total cancer risk for children ($6.35\text{E}-05$) and adults ($1.06\text{E}-05$) were within the probable negligible risk of 10^{-6} - 10^{-4} . By implication, surface water poses no cancer risk to potential consumers.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-161992: Aqua-toxicity of Pharmaceuticals and Illicit Drugs: Planetary Boundary Interactions, Sustainability Relations, and Future Readiness—Are We Prepare to Combat the Threat?

Farzana Ferdoush ^{1,*}, Rakib Parvez ², Mohammed Ali Nause Russel ³ and Mosammat Mustari Khanaum ⁴

¹ School of Applied Science, Edinburgh Napier University, Edinburgh, UK

² Environmental Engineering Research Lab, Department of Civil Engineering, Inha University, Incheon, South Korea

³ School of Social & Environmental Sustainability, University of Glasgow, Glasgow, UK

⁴ Environmental and Conservation Sciences Program, North Dakota State University, Fargo, ND, USA

Water pollution from pharmaceuticals and illicit drugs has long been a critical environmental issue, and the recent pandemic has intensified this problem due to significant lifestyle changes. While several studies have explored the effects of individual drugs on surface and groundwater, there remains a gap in understanding their broader impacts on planetary boundaries and sustainability assessments. This study aims to systematically review the literature on how the pandemic has influenced pharmaceutical and illicit drug contamination in surface waters, with a particular focus on its connections to planetary boundaries and sustainability. Using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) method, 19 relevant studies were selected from an initial pool of 556 articles for detailed analysis. The review identifies key interconnections between pharmaceutical and illicit drug pollution, human health risks, and planetary boundaries, with a particular focus on the implications for Sustainable Development Goals (SDGs). Results reveal that human health faces significant risks from this contamination threat, underscoring the need for integrated monitoring, policy intervention, and sustainable management strategies. This study provides valuable insights into the impact of pharmaceuticals and illicit drugs on water resources and highlights the importance of bridging scientific research with policy to mitigate long-term environmental and health risks.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-158446: Assessing the Ecotoxicological Impact of Antibiotics on Aquatic Organisms

Anna Bilida * and Maria Antonopoulou

Department of Sustainable Agriculture, University of Patras, GR-30131 Agrinio, Greece

The increasing use of antibiotics in aquaculture, notably sulfamethoxazole (SMX) and trimethoprim (TMP), has raised environmental concerns due to their persistence and potential toxicity to non-target aquatic species. These compounds are frequently used in combination as a composite (co-trimoxazole), which may demonstrate distinct biological effects relative to the individual compounds. Evaluating the risks associated with their presence in the environment requires understanding their ecotoxicological profiles and potential interactions.

This study examined the effects of SMX, TMP, and their combination on the green microalga *Chlorococcum* sp., selected as a representative aquatic species. Cultures were subjected to environmentally relevant concentrations of each compound and their combinations under controlled laboratory conditions to evaluate potential toxic responses.

The purpose of this research is to elucidate the individual and combined detrimental effects of SMX and TMP and to propose alternative approaches to mitigate their environmental impacts. The work advances our understanding of the environmental behaviour of antibiotic combinations and their relevance to sustainable aquaculture methods.

Acknowledgements

"The research project is implemented in the framework of H.F.R.I call "3rd Call for H.F.R.I.'s Research Projects to Support Faculty Members & Researchers" (H.F.R.I. Project Number: 26141)".



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-157582: Assessment of Atmospheric Pollutants and Environmental Parameters in an Industrial Urban Area of Albania

Marilda Osmani ^{1,*}, Armela Mazrreku ¹, Belinda Hoxha ¹, Elona Gaxhja ², Gazment Koduzi ², Mina Kallajxhiu ³, Rezarta Saliu ³, Arkida Skenderi ² and Enis Hoxha ¹

¹ Faculty of Natural Sciences, University of Elbasan "Aleksandër Xhuvani", Elbasan, Albania

² Faculty of Medical Technical Sciences, University of Elbasan "Aleksandër Xhuvani", Elbasan, Albania

³ "Xhafer Kongoli" Hospital Center, Elbasan, Albania

Air pollution has become a significant public health concern in our country. In recent years, scientific research has focused mainly on the sources of pollution and its impacts on human health. This study was conducted as part of the National Agency for Scientific Research and Innovation's initiative to evaluate outdoor air pollution in the Elbasan region, one of the main industrial urban areas of Albania. The research aims to characterize the spatial and temporal variability of key atmospheric pollutants through real-time monitoring. The parameters measured include iBut, SO₂, PH₃, NH₃, O₃, NO, CO, CO₂, CH₄, O₂, H₂S, and NO₂, along with particulate matter (PM_{2.5} and PM₁₀), ambient noise level, temperature, and relative humidity. Data were collected using portable air monitoring equipment, allowing high-resolution temporal analysis. The concentrations of pollutants were statistically evaluated and compared with the limit values established in the European Union Directive 2008/50/EC on ambient air quality and cleaner air for Europe. Preliminary findings reveal significant temporal variations in pollutant concentrations, primarily influenced by traffic density, industrial activities, and meteorological conditions. The results contribute to establishing a comprehensive air quality database for the Elbasan region and provide a scientific basis for evidence-based environmental management and policy planning in Albania.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-162913: Assessment of Pb and Mn Accumulation in *Marrubium vulgare* L. as a Bioindicator and Phytoremediation Candidate in Industrial and Urban Environments of Sétif (Algeria)

Amina Belguidoum ^{1,2,*}, Khaoula Benlembarek ^{2,3}, Takia Lograda ^{2,4} and Messaoud Ramdani ^{2,4}

¹ Ecology and Environment Department, Faculty of Biological Sciences, University of Sciences and Technology Houari Boumediene (USTHB), Algiers, Algeria

² Laboratory for Valorization of Natural biological Resources of University Setif-1, Setif, Algeria

³ Ecology and Environment Department, Faculty of Sciences, University 20 Aout 1955 Skikda, Skikda, Algeria

⁴ Ecology and Environment Department, Faculty of Biological Sciences, Ferhat Abbas University Setif-1, Setif, Algeria

Heavy metal contamination has become one of the most critical environmental challenges affecting ecological integrity, soil functionality, and human health. Identifying native plant species capable of accumulating and tolerating toxic metals is, therefore, essential for improving environmental monitoring and supporting sustainable remediation strategies. In this study, we assess the bioaccumulation potential of *Marrubium vulgare* L., a widely distributed medicinal species, for lead (Pb) and manganese (Mn) across ten industrial and urban stations in Sétif (Algeria). Aerial plant tissues were collected and analyzed using Flame Atomic Absorption Spectroscopy (FAAS). Pb concentrations ranged from 138.82 to 582.54 mg/kg, while Mn levels varied from 3402.94 to 4402.55 mg/kg, both largely exceeding internationally certified limits for plant tissues. Statistical and multivariate analyses revealed pronounced spatial variability for Pb and a more uniform accumulation pattern for Mn, suggesting a combined influence of industrial emissions, vehicular traffic, and the natural geochemical background of the region. UPGMA clustering distinguished two major groups of stations corresponding to differing contamination intensities. Overall, the results confirm the strong capacity of *M. vulgare* to accumulate high metal loads, highlighting its reliability as a bioindicator of heavy-metal pollution and its promising potential in phytoremediation applications within semi-arid, anthropogenically impacted environments. This work provides relevant insights for environmental monitoring programs and supports the development of future ecological restoration and pollution-mitigation strategies.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-158278: Bisphenol A Impairs Androgen Receptor Pathway and Prostate Development

Aldo Mileo ^{1,2,*}, Stefania Boccia ¹, Benedetta Sgangaella Valvano ¹, Rosaria Sciarrillo ³, Anna Capaldo ¹ and Maria De Falco ^{1,4}

¹ Department of Biology, University of Naples Federico II, Napoli, 80126, Italy

² Department of Medicine and Health Sciences, University of Molise, Campobasso, 86100, Italy

³ Department of Science and Technologies, University of Sannio, Benevento, 82100, Italy

⁴ National Institute of Biostructures and Biosystems (INBB), Rome, 00165, Italy

Endocrine Disruptor Chemicals (EDCs) are emerging environmental contaminants widely used in domestic, agricultural, and personal-care products to enhance their performance. Their persistence in different environmental matrices and their ability to bioaccumulate have raised major concerns about continuous human exposure, even at low doses, through ingestion or skin contact. Among these compounds, Bisphenol A (BPA) has gained particular attention due to its structural similarity to steroid hormones and its ability to interfere with the endocrine system. Increasing evidence suggests that BPA adversely affects the male reproductive system, especially the prostate gland that appears sensitive to its activity. In this study, we showed preliminary data comparing the actions of BPA and the endogenous hormone Dihydrotestosterone (DHT) on 2D and 3D human prostate cell cultures. MTT and cell proliferation assays were performed to identify the concentration ranges of BPA and DHT that significantly influenced cell physiology. Protein expression of Proliferating Cell Nuclear Antigen (PCNA) was analyzed by Western blot, while Androgen Receptor (AR) localization after BPA exposure was examined by immunofluorescence. Our results showed that BPA exerted an inhibitory effect on both culture models. In 2D cultures, BPA caused AR retention in the cytoplasm, leading to a reduction in cellular proliferation. Moreover, the proliferative effect of DHT decreased when cells were co-treated with DHT and BPA, suggesting that BPA interferes with AR nuclear translocation and hormone responsiveness. In 3D prostate organoid (PO) cultures, DHT played a crucial role in PO maturation. Conversely, BPA did not replace DHT activity, but it showed its antiandrogenic activity when the PO was treated by BPA+DHT that resulted in smaller, less developed organoids, confirming BPA's interference with DHT-driven morphogenesis. Overall, our findings indicated that BPA interfered with androgenic pathways acting as an antiandrogenic compound, ultimately impairing normal prostate development.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-158310: Climate Change Impacts on Soil Salinity Dynamics in the Coastal Areas of Albania: Challenges and Adaptation Strategies

Enkelejda Kucaj ^{1*}, Sherif Lushaj ², Belinda Hoxha ³, Marilda Osmani ³, Anira Gjoni ¹ and Azem Bardhi ¹

¹ Institute of Geosciences, Department of Meteorology, Polytechnic University of Tirana, Tirana, Albania

² Faculty of Planning, Environment and Urban Management, Polis University, Tirana, Albania

³ Department of Chemistry, Faculty of Natural Sciences, University of Elbasan “Aleksandër Xhuvani”, Elbasan, Albania

Soil salinization in Albania’s coastal zone has emerged as one of the most critical forms of land degradation, increasingly exacerbated by climate change. Rising air temperatures, prolonged droughts, sea-level rise, and declining precipitation alter the water-salt balance, accelerating the accumulation of soluble salts such as sodium, chloride, and sulfate in agricultural soils. These processes directly threaten soil fertility, crop productivity, and rural livelihoods in one of Albania’s most productive agricultural regions. This study examines the interplay between climatic variability and salinity dynamics in the municipalities of Vlora, Fier, Lushnje, and Divjaka, areas where the combined influence of marine intrusion and human-induced land-use changes has intensified salinity risks. A mixed-methods approach was employed, integrating laboratory analyses of soil samples collected in 2021 with climatic data (the last 5 years) from the Institute of Geosciences. The assessment of soil parameters, including electrical conductivity, sodium (Na), chlorides (Cl), sulfates (SO₄), pH, and dry residue at various depths, and correlated them with temperature and precipitation trends. The findings reveal that salinity levels have increased by over 40% compared to pre-1990 measurements, confirming an upward trend in the re-salinization of previously reclaimed lands. The deterioration of drainage and irrigation infrastructure, coupled with rising evapotranspiration and seawater intrusion, has contributed to the progressive degradation of coastal soils. The study highlights that soil salinization in Albania is no longer a solely hydrological or agricultural issue but a climate-driven phenomenon. Effective adaptation strategies are required to mitigate its long-term impacts. These include rehabilitating drainage and irrigation systems, applying gypsum and organic amendments, cultivating salt-tolerant crops, and adopting precision irrigation and monitoring technologies. Strengthening institutional capacity and implementing climate-smart land management policies are essential to preserve the limited agricultural resources and ensure sustainable food production under changing climatic conditions.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-161326: Cocaine As An Emerging Environmental Contaminant: Cb1 And Barrier Function Alterations In Intestinal Human Cells

Stefania Boccia ^{1,*}, Aldo Mileo ^{1,2}, Benedetta Sgangaella Valvano ¹, Antonio De Luca ³, Anna Capaldo ¹ and Maria De Falco ^{1,4}

¹ Department of Biology, University of Naples Federico II, Naples, Italy

² Department of Medicine and Health Sciences "Vincenzo Tiberio", University of Molise, Campobasso, Italy

³ Department of Mental and Physical Health and Preventive Medicine, section of Human Anatomy, University of Campania "Luigi Vanvitelli", Naples, Italy

⁴ National Institute of Biostructures and Biosystems (INBB), Rome, Italy

Cocaine (COC) is among the most widely used substances of abuse worldwide, with a global production estimated at approximately 1,982 tons in 2020 (UNODC). Its extensive consumption has led to its detection in both drinking and non-drinking water, suggesting risks of unintentional exposure and confirming its emerging role as an environmental contaminant. The impact of COC on public health is therefore significant, as it acts on the central nervous system (CNS) by inhibiting the dopamine transporter (DAT) and increasing extracellular dopamine levels, generating potent psychostimulant effects. Recent evidence also indicates that the endocannabinoid (eCB) system modulates many behavioral and physiological responses induced by cocaine. In particular, the type-1 cannabinoid receptor (CB1), predominantly expressed in the CNS but also present in several peripheral districts, plays a crucial role. However, while the interaction between COC and CB1 in the CNS is well documented, the peripheral regulation of this receptor remains poorly understood. The gastrointestinal (GI) tract, where CB1 is involved in motility, secretion, and modulation of inflammation, represents a potential gut–brain axis node relevant to cocaine responses. In light of this, the present study investigated whether COC influences CB1 expression in human colorectal adenocarcinoma cells (Caco-2). Exposure to COC concentrations consistent with environmental levels (0–330 nM) revealed a non-monotonic response: 1 nM increased cellular metabolic activity, measured via MTT assay. Western blot analysis further showed that 24 hours of treatment reduced CB1 expression and altered the regulation of junctional proteins (E-cadherin and Claudin-5), results confirmed by immunofluorescence. These preliminary data suggest that COC may modulate both CB1 and metabolic and junctional parameters in Caco-2 cells, indicating a potential contribution to increased intestinal permeability ("leaky gut"), a phenomenon associated with various gastrointestinal disorders.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-157419: Combined Effects of Microplastics and Trace Metals on Stress-Response Gene Expression in the Mediterranean Mussel *Mytilus galloprovincialis*

Ryhane Lounas ^{1,*}, Amina Tifoura ², Houda Fellah ², Samira Sarih ³, Sara Haouam ⁴
and Nabila Meslem-Haoui ⁴

¹ Department of Marine Science, Universidad de Las Palmas de Gran Canaria, Las Palmas de Gran Canaria 35017, Spain

² Department of Marine Science, Faculty of Marine Studies, University of Alicante, Alicante 03080, Spain

³ Aquaculture Unit, National Institute for Research and Technology of Agrifood (INRTA), Tarragona 43004, Spain

⁴ Department of Living Resources, National Higher School of Marine Sciences and Coastal Management (ENSSMAL), Algiers 16320, Algeria

Microplastic (MP) contamination and trace metal pollution are pervasive and often co-occurring stressors in marine ecosystems, particularly in the Mediterranean Sea, one of the world's most polluted semi-enclosed basins, posing increasing risks to marine biota. This study investigated the individual and combined effects of microplastics and trace metals—cadmium (Cd), lead (Pb), and arsenic (As) on antioxidant and stress-response pathways in the Mediterranean mussel *Mytilus galloprovincialis*. Mussels (27.04 ± 6.45 g; 4.02 ± 0.21 cm) were exposed for 14 days to four treatments: (1) control (synthetic seawater, 18 °C), (2) microplastics ($=1$ mg L⁻¹), (3) metals (Cd, Pb, As; 10 µg L⁻¹ each), and (4) combined microplastics + metals. At the end of exposure, gill and digestive gland tissues were analyzed by qPCR to assess the expression of antioxidant genes (*cat*, *sod1*, *sod2*) and the stress-inducible chaperone *hsp70*.

Both microplastics and metals individually induced moderate up-regulation of antioxidant genes, consistent with enhanced reactive oxygen species (ROS) generation and activation of cellular defense mechanisms. The combined treatment elicited the strongest transcriptional responses, particularly for *sod2* and *hsp70*, indicating pronounced mitochondrial oxidative stress.

Overall, the findings demonstrate that co-exposure to microplastics and trace metals imposes a greater oxidative burden than exposure to either stressor alone, potentially compromising the physiological resilience of *M. galloprovincialis*. Understanding such multi-stressor interactions is essential for evaluating the ecological risks of emerging pollutants in the Mediterranean coastal environment.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-158434: CRISPR/Cas9 Genome Editing: Opportunities and Environmental Consequences for Biotic Stress Resistance in Crops

Anita Bhoi ^{1,*} and Surajit Demandal ²

¹ Department of Biotechnology, Shri Davara University, Raipur (Chhattisgarh) 493661, India

² Department of Microbiology, Shri Davara University, Raipur (Chhattisgarh) 493661, India

Abiotic stressors, such as drought, salinity, extreme temperatures, and nutrient imbalances, negatively impact crop development and productivity, posing serious risks to global food security. Climate change exacerbates these stressors, leading to soil degradation, water scarcity, and the loss of agricultural land. Although transgenic and conventional breeding systems have improved stress tolerance, their effectiveness is constrained by extended developmental stages and poor precision. CRISPR/Cas9 genome-editing technology provides a unique and efficient platform for the accurate modification of stress-responsive genes, enabling rapid growth of resilient crop variants. This study examines advances in CRISPR/Cas9 applications to improve abiotic stress tolerance in crops such as rice, maize, wheat, and soybean. Key genes associated with osmotic regulation, ion transport, antioxidant defense, and stress-related signaling are addressed together with multiplex editing and promoter engineering techniques.

In the context of environmental science, CRISPR/Cas9-driven crop enhancement facilitates sustainable ecosystems by reducing dependency on chemical fertilizers, over-irrigation, and soil additives, thereby lowering greenhouse gas emissions and mitigating ecological consequences. The development of stress-tolerant cultivars also promotes sustainable land management and climate-smart agricultural technologies. Nevertheless, biosafety concerns, adverse consequences, and regulatory challenges necessitate a thorough environmental risk assessment before large-scale implementation. In conclusion, CRISPR/Cas9 is a breakthrough biotechnological innovation that integrates molecular genetics and ecological sustainability, paving the way for more resilient agricultural systems in an evolving climate.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-158124: Dexamethasone: a potential hazard for aquatic organisms? Assessment of neurotoxic effects on mussel gills using a multi-biomarker approach

Giuseppe De Marco ^{1,*}, Mariachiara Galati ¹, Mery Terranova ^{1,2,3}, Barbara Billè ¹, Mohamed Anouar Ouedi ¹, Noemi Caruso ¹, Tiziana Cappello ¹ and Maria Maisano ¹

¹ Department of Chemical, Biological, Pharmaceutical and Environmental Sciences, University of Messina, 98166 Messina, Italy

² Department of Earth and Marine Sciences, University of Palermo, Palermo, Italy

³ National Biodiversity Future Center (NBFC), Palermo, Italy

The detection of pharmaceutical active compounds (PhACs) in the aquatic environment poses a serious concern for the wellness of biota due their ability to interfere with various biological targets (i.e., receptors, enzymes) causing alterations at different biological levels, including neurotransmission, antioxidant system and energy pathways. Among PhACs, the anti-inflammatory dexamethasone (DEX) results globally employed for the treatment of diseases, like arthritis, allergies, and asthma, but also as antiemetic interacting with the nervous system, particularly the serotonergic one. Therefore, the potential interference of DEX on the neurotransmission systems was evaluated on the non-target aquatic organism *Mytilus galloprovincialis*. The specimens were exposed to different DEX concentrations (4 ng/L-2000 ng/L), according to those recorded in the environment and wastewaters, considering three different times of sampling (3, 6, 12 days). A multi-biomarker approach (enzymatic, immunohistochemical and metabolomic analyses) was performed on mussel gills since their functions (i.e., gas exchange, filter feeding, osmoregulation) result regulated by serotonergic, cholinergic, and dopaminergic neurotransmission systems. A severe neurotoxic effect in the serotonergic and dopaminergic system caused by the tested doses of DEX was supported by a drop in the immunopositivity for serotonin (5-HT) and its receptor (5-HT₃R), as well as the enzyme tyrosine hydroxylase (TH), respectively. The effect on the cholinergic system revealed a similar trend with a reduction of acetylcholinesterase (AChE) immunopositivity coupled with an inhibition of its enzymatic activity, but with a partial recovery after 12 days of exposure as supported by a rise in the immunopositivity of choline acetyltransferase (ChAT) and a restoring of acetylcholine levels. The neurotransmission impairments, probably associated with alteration in the membrane integrity, seemed to be supported by changes in the levels of different osmolytes (i.e., taurine, betaine, homarine). Overall, this study confirms the environmental impact of PhACs on marine biota and the high evolutionary conservation of various drug biological targets.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-162701: DNT-Induced Soil and Crop Toxicity: Mechanisms, Consequences, and Sustainable Remediation

Anita Bhoi ^{1,*} and Surajit Demandal ²

¹ Department of Biotechnology, Shri Davara University, Raipur (Chhattisgarh) 493661, India

² Department of Microbiology, Shri Davara University, Raipur (Chhattisgarh) 493661, India

Explosive residues, such as 2,4-dinitrotoluene (DNT), are pervasive xenobiotic pollutants that accumulate in soils during the manufacturing, transportation, and testing of explosives, posing significant threats to the ecosystem and agricultural yield. The persistent nature of nitroaromatic compounds leads to destruction of microbial communities, and detrimental effects on plant physiology, including inadequate germination, decreased photosynthetic efficiency, and elevated oxidative stress, have all been reported in various experiments. The present study aims to summarize the current understanding of the environmental fate of DNT, its physiological and biochemical effects on crop plants, and forthcoming bioremediation strategies intended to reduce contamination. Furthermore, this review offers evidence of alterations in detoxification-related gene expression, oxidative damage pathways, and the deficits of traditional remediation techniques. Phytoremediation and plant-microbe interactions, which have been proven to be environmentally acceptable alternatives for chemical or physical treatments, garnered special attention. The creation of DNT-scavenger plants and engineered microbial consortia is an example of a recent biotechnology advancement that shows promise for restoring soil health. This review addresses essential knowledge gaps and futuristic research priorities by applying outcomes of various disciplines, particularly concerning field-based applications and prospective ecological impacts. The summary provided in this case is intended to deliver a unified framework for researchers and practitioners seeking sustainable solutions to nitroaromatic pollution.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-162847: Ecotoxicity threshold of bentazone towards *Lactuca sativa* under Albufera lake conditions

Teresa Girona-Albuixech *, Montserrat García-Gabaldón, Valentín Pérez-Herranz and Maria Teresa Montañés

IEC Group, ISIRYM, Universitat Politècnica de València, Camí de Vera s/n, 46022, València, P.O. Box 22012, E-46071, Spain

Introduction

Bentazone (BTZ) is an herbicide used in rice paddies. BTZ has been detected in the Albufera Natural Park (Spain), recognized as a "Wetland of International Importance". The Albufera lake waters contain variable concentrations of sulfates and chlorides over time. This study aimed to analyze the impact that these two compounds may have on the BTZ ecotoxicity.

Methods

Ecotoxicity was determined using *Lactuca sativa* seeds according to US EPA OPPTS 850.4200 standard.

First, the individual ecotoxicity of BTZ was determined. Later, 64 samples were prepared using all possible combinations of 0, 300, 600, and 900 mg L⁻¹ of BTZ; 0, 0.8, 1.6, and 2.4 g L⁻¹ of NaCl; and 0, 1.4, 2.8, and 4.2 g L⁻¹ of Na₂SO₄. The maximum concentration for each compound was approximately equal to its individual ecotoxicity threshold.

Results

BTZ exhibits an EC₅₀(5 days) towards *Lactuca sativa* of 900 mg L⁻¹, showing a hormetic effect. The toxic effects of a BTZ, NaCl and Na₂SO₄ mixture are generally lower than the individual toxic effects considered additively. A statistical model was obtained to predict the ecotoxicity thresholds for combinations of the three compounds. In general, when the concentration of one compound increases, a lower concentration of the others is necessary for the mixture to be toxic. However, in the presence of NaCl, below 382 mg L⁻¹ of BTZ, the concentrations of both compounds need to be increased. This is attributable to the hormetic behavior of BTZ. This BTZ concentration decreases as the Na₂SO₄ concentration increases.

Conclusions

EC₅₀(5 days) for BTZ towards *Lactuca sativa* is 900 mg L⁻¹. This value decreases when concentrations of Na₂SO₄ and NaCl increase. However, below 382 mg L⁻¹ of BTZ (a value that is lower as the concentration of Na₂SO₄ increases), the concentration of NaCl must also be decreased.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-158069: Effect of Di-N-butyl phthalate (Dbp) on the Prostate Gland and Adipogenesis: Possible Connections Between Metabolic Syndrome and Male Infertility

Benedetta Sgangarella Valvano ^{1,*}, Stefania Boccia ¹, Aldo Mileo ^{1,2}, Emiliano Del Genio ³, Claudia Pivonello ⁴, Antonio De Luca ³, Anna Capaldo ¹ and Maria De Falco ^{1,5}

¹ Department of Biology, University of Naples Federico II, Naples, Italy

² Department of Medicine and Health Sciences "Vincenzo Tiberio", University of Molise, Campobasso, Italy

³ Department of Mental and Physical Health and Preventive Medicine, section of Human Anatomy, University of Campania "Luigi Vanvitelli", Naples, Italy

⁴ Department of Public Health, University of Naples Federico II, Naples, Italy

⁵ National Institute of Biostructures and Biosystems (INBB), Rome, Italy

Di-n-butyl phthalate (DBP) is an endocrine-disrupting chemical (EDC) widely used in the production of plastics, synthetic materials, and cosmetics; it is therefore widespread in the environment as a contaminant. In recent years, DBP has been increasingly associated with metabolic and reproductive dysfunctions. Considering the growing evidence linking metabolic syndrome (MetS) to male infertility, this study explores the effects of DBP on prostate physiology and adipocyte differentiation, which are considered interconnected biological pathways. Using the non-tumor human prostate cell line PNT1A, DBP was analyzed individually and in combination with endogenous hormones: testosterone (T) and 17 β -oestradiol (E2), to simulate environmental exposure conditions. The results showed that DBP and all tested mixtures increased cell viability by activating both the oestrogen receptor (ER α) and the androgen receptor (AR). DBP modulated the expression of steroid receptors in a non-monotonic, hormone-specific manner, inducing delayed activation of ER α and AR compared to endogenous hormones. This delay could lead to the activation of proliferation and migration pathways at inappropriate times, altering prostate physiology and increasing susceptibility to neoplastic transformation. Given the central role of ER α , the effects of DBP were subsequently analyzed on adipogenesis in 3T3-L1 preadipocytes. Abnormal activation of ER α led to aberrant regulation of adipogenic genes PPAR- γ and C/EBP α , resulting in increased lipid accumulation (Oil Red O) and overexpression of adipogenic markers. Overall, DBP emerges as an endocrine-disrupting chemical capable of profoundly altering prostate and adipose physiology, suggesting a potential mechanistic link between environmental exposure, metabolic dysfunction, and male infertility.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-159096: Electrochemical Detection of Thallium as a Tool for Environmental Impact and Risk Assessment

Anna Modrzejewska-Sikorska *, Emilia Konował and Bożena Karbowska

Faculty of Chemical Technology, Institute of Chemistry and Technical Electrochemistry, Poznan University of Technology, Berdychowo 4, 60-965 Poznan, Poland

Introduction

Thallium is considered one of the most dangerous heavy metals, and even very small amounts can pose a serious threat to ecosystems and human health. To properly assess the environmental risks associated with its presence, reliable analytical methods are needed. In practice, however, measuring thallium at trace levels is demanding due to its low concentration and the complexity of environmental samples. This has created a need for improved, mercury-free detection tools that can support accurate environmental monitoring.

Methods

In this work, glassy carbon electrodes were modified with starch-stabilized silver nanostructures to increase their sensitivity toward thallium. The nanostructures were obtained through a controlled reduction process to ensure good stability and surface coverage. The modified electrodes were characterized electrochemically and used for anodic stripping voltammetric measurements in both model electrolyte solutions and real environmental samples.

Results

The applied surface modification markedly enhanced the analytical performance of the electrodes. Higher sensitivity, good repeatability, and a clearly improved detection limit enabled the reliable determination of thallium at concentrations relevant to environmental risk evaluation. The electrodes showed stable behavior over repeated measurements and performed well even in more complex sample matrices.

Conclusions

The proposed electrode system offers a practical and environmentally friendly alternative to traditional mercury-based sensors. Its analytical capabilities make it a useful tool for monitoring thallium contamination and supporting environmental impact and risk assessments.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-162702: Environmental Impact and Risk Assessment of Phthalate Contamination in Indoor Dust and PM₁₀ from Car Repair Workshops

Nadeem Ali ^{1,*}, Ahmed Saleh Summan ², Muhammad Salman Zeb ³ and Mansour A. Alghamdi ³

¹ Center of Excellence in Environmental Studies, King Abdulaziz University, Jeddah, Saudi Arabia

² Department of Environment, Faculty of Environmental Sciences, King Abdulaziz University, Jeddah, Saudi Arabia

³ Department of Environmental Sciences, King Abdulaziz University, Jeddah, Saudi Arabia

Phthalates are widely used plasticizers that readily migrate from indoor materials into dust and airborne particles, potentially posing health risks for workers in small enterprises such as car repair shops. This study assessed the concentrations of 13 phthalate esters in indoor dust and PM₁₀ from car repair workshops in Jeddah, Saudi Arabia, and estimated occupational exposure for adult workers. Floor dust samples were collected from multiple car repair workshops using a standard vacuum-based sampling method. Indoor PM₁₀ was simultaneously sampled on quartz fiber filters using a Micro-Environmental Monitor 400, and all samples were analyzed by gas chromatography-mass spectrometry (GC-MS). All target phthalates were frequently detected in both matrices, with substantially higher levels in dust than in PM₁₀. In dust, di(2-ethylhexyl) phthalate (DEHP) was the predominant compound, with mean and maximum concentrations of 4.1×10^5 and 8.0×10^5 ng/g, respectively, followed by benzyl butyl phthalate (BzBP) and diethyl phthalate (DEP). In PM₁₀, DEHP also dominated (mean 2.8×10^3 ng/g), with notable contributions from Di-isobutyl phthalate (DiBP), DEP, and dimethyl phthalate (DMP). Combined exposure through dust ingestion and inhalation was primarily driven by DEHP (median 538 ng/kg bw/day; 90th percentile 1055 ng/kg bw/day), while other phthalates, including BzBP, DEP, DiBP, DMP, and di-n-octyl phthalate (DnOP), contributed appreciably to the cumulative phthalate burden. The exceptionally high DEHP levels in dust, coupled with measurable airborne concentrations, indicate an intense use or continuous presence of DEHP-containing materials, lubricants, and plastic components in car repair environments. The estimated occupational exposures approach, and in some cases exceed, those reported for other high-contact indoor micro-environments, highlighting car repair shops as an overlooked yet significant source of phthalate exposure for adults. These findings highlight the need for better material selection, improved ventilation, personal protective equipment, and stronger hygiene practices to reduce phthalate exposure among auto-repair workers in similar settings.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-159089: Environmental Impact Assessment of Industrial and Urban Discharges on Groundwater and Surface Water in the Commune of Dar Bouazza

Nihad Chakri ^{1,*}, Halima Jounaid ², Faouzi Berrada ³, Btissam El Amrani ³ and Fouad Amraoui ³

¹ Chemistry/Research-Action Association for Sustainable Development (ARADD) – Faculty of Sciences Ain Chock (FSAC), University Hassan II of Casablanca, Casablanca, Morocco

² Departement of geology/ Faculty of Sciences Ain Chock, University of Hassan II of Casablanca, Casablanca, Morocco

³ Research-Action Association for Sustainable Development (ARADD), Faculty of Sciences Ain Chock, University of Hassan II of Casablanca, Casablanca, Morocco

The commune of Dar Bouazza is facing a progressive deterioration of its water resources. A study characterizing the well water used by local hammams revealed significant contamination, characterized by high concentrations of total bacteria, total coliforms, sulfite-reducing spores, and heavy metals such as chromium and nickel, along with substantial nitrate levels. These findings suggested long-standing pollution, likely resulting from the slow percolation of untreated wastewater through geological layers and from the use of undersized septic systems in informal settlements.

To better understand the true origin and extent of this pollution, an environmental prospection was conducted upstream of the initial study area. This investigation enabled mapping of industrial facilities and informal housing zones and the assessment of their wastewater discharge practices. Observations indicated that several industries and peri-urban settlements discharge wastewater directly into the environment, including rivers, thereby constituting a major source of contamination affecting both surface water and groundwater.

Water samples were collected from a douar and from the river to evaluate the impact of these discharges on water quality. Physicochemical and microbiological analyses confirmed significant pollution, indicating strong anthropogenic pressure and a pronounced environmental risk.

This study highlights the urgent need to implement sustainable wastewater management solutions and protective measures for water resources to safeguard public health and ecological balance within the commune of Dar Bouazza.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-158442: Evaluating the Ecotoxicological Effects of Glyphosate on Soil Systems: Towards Sustainable Agroecosystems

Elisabete Muchagato Maurício ^{1,2,*}, Patricia Branco ^{1,3} and Anabela Cruces ^{1,4}

¹ BIORG - Bioengineering and Sustainability Research Group, Faculty of Engineering, Lusófona University, Campo Grande 376, 1749-024, Lisbon, Portugal

² CBIOS - Research Center for Biosciences & Health Technologies, School of Health Sciences and Technologies, Lusófona University, Campo Grande 376, 1749-024, Lisbon, Portugal

³ Linking Landscape, Environment, Agriculture and Food (LEAF), TERRA Associated Laboratory, Higher Institute of Agronomy, University of Lisbon, Tapada da Ajuda, 1349-017 Lisbon, Portugal

⁴ IDL - Dom Luiz Institute (IDL) and Department of Geology (DG), Faculty of Sciences, University of Lisbon, Campo Grande, 1749-016 Lisbon, Portugal

Glyphosate ($C_3H_8NO_5P$) is a broad-spectrum herbicide commonly used in agriculture to effectively control weeds in cereal, vineyard, and horticultural crops. However, excessive glyphosate application can negatively impact soil health by altering microbial diversity, disrupting nutrient cycling, and reducing fertility and biodiversity. Furthermore, prolonged exposure to glyphosate has been linked to potential health risks for humans, including cancer and endocrine disruption. The International Agency for Research on Cancer (IARC, 2015) classified glyphosate as "probably carcinogenic to humans" (Group 2A), underscoring the need for stricter regulations and environmentally responsible agricultural practices. This study aimed to evaluate the phytotoxicity of glyphosate on the germination of *Raphanus sativus* and *Lepidium sativum* seeds. This study contributes to our understanding of the environmental risks associated with increasing concentrations of this compound in agroecosystems. A triplicate bioassay was conducted using glyphosate concentrations of 3.6, 1.8, 0.9, 0.45, and 0.225 g/L. Twenty seeds of each species were evenly distributed in Petri dishes containing cotton soaked with the respective test solutions. After seven days, germinated seeds were counted, and median lethal concentrations (LC_{50}) were calculated. Statistical analyses were performed to evaluate the correlation between glyphosate concentration and germination inhibition. The results demonstrated a significant increase in germination inhibition between 1.8 and 3.6 g/L for both seed species. Turnip seeds were more sensitive than watercress seeds. A positive and significant correlation was found between glyphosate concentration and inhibition rate. The LC_{50} values obtained were 2.18 g/L for *Raphanus sativus* and 1.43 g/L for *Lepidium sativum*. These results confirm that glyphosate impairs seed germination. The study emphasizes the need for continuous environmental monitoring and the adoption of sustainable soil management practices to mitigate glyphosate's ecological impact.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-162790: Evaluating the Initial Nutrient Content in Green-System Porous Media Through Aqueous Extraction

Michele Turco *, Stefania Anna Palermo, Behrouz Pirouz and Patrizia Piro

Department of Civil Engineering, University of Calabria, 87036 Rende, CS, Italy

It is well established in the literature that green systems can reduce pollutants from urban runoff. However, they may have a negative impact on wastewater quality due to chemical leaching of nutrients from the substrate, with nitrogen and phosphorous being the key elements of concern. The process governing the release or retention of nutrients in porous media is adsorption. It is a surface phenomenon driven by molecular attraction occurring when a solid phase (the adsorbent) comes into contact with a liquid or gaseous phase (the adsorbate). This mechanism is typically investigated through batch experiments. Nevertheless, before conducting batch tests, we performed an aqueous extraction to quantify the amount of nitrogen and phosphorus already present in a green-system substrate.

The experiment was carried out by mixing distilled water and soil at well-defined ratios using a magnetic stirrer, with the mixture sealed in a beaker. An S/L (Solid/Liquid) ratio of 1:10 and a stirring time of 24 h were considered to ensure proper dilution of the medium. The sample was then centrifuged for 15 minutes at 4500 rpm to ensure proper separation of the solid and liquid phases. Afterwards, the supernatant was filtered (90 μm) under vacuum, and the extracted liquid phase was analyzed for reactive phosphorus, nitrate nitrogen, and ammonium nitrogen using a UV-VIS spectrophotometer. Results from the aqueous extract showed very low concentrations of reactive phosphorus, nitric nitrogen, and ammonium nitrogen with values of 1,24 mg L^{-1} , 2,83 mg L^{-1} , and 0,084 mg L^{-1} , respectively. These findings indicate that the substrate does not contribute significantly to nutrient loads through initial leaching. In addition, the results provide an essential reference point for the design and interpretation of subsequent adsorption batch experiments, and they indicate that the substrate has a negligible initial nutrient release.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-162438: Evaluating the Use of Scanning Electron Microscopy with Energy-Dispersive X-ray Spectroscopy for Identifying Airborne Particles in Industrial Areas

Marius Roman *, Lucian Dordai, Anca Becze and Dorina Simedru

INCDO-INOE2000, Subsidiary Research Institute for Analytical Instrumentation, Cluj-Napoca, Romania

Airborne particles constitute complex mixtures of liquids and solids that originate from both natural phenomena and anthropogenic activities, significantly impacting environmental systems and human health. In addition to assessing the concentration of these pollutants in the atmosphere and their subsequent effects on ecosystems and public health, it is essential to develop rapid and reliable methodologies for detecting their presence. This study aims to establish and evaluate a novel rapid method for confirming, identifying and quantifying airborne particles present in soil samples utilizing Scanning Electron Microscopy coupled with Energy-Dispersive X-ray Spectroscopy (SEM-EDX). SEM-EDX is an important analytical technique that provides critical morphological and compositional information regarding material surfaces.

Testing was conducted on acidic soil (pH = 5) with a moisture content of 42.05% from an area subjected to airborne pollution. The SEM images do not reveal any particles that could be definitively linked to industrial contamination. The average chemical composition of the analyzed soil was as follows: Oxygen (O) at 53.27%, Silicon (Si) at 31.07%, Aluminum (Al) at 6.94%, Iron (Fe) at 3.21%, Calcium (Ca) at 2.61%, Potassium (K) at 1.44%, Sulfur (S) at 0.62%, Magnesium (Mg) at 0.50%, and Sodium (Na) at 0.32%. Carbon (C) was excluded from elemental analysis due to the deposition of samples on carbon substrates. These results are in good accordance with those obtained from soil analysis conducted using Inductively Coupled Plasma Mass Spectrometry (ICP-MS).

The findings showed that while industrial areas with a high risk of airborne pollutants have a greater likelihood of contaminated soil, in this specific case, the soil composition did not indicate the presence of potentially hazardous particles, implying a lower risk of pollution in the area studied. The study also confirms that SEM-EDX results are sufficiently sensitive to detect the presence of airborne particles when they are present and can be subjected to further testing.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-162856: Exploring the effects of glyphosate on the male reproductive system through in vivo studies on *Podarcis siculus* and in vitro studies on PNT1A cells

Teresa Chianese *, Sabrina Balsamo, Luigi Rosati, Giovanna Trinchese and Rosaria Scudiero

Department of Biology, University of Naples Federico II, Via Cinthia, Edificio 7, 80126 Naples, Italy

The expansion of intensive agricultural systems leads to increasing degradation of natural habitats, caused, among other factors, by the widespread use of herbicides such as glyphosate (Gly), which is widely used despite growing evidence of its potential adverse effects. Among the vertebrates most exposed to ecotoxicological risk are reptiles, whose populations are particularly sensitive to habitat loss and endocrine disruption. In this context, this study combines in vivo and in vitro approaches to assess the impact of glyphosate on the male reproductive system.

In the in vivo model, adult males of *Podarcis siculus* lizards were exposed orally, every other day for three weeks, to two concentrations of Gly (0.05 and 0.5 µg/kg bw). The analyses conducted revealed marked alterations in testicular morphology, a reduction in spermatogenesis and changes in the cell junctions. In addition, the expression and localisation of oestrogen receptors (ER α and ER β) in germ cells were significantly altered, with a dose-dependent increase in expression. Gly, at the concentrations tested, did not cause appreciable changes in steroidogenesis parameters. Overall, these results indicate that the herbicide can compromise the reproductive morphophysiology of male lizards, potentially reducing their reproductive fitness.

At the same time, in the in vitro model based on human prostate epithelial cells PNT1A, Gly induced cytotoxicity and rapid activation of oestrogen receptors via nuclear translocation. Functional analyses of mitochondrial metabolism showed reduced ATP production, respiratory reserve capacity and proton leak, suggesting the onset of mitochondrial dysfunction. Furthermore, the data suggest the activation of apoptotic pathways in response to treatment.

Overall, the evidence gathered confirms Gly as a potential endocrine disruptor, capable of altering reproductive function in both animal models and human cells, highlighting the urgent need for more controlled use of the herbicide.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-155495: Flooding in Ibadan North East: Gis As A Tool For Managing Drainage System Collapse, River System Encroachment, and Building Code Violations

Boluwatife Joseph Atere *, Olanike Kudirat Olayiwola, Dauda Rotimi Awoniran
and Suleiman Abdul-Azeez Adegboyega

Remote Sensing and Geoscience Information System, Federal University of Technology, Akure, Nigeria

Flooding is a persistent and worsening environmental hazard in Ibadan North East Local Government Area (LGA), driven by rapid urbanization, poor drainage systems, river encroachment, and building regulation violations. The study was motivated by the need to assess these risks spatially and support effective planning and intervention. The primary objective was to identify and map flood-prone areas resulting from drainage collapse, river system encroachment, and non-compliance with urban planning regulations.

Data used include high-resolution satellite imagery, building footprints digitized in ArcGIS 10.8, and a Digital Elevation Model (DEM) used for slope and elevation analysis. GIS techniques applied were buffer analysis (to detect building encroachment within 15 meters of rivers and 30 meters of major roads), overlay analysis (to identify intersecting risk zones), and terrain modeling (to map vulnerable low-slope and low-elevation areas). Software used includes ArcGIS 10.8.2, ArcGIS Pro, QGIS, Google Earth Pro, Google Earth Engine, and Microsoft Excel. Field observations were conducted to validate spatial outputs.

Findings reveal that 23% of structures (6,053) in the LGA violate river buffer regulations, while 18% (5,090) encroach on road buffer zones, indicating widespread non-compliance. Additionally, 45% of the land area falls within low-slope zones (3°), increasing susceptibility to runoff accumulation and surface flooding. Communities such as Beere, Oje, Idi-Arere, and Olomi, with a population of approximately 66,858, exhibited the highest concentration of overlapping risk factors. The study concludes that flooding in Ibadan North East is both a natural and structural hazard, exacerbated by institutional lapses in planning enforcement. It recommends the use of GIS for urban monitoring, enhanced drainage planning, and strict compliance with development controls to mitigate future flood risks.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-162724: From gray water to green solutions: Life Cycle Sustainability Assessment of heavy metals removal using inactive yeast

Isabela Simion ^{1*}, Raluca Maria Hlihor ¹, Petronela Cozma ² and Alessandra Bonoli ³

¹ “Ion Ionescu de la Brad” Iasi University of Life Sciences, 3 Mihail Sadoveanu Alley, 700490 Iasi, Romania

² “Gheorghe Asachi” Technical University of Iasi, 73 Prof. D. Mangeron Blvd., 700050 Iasi, Romania

³ Alma Mater Studiorum-Università di Bologna, Via Terracini, 28, 40131 Bologna

Due to increasing anthropogenic pressures, significant quantities of heavy metals are released into the environment, posing severe risks to human health because of their persistence, non-biodegradability, and long-term accumulation within ecosystems. This study aimed (i) to investigate the removal efficiency of Cd(II) and Cr(VI) from aqueous solutions using *Saccharomyces cerevisiae*, an inactive yeast biomass characterized by a high surface-to-volume ratio, wide availability, and low cost, as a biosorbent; and (ii) to evaluate the environmental sustainability of the biosorption process through Life Cycle Assessment (LCA).

The environmental impacts associated with biosorption were quantified across the four phases of the LCA methodology, conducted using Sphera Product Sustainability Solutions Software. The results revealed that the highest environmental burdens, for both Cr(VI) and Cd(II) removal, were recorded in the impact category *Ionizing Radiation*, with values of 17.8 person equivalents for Cd(II) and 17 person equivalents for Cr(VI), primarily due to the energy-intensive processes and electricity mix linked to biosorption system operation and LCA modeling.

A negative value was identified for *Human Toxicity, cancer effects* (−38.9 person equivalents) in the case of Cr(VI) removal indicating an apparent environmental benefit in this category employing *S. cerevisiae*. Conversely, Cd(II) biosorption showed a positive value to potential human toxicity (0.458 person equivalents), reflecting a measurable burden on the environment.

The application of LCA provided a comprehensive perspective on the environmental impacts generated at each stage, highlighting the biosorption phase as the main contributor to the overall environmental performance.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-162835: Health Risk Assessment of PM_{2.5}, NO₂, and BC Exposure on Adults and Children in Karachi, Pakistan

Haider Khwaja ^{1,*}, Najm Alsadat Madani ² and David O Carpenter ²

¹ NYSDOH/University at Albany, NY, USA

² Department of Environmental Health Sciences, School of Public Health, University at Albany, Albany, NY 12201, USA

Air pollution is a major environmental health hazard. The WHO estimates that air pollution contributes more than 7 million premature deaths globally on an annual basis. This estimate is not uniformly distributed: more than two third deaths occur in developing countries of South Asia. This study evaluates the health risks of air pollution exposure in a megacity Karachi, Pakistan, using the cigarette-equivalent technique. Sampling of fine particulate matter (PM_{2.5}), nitrogen dioxide (NO₂), and black carbon (BC) was performed at various fixed locations throughout the four seasons of the year. We evaluated the health risks of pollutants exposure using four different health endpoints including low birth weight (2500 g at term after 37 weeks of gestation), decreased lung function (Forced Expiratory Volume in 1 second), cardiovascular mortality, and lung cancer in residents of Karachi. The average risks of low birth weight from PM_{2.5}, NO₂, and BC were 37.2, 14.8, and 1.01, respectively, while the average risks of decreased lung function were 93.9, 38.8, and 2.87. Risks of cardiovascular mortality were 51.9, 14.3, and 2.79, and those of lung cancer were 31.3, 6.47, and 1.32, respectively. The remarkably high risks are attributed to high concentrations of air pollutants. These results suggests that residents of Karachi may experience other adverse health effects beyond those typically usually attributed to air pollution.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-161400: Heavy metal pollution and the effects on food security and soil health

Sherif Lushaj ^{1,*} and Enkelejda Kucaj ²

¹ Department of Environment of Planning, Environmental Faculty, Polis University, Tirana, Albania

² Department of Meteorology - Institute of GeoSciences, Polytechnic University of Tirana, Albania

Soil contamination by heavy metals is a significant environmental challenge impacting agricultural production, food safety, and ecosystem sustainability. This study seeks to identify and characterise the concentration and spatial distribution of heavy metals in agricultural soils across several industrially affected regions in Albania, as well as to evaluate their transfer to agricultural products and their ramifications for human health and soil quality. The research technique encompassed the systematic sampling and monitoring of soils at depths of 0–30 cm, 30–60 cm, and 60–90 cm, in addition to the analysis of agricultural products from polluted locations. Laboratory investigations aimed to ascertain the amounts of chromium (Cr), nickel (Ni), cobalt (Co), copper (Cu), lead (Pb), mercury (Hg), and arsenic (As), compared to European Union (EU) soil quality requirements. Supplementary evaluations encompassed marine goods in regions with verified industrial contamination. The findings demonstrate that heavy metal levels at the former Elbasan Metallurgical Complex substantially surpass EU legal thresholds. Chromium contents vary from 1041 to 1090 mg/kg, whereas nickel averages 473 mg/kg—significantly exceeding acceptable limits. Increased concentrations of mercury were identified in soils, marine waterways, and human biomarkers next to the defunct PVC facility in Vlora. Analogously, elevated levels of arsenic and lead were detected in regions next to historic nitrogen fertiliser and battery production sites. A robust positive association was identified between metal concentrations in agricultural crops, validating the bio-transfer along the food chain. The study indicates that prompt remedial efforts are necessary, encompassing the application of biological (phytoremediation), chemical, and physical treatment methods. It is advisable to use tolerant plant species and implement adaptive cultivation practices to rehabilitate contaminated soils and improve agricultural and environmental resilience.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-161183: High-Resolution Soil Organic Carbon Mapping Using Sentinel-2 and Gaussian Process Regression on Google Earth Engine

Tarun Teja Kondraju *, R. G. Rejith, Amrita Bhandari, Rajeev Ranjan and Rabi N. Sahoo

Division of Agricultural Physics, ICAR-Indian Agricultural Research Institute, New Delhi 110012, India

Accurate assessment of soil organic carbon (SOC) is fundamental to evaluating risks of land degradation, soil fertility decline, and climate-related vulnerabilities in rapidly transforming urban–agricultural landscapes. This study presents a remote-sensing-driven SOC estimation framework that integrates **Sentinel-2 multispectral imagery**, **Gaussian Process Regression (GPR)**, and **Google Earth Engine (GEE)** to produce high-resolution SOC maps for the ICAR–Indian Agricultural Research Institute (ICAR-IARI) region of New Delhi, India. Ground-measured soil fertility parameters were paired with Sentinel-2 surface reflectance spectra to train a GPR model, which achieved strong predictive performance ($R^2 = 0.67$, $RMSE = 0.099$, $MAE = 0.075$) across 78 soil samples. The trained model was then migrated into GEE to enable scalable, cloud-based SOC prediction. A cloud-free Sentinel-2 image acquired on **25 May 2018** was used, and a multi-index soil mask (NDVI, NDWI, NDBI) was applied to remove vegetation, water bodies, and impervious surfaces, thereby ensuring SOC mapping was limited to exposed soil. The resulting SOC map demonstrates clear spatial variability influenced by land use, irrigation patterns, and management practices, highlighting zones of lower carbon content that may be at higher risk of degradation. By combining machine learning with openly accessible satellite data and cloud computation, this framework provides a rapid, transferable method for soil-quality risk assessment. The approach supports evidence-based planning, monitoring of anthropogenic impacts on soil health, and identification of priority zones for carbon-enhancing interventions, contributing to broader goals of sustainable land management and climate-impact mitigation.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-162905: Histological effects of and cellular responses to microplastics in the gills of *Mytilus galloprovincialis*

Sabrina Balsamo *, Teresa Chianese, Roberta Gatta, Rosaria Scudiero and Luigi Rosati

Department of Biology, University of Naples Federico II, Via Cinthia, Edificio 7, 80126 Naples, Italy

Microplastic (MP) pollution is now one of the main threats to marine ecosystems, due to MP's ubiquity, persistence, and ability to interact with aquatic organisms at different biological levels. Microplastic beads and/or fibers, resulting from the fragmentation of larger plastics or released as primary particles, can be easily ingested, or accumulated by numerous marine species, with potential toxic effects including oxidative stress, inflammation, and histopathological alterations. In this context, filter feeders such as *Mytilus galloprovincialis* mussels are ideal experimental models and sensitive bioindicators for monitoring the impact of marine pollutants, thanks to their ability to rapidly accumulate substances present in the water column. The research presented in this paper is part of a project aimed at characterising the damage caused by marine contaminants on adult individuals of *M. galloprovincialis*. Specifically, the objective of this study was to evaluate the toxic effects of polystyrene MPs, administered at different concentrations, on the respiratory system of the chosen model. Through qualitative histological analyses including Mallory's trichrome, PAS, and Picrosirius Red staining, it has been possible to highlight significant morphological and structural alterations in the gills by comparing control and MP-exposed animals. Subsequently, the investigation was extended to the study of the cellular response to stress, using immunocytochemistry aimed at the tissue localisation of Proliferating Cell Nuclear Antigen (PCNA), a known marker of proliferation and cellular damage. Preliminary validation of the antibody by Western blot confirmed the results obtained, allowing us to accurately describe the changes in PCNA distribution following MP exposure. The results show a more accurate picture of how microplastics compromise gill integrity, providing useful information for assessing the ecotoxicological impact of these contaminants.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-156651: Index-based environmental risk assessment of micro- and nanoplastics: handbook for conscious, accurate, and standardized use

Manuela Piccardo * and Stanislao Bevilacqua

Department of Life Sciences, University of Trieste, Via Giorgieri, 10, 34127, Trieste, Italy

Pollution from micro- and nanoplastics currently represents one of the main environmental challenges, raising concerns both for its ecological consequences and for the potential risks to human health. After two decades of data collection since the first appearance of the term “microplastic” in the scientific literature, research is moving toward a new direction—that of assessing ecological and human health risks. In this perspective, a rising interest is converging on the use of indices, which may represent an effective tool for describing environmental quality in a clear and straightforward manner.

This contribution, based on the systematic review of 316 papers collected from the Web of Science database, aims to examine the use of indices for environmental risk assessment from both an editorial perspective (when the first publication dates back to, how the topic has evolved over time, and which publishers and journals have shown the greatest interest) and a technical point of view (which and how many indices have been proposed to date, which environmental matrices have been considered, and which geographical areas have received the most attention). Furthermore, what limitations does each index present, and how can they be improved? The goal is to gather and summarize all information on the topic, which to date remains somewhat fragmented, and propose a roadmap to guide researchers and practitioners through an informed, accurate, and standardized use of indices for ecological risk assessment of microplastic pollution.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-162769: Influence of Electrode Material on the Electroflocculation Treatment Efficiency of Swine Wastewater

Yesica Pallavicini *, Julio Martín-Margüello and María Virginia Ozcariz-Fermoselle

R&D Department, ITAGRA.CT, Palencia 34004, Spain

Swine wastewater, composed of farm effluents, poses significant risks to the environment and public health due to its pollutant loads. This wastewater is frequently applied as fertilizer, but repeated use can lead to soil and water eutrophication and contamination. Various pre-treatment techniques have been explored to mitigate these impacts. Electroflocculation has emerged as a promising technique to reduce the pollution load before soil application. This process involves the controlled release of metal ions, which destabilize colloidal particles in the mixture, resulting in an effluent with substantially lower contaminant levels. Electrode material is a critical parameter in the electroflocculation process. Aluminum and iron are the most commonly used electrodes; however, the required exposure time to the electric current is usually long, making the process costly in terms of both time and financial resources. This study investigated the electroflocculation of swine manure using various alternative electrodes (aluminum, stainless steel, carbon, copper, and zinc) to assess the efficiency of contaminant removal under short exposure times and low voltage conditions, aiming to optimize the process. Manure collected from a farm in Palencia (Spain) was treated at 12 volts for 3, 6, and 9 minutes. After the treatments, both treated and control samples were analyzed in the laboratory for pollutants including turbidity, organic matter, phosphorus and other minerals. The results showed that stainless steel and zinc electrodes were particularly effective reducing turbidity (47% - 67%), organic matter (23%), phosphorus (34% - 62%), and calcium (27% - 54%) in the effluent after 9 minutes of current exposure. The average energy consumption was 0.36 W/L which was considerably lower than previous studies. However, these electrodes released some heavy metals into the solution, which could be further reduced through a complementary treatment. Overall, electroflocculation using alternative electrode materials with short treatment times appears to be a suitable pre-treatment strategy for swine manure, reducing pollutant loads while maintaining low energy consumption.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-141519: Integrated approach for the characterization and risk assessment of soils in environmental liabilities derived from metallurgy

Jherson Antonio Morales Laurente *, Jose Ignacio Barquero, Pablo Higuera, Saturnino Lorenzo, Luis Mansilla and Oscar Avalos

Institute of Applied Geology, University of Castilla-La Mancha, Ciudad Real, 13400, Spain

The assessment of environmental liabilities associated with metallurgy requires integrating chemical, physical, and biological indicators to estimate risks and inform remediation strategies. In this case study, a smelting complex was investigated through georeferenced sampling at a site in southwestern Spain, within the Almadén region, affected by historical metallurgical slags. Part of these slags was reused during a partial reactivation of the area, resulting in heterogeneous materials that may serve as sources of contamination. At present, the site is embedded in a forested environment that supports wildlife, thereby increasing the ecological relevance of the study.

Soil pH (6.26–8.23) and electrical conductivity (30–1,539 $\mu\text{S}\cdot\text{cm}^{-1}$) were determined, together with multielemental composition by XRF-ED and enzymatic bioindicators (acid phosphatase, β -glucosidase, and dehydrogenase). Extremely high concentrations of Pb (up to 121,235 $\text{mg}\cdot\text{kg}^{-1}$), Zn (1,525 $\text{mg}\cdot\text{kg}^{-1}$), Cu (3,110 $\text{mg}\cdot\text{kg}^{-1}$), As (663 $\text{mg}\cdot\text{kg}^{-1}$), and Sb (1,510 $\text{mg}\cdot\text{kg}^{-1}$) were detected, largely exceeding guideline values for contaminated soils. Multivariate analysis revealed a coherent polymetallic association (Pb-Zn-Cu-As-Sb) associated with the dispersion and reuse of slags, which is distinguishable from the natural geochemical background.

Acid phosphatase and β -glucosidase activities remained at moderate levels even in areas with high metal loads. In contrast, dehydrogenase activity was inhibited by more than 60%, indicating a marked impact on soil biological quality. These findings highlight the need for integrated assessments to effectively manage environmental impacts and ecological risks associated with metallurgy-derived liabilities.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-161067: Investigating the Effects of Psychoactive Emerging Contaminants in Early Frog Life Stages

Simona Di Marino *, Chiara Fogliano, Bice Avallone, Chiara Maria Motta and Rosa Carotenuto

Department of Biology, University of Naples Federico II, 80126 Naples, Italy

The widespread use of psychoactive substances, combined with their incomplete removal in conventional wastewater treatment plants, has led to the increasing environmental presence of biologically active compounds now classified as emerging contaminants. These include pharmaceuticals such as clonazepam, a benzodiazepine prescribed for anxiety and epilepsy, and widely consumed stimulants like caffeine and nicotine. After ingestion, these substances are metabolised and excreted mainly via urine, ultimately entering wastewater systems and aquatic environments, where they persist at ng/L–µg/L concentrations.

Caffeine, nicotine, and clonazepam are among the most commonly detected psychoactive contaminants in surface waters. Although their effects on humans are well understood, their impact on aquatic organisms, especially during early development, remains poorly characterised. While these contaminants often co-occur, understanding the specific role of each compound is crucial for ecological risk assessment.

This preliminary study examined the individual effects of caffeine, nicotine, and clonazepam on the embryonic development of *Xenopus laevis*, a widely used vertebrate model in ecotoxicology. Embryos were exposed from the 4–8 cell stage using a modified FETAX protocol designed to better reflect environmentally relevant exposure. Concentration ranges similar to those found in surface and wastewater were tested. In addition to standard FETAX endpoints (mortality, body length, and malformations), we measured heart rate, embryo motility, and oxidative stress biomarkers to identify sublethal alterations.

Preliminary results revealed significant developmental abnormalities, including cephalic and abdominal oedema, intestinal defects, bent tail phenotypes, and altered dorsal pigmentation. LC₅₀, EC₅₀, and Teratogenic Index (TI) values confirmed a detectable teratogenic potential for all three compounds. Overall, these findings demonstrate that individual psychoactive contaminants, even at environmentally relevant concentrations, can disrupt early vertebrate development, highlighting their ecological importance and the need for further toxicity assessment.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-155404: Land Use Intensity, Power Density, and Energy Density of Photovoltaic Power Plants

Szymon Pelczar

Faculty of Civil Engineering and Resource Management, AGH University of Krakow, al. A. Mickiewicza 30, 30-059 Krakow, Poland

Introduction

Photovoltaic power plants are expanding their installed capacity worldwide, accompanied by a growing number of installations. This relates to land-use transformation and to competition among various land-use forms. Specifically, photovoltaic power plants, particularly utility-scale ones, can compete with agriculture and other land uses, such as mining and urban development. Thus, it is important to investigate the intensity of land use and the power density of these generation units to adequately evaluate the impact of this type of renewable energy on land-use structures.

Methods

The works aimed at determining the power density, land-use intensity, or energy density of the power plants in question were considered. Scientific databases (Scopus and Web of Science) were used to find relevant articles. Subsequently, the calculations, which enable comparison of the examined coefficients, were performed.

Results

The results provide important information on environmental impact, enabling evaluation of the scale of potential land-use transformation relative to the planned volume of installed capacity. This study, building on recent work on this topic, examines the land-use intensity of photovoltaic power plants. Moreover, the power density of the considered power plants is determined. This coefficient is essential when comparing different types of generation units, as it allows assessment of the electricity production efficiency of individual technologies in terms of land use. Furthermore, energy density, being a derivative of power density, is presented. In addition, the interrelation of the indicated coefficients is described.

Conclusions: Power density is a parameter strictly related to land-use intensity and varies under specific conditions across regions. Additionally, when evaluating the employment of photovoltaic power plants, the energy density factor should be taken into account.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-158054: Limitations of Project-Based Environmental Impact Assessment (EIA) and the Need for Cumulative Effects Assessment (CEA) in the Assaluyeh Coastal Industrial Zone, Iran

Tayebeh Lohraseb ^{1,*} and Maria Teresa Sebastià Frasquet ²

¹ Marine and Coastal Science and Technology, Universitat Politècnica de València, C/Paraninfo, 1, 46730 Grau de Gandia, Spain

² International Action and Academic Coordination in the Area of Environment and Tourism / Universitat Politècnica de València, C/Paraninfo, 1, 46730 Grau de Gandia, Spain

The Assaluyeh coastal industrial zone on the Persian Gulf hosts one of Iran's largest clusters of oil, gas, and petrochemical facilities. Despite decades of project-level Environmental Impact Assessments (EIAs), the region continues to face severe environmental stress, raising important questions about the effectiveness of traditional assessment approaches. This study examines the core limitations of project-based EIA in Assaluyeh and highlights why a shift toward Cumulative Effects Assessment (CEA) is urgently needed. To explore this issue, we reviewed publicly available EIA and Environmental, Social, and Health Impact Assessment (ESHIA) reports, along with scientific publications from 2015 to 2024. Our analysis focused on whether cumulative impacts were acknowledged, the quality and clarity of the methods used, and the overall transparency of documentation. The findings reveal a consistent pattern; most reports limit their evaluations to individual project boundaries and either ignore cumulative impacts or address them only superficially. At the same time, field-based environmental studies draw a much clearer picture of the real situation on the ground. Multiple pollutants, including heavy metals (Pb, Cd, Ni, V), PAHs, BTEX compounds, and high levels of particulate matter, have accumulated across the region. These pollutants originate from numerous sources and interact in complex ways, creating environmental pressures that single-project EIAs are not equipped to capture. Together, these insights point to a crucial gap in current environmental governance. A regional CEA framework, embedded within a Strategic Environmental Assessment (SEA), would provide a more holistic view of industrial development and its long-term consequences. Such an approach can improve coordination among institutions, enhance environmental data sharing, and support more sustainable planning for Iran's rapidly expanding coastal industrial zones. Overall, this study emphasizes that managing the environmental challenges of Assaluyeh requires moving beyond project-level assessments and adopting tools that can address the full scale of cumulative and synergistic impacts.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-162169: Mercury Speciation and Functional Gene Markers in Amazonian River Biofilms

Tatiana Pedron ^{1,*}, Bruno Lemos Batista ¹ and Vera Slaveykova ²

¹ Center for Natural and Human Sciences, Federal University of ABC, Santo André 09210-580, SP, Brazil

² Department F.A. Forel for Environmental and Aquatic Sciences and the Institute for Environmental Sciences, University of Geneva, 66 Boulevard Carl-Vogt, CH-1211 Geneva, Switzerland

Mercury (Hg) is a global contaminant of significant concern, especially due to its transformation into methylmercury (MeHg), a potent neurotoxin. River biofilms, such as those found in the Tapajós River, are recognized as crucial hotspots for microbial methylation of Hg. This study investigated the interaction between Hg and selenium (Se), an element known to mitigate Hg toxicity, in freshwater biofilms. The objective was to evaluate Hg speciation and correlate it with the detection of key genes involved in Hg methylation and resistance (*hgcA*, *merA*, *gcs*, *dsrA*) under different exposure conditions to IHg and SeO_3^{2-} . The results demonstrated that biofilms act as efficient sinks for Hg, with high bioaccumulation of the metal. Speciation analysis revealed that Hg remained predominantly in the inorganic form (IHg) in the dissolved phase, with MeHg was below the detection limits, suggesting a low methylation rate under experimental conditions. PCR analysis revealed a detection pattern suggesting strong selectivity and toxicity of IHg. The resistance gene *merA* was not detected in treatments with IHg alone and IHg+ SeO_3^{2-} , suggesting the elimination of the subpopulation carrying this gene due to toxicity. Crucially, the methylation gene *hgcA*, which was detected in single treatments with IHg, was not detected under the co-exposure to IHg + SeO_3^{2-} , suggesting that SeO_3^{2-} mitigated the methylation. From an environmental perspective, our results suggest that naturally occurring Se may play a protective role in Amazonian ecosystems impacted by Hg, reducing the bioavailable fraction of this potent neurotoxin and, consequently, eliminating susceptible microbial populations. This has important implications for risk assessment and potential bioremediation strategies in regions affected by artisanal gold mining and other sources of Hg contamination.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-158304: Microplastics Reflecting Water Quality Degradation in a Sediment-Laden Urban River of India

Karuna Singh * and Kapil Kumar

Department of Civil Engineering, National Institute of Technology Delhi, Delhi, India

Microplastics (MPs) have emerged as significant indicators of anthropogenic pressure and deteriorating water quality in riverine systems. This study investigates the interrelationship between microplastic abundance and key physico-chemical parameters of the Yamuna River to elucidate how hydrochemical conditions influence MP distribution along the Delhi stretch. Water samples were analyzed for pH, dissolved oxygen (DO), electrical conductivity (EC), total dissolved solids (TDSs), and salinity, and the correlations were assessed. Strong negative correlations between pH and both EC ($r = -0.99$) and TDS ($r = -0.99$) reveal that acidic conditions correspond to higher ionic concentrations, likely resulting from untreated industrial effluents and urban runoff. A positive correlation between pH and DO ($r = 0.88$) indicates relatively cleaner and photosynthetically active regions within the river. In contrast, MP abundance exhibited strong positive correlations with EC ($r = 0.95$) and TDS ($r = 0.94$), but negative correlations with pH ($r = -0.96$) and DO ($r = -0.81$), suggesting greater accumulation of MPs in low-oxygen, high-ionic-strength waters. A moderate positive correlation with salinity ($r = 0.68$) further suggests enhanced deposition of MPs in sediment-laden and low-flow zones. The results collectively demonstrate that microplastic occurrence in the Yamuna River is closely governed by hydrochemical dynamics, reflecting complex interactions between pollution inputs and physical transport processes. Thus, microplastics can serve as effective indicators of water quality degradation, underscoring the need for integrated monitoring frameworks that couple conventional hydrochemical assessments with emerging contaminant analyses for sustainable river restoration.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-162358: Military Pollutant Emissions

Christina Pourani ^{1,2}

¹ Department of Legal services, Hellenic Regulatory Authority for Waste, Energy and Water, Athens, Greece

² Department of International and European Studies, School of International Studies, Panteion University of Social and Political Sciences, Athens, Greece

Introduction

The already increased greenhouse gas emissions are growing, beyond the factors of climate change and military operations, leading to harmful environmental implications, before, during, and after armed conflicts, that both need detailed assessment.

Methods

Defining the context of «carbon footprint», «greenhouse gas emissions», and «methane emissions», the popular 5.5% footprint of the largest carbon polluter, the military, emerges. Based on analytical tables with emissions sources and their CO₂e/Mt percentage, the four categories of pollutant emissions (scopes 1, 2, 3, and 3 plus) are also identified.

Simultaneously, the regulatory framework regarding environmental protection against military emissions is investigated holistically, at international (humanitarian, environmental, and criminal), European, and jurisprudential levels.

Despite the increased amount of emissions, which is growing, «additional» emissions (front line) and massive military expenses are exacerbating this amount. However, states' non-accountability or double reporting, given contemporary examples of warring countries (Russia, Ukraine, Georgia), causes data gaps and uncertain evaluations of emissions' accounting, for which three key calculation methods are used.

Observing the devastating repercussions of armed conflicts on the quality of air, soil and water, and the aquifer horizon, with climate change on top, three possible climate scenarios arise and viable solutions have to be sought to align with essential guidelines (e.g., 1.5 oC goal—Paris Agreement).

Results

Identifying the deep sources—causes of the issue—through terms analysis and emissions accounting; assessing the quantity of military pollutant emissions based on poor data to observe, perceive, and combat the caused environmental side-effects.

Conclusions

In a nutshell, the military contributes noticeably to the global increase in GHG emissions. Despite the obstacle of the voluntary nature of states' emissions reporting, data collection is truly substantial in accurately assessing the environmental effects of armed conflicts and in urgently managing them, adapting with global climate commitments.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-158409: Natural and anthropogenic contamination processes in the sediments of the Sacca di Goro lagoon (Po River delta, northern Italy)

Dimitra Rapti

Department of Chemical, Pharmaceutical and Agricultural Sciences, University of Ferrara, Ferrara 44122, Italy

The Sacca di Goro lagoon, located in the Po River delta (Northern Italy), represents a significant area of interest due to its natural and economic value. Spanning an area of approximately 20 km², with an average depth of 1.5 meters and salinity levels of 29‰, the lagoon is not only crucial for its biodiversity but also plays a pivotal role in regional aquaculture, particularly for mussels and clams.

In the present study, 15 continuous core-drilling surveys were conducted, with depths ranging from 100 to 200 cm and distributed evenly across the lagoon area. A total of 70 sediment samples were collected and analyzed for grain size composition, organic matter content, and concentrations of various elements such as SiO₂, TiO₂, Al₂O₃, Fe₂O₃, MgO, MnO, CaO, Na₂O, K₂O, P₂O₅, Ba, Ce, Co, Cr, La, Nb, Ni, Pb, Rb, Sr, Th, V, Y, Zn, Cu, Ga, Nd, S, and Sr. Furthermore, in selected samples, sediment toxicity was evaluated using the bacterial bioluminescence toxicity assay, which provides insight into the potential biological impact of the sediments.

The comprehensive dataset obtained from these analyses enabled us to achieve several important goals: i) defining the overall environmental quality of the sediments, ii) identifying areas with the highest contamination risks, iii) establishing a relationship between grain size distribution and chemical concentrations, and iv) emphasizing the local occurrence of natural pollution phenomena linked to metals such as chromium (> 50 ppm) and nickel (> 30 ppm), as well as human-induced contamination from lead (> 30 ppm) and copper (> 60 ppm).



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-162861: Occurrence and characterization of microplastics and trace metals in aquatic matrices of the ABC Paulista region

Caroline Cristine Augusto *, Tatiana Pedron, Renata Tatsuco Silva Fukuwara, Bruna Moreira Freire and Bruno Lemos Batista

Department of Chemistry, Federal University of ABC, Santo André, São Paulo, Brazil

Plastic pollution represents a major environmental issue due to its persistence and interaction with chemical contaminants in aquatic ecosystems. Once released into the environment, plastics undergo biological and chemical transformations that influence their transport and fate. The fragmentation of larger plastic items results in microplastics (MPs), defined as particles ranging from 1 μm to 5 mm, which may be ingested by organisms and act as vectors for contaminants, including potentially toxic elements (PTEs). Elevated concentrations of these elements pose significant ecological and human health concerns. This study aimed to quantify the concentrations of As, Cd, Cu, Hg, Pb, and Zn, as well as to identify and quantify plastic and microplastic particles in rivers located in the ABC Paulista region (Brazil). The relationship between water quality parameters and contaminant occurrence was also investigated. Eight sampling sites were selected along downstream sections of the Tamanduateí River, covering areas influenced by residential, industrial, and tourist activities. Chemical element concentrations were determined using inductively coupled plasma mass spectrometry. Plastic and microplastic particles were identified and quantified following standardized National Oceanic and Atmospheric Administration (NOAA) protocols, using Raman and FT-IR spectroscopy. Sediment samples contained between 2 and 1,000 plastic particles per kilogram, predominantly composed of polyethylene, polypropylene, and fibers. In the water column, an average concentration of approximately 350 microplastic particles per cubic meter was observed. Analyses of leaves, water, and sediments revealed elevated concentrations of PTEs, with Pb identified as the dominant contaminant. Maximum Pb concentrations reached 7 ppb in water, 4000 ppb in leaves, and up to 25000 ppb in sediments. Cadmium and As were detected as secondary contaminants, with concentrations reaching up to 5000 ppb. Overall, the results demonstrate the widespread occurrence of microplastics and potentially toxic elements across multiple environmental matrices, highlighting potential risks to aquatic ecosystems and human health in urban-industrial river systems.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-162914: Optimizing SP-ICP-MS for Detection of Silver Nanoparticles in Water: Implications for Environmental Monitoring

Melissa Garutti *, Bruno Lemos Batista, Caroline Cristine Augusto and Bruna Moreira Freire

Federal University of ABC (UFABC), Center for Natural and Human Sciences (CCNH), Santo André, São Paulo 09210-580, Brazil

Nanotechnology is a multidisciplinary field that has gained increasing attention. Silver nanoparticles (AgNPs) stand out due to their broad-spectrum antimicrobial activity and widespread use in medical, food, cosmetic, and textile applications. However, the lack of data on the release of AgNPs into water and soil, along with the absence of standardized protocols for analyzing them in environmentally relevant samples and concentrations, raises concerns regarding their environmental impact and potential human exposure. In this context, analytical techniques for NP characterization are essential. Single particle ICP-MS (SP-ICP-MS) has emerged as a powerful tool for the detection of nanoparticles in aqueous solutions. Nevertheless, further studies are required to optimize and expand the application of this technique. This study aims to optimize a SP-ICP-MS method for the detection of AgNPs in water samples. The following aspects were evaluated: detection of AgNPs through adequate signal-to-noise separation; transport efficiency, size limit of detection (LOD_{size}); and the ability to distinguish nanoparticles of different sizes within the same suspension. The optimized method enabled the detection of AgNPs as small as 12 nm at environmentally relevant concentrations (in the ppt range). It was also possible to distinguish between AgNPs of 50 and 80 nm within the same sample. The optimized methodology was then applied to water samples collected from the ABC Paulista region (Brazil), along downstream sections of the Tamanduateí River and nearby residential, industrial, and tourist zones as a proof of concept. The addition and recovery study with commercial AgNPs confirmed the applicability of the method for environmental samples. No AgNPs were detected in the collected water samples of the ABC Paulista region, indicating no health risk regarding AgNPs exposure. These findings help address existing gaps in analytical methods for detecting metallic nanoparticles and may contribute to the monitoring of AgNPs and other NPs in environmental samples.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-162871: Potentially toxic metals in water, sediments, and fish from an urban river in southeastern Brazil

Renata Tatsuco Silva Fukuwara *, Caroline Cristine Augusto and Bruno Lemos Batista

Department of Chemistry, Federal University of ABC, Santo André, São Paulo, Brazil

The presence of potentially toxic metals in aquatic environments is a growing concern, particularly in urban and industrialized regions where anthropogenic activities intensify contamination. Metals such as Pb, Cd, and Hg are especially relevant due to their persistence, bioaccumulation potential, and adverse effects on aquatic ecosystems and human health. This study quantified Pb, Cd, and Hg concentrations in water, sediments, and fish from an urban river segment in Santo André, São Paulo State, Brazil. To date, no systematic monitoring of metal contamination has been reported for this river, highlighting the novelty of this biomonitoring assessment. Surface water samples were collected at three sites spaced approximately 200m apart, and sediment samples were obtained at two intermediate locations. Sampling was conducted during the rainy (February) and dry (August) seasons to evaluate seasonal variability. Fish were collected during the rainy period; no specimens were found during the dry season due to a previously reported mass mortality event. Metal accumulation in fish was assessed separately in muscle and skin tissues. Metal concentrations were determined using inductively coupled plasma mass spectrometry (ICP-MS). In surface water, metal concentrations reached up to 7 ppb, whereas sediment concentrations reached values as high as 10,000 ppb. Pb and Cd were detected in all matrices, while Hg was detected only in sediments and fish tissues. Higher concentrations were observed in sediments and biota compared to the water column, indicating accumulation processes and potential trophic transfer. Metal concentrations increased by at least 20% during the dry period, and analysis of variance (ANOVA) confirmed significant seasonal differences. These results indicate concerning levels of metal contamination in this metropolitan river system, highlighting potential ecological risks and human health implications related to water use and fish consumption. This study provides essential baseline data for future environmental monitoring in urban tropical rivers.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-157982: Preliminary insights into macroinvertebrate communities associated with floating islands in two rivers under distinct anthropogenic pressures

Nathália Ferreira ^{1,*}, Isabel Sá ¹, Clotilde Nogueira ¹, Ivone Fachada ², Cristina Calheiros ³ and Ana Maria Antão-Geraldes ⁴

¹ Bragança Ciência Viva Science Center, Rua do Beato Nicolao Dinis, Bragança, 5300-130, Portugal

² Ciência Viva – National Agency for Scientific and Technological Culture, Largo José Mariano Gago No. 1, Parque das Nações, Lisbon, 1990-073, Portugal

³ Interdisciplinary Centre of Marine and Environmental Research (CIMAR), University of Porto, Avenida General Norton de Matos, S/N, Matosinhos, 4450-208, Portugal

⁴ CIMO, LA SusTEC, Instituto Politécnico de Bragança, Campus de Santa Apolónia, Bragança 5300-253, Portugal

Floating islands are bioengineering structures vegetated with riparian plant species that replicate natural ecological functions in degraded aquatic environments. As Nature-Based Solutions, these structures create new microhabitats that can support biological recolonization, enhance ecological connectivity, and provide new opportunities for environmental monitoring. In the context of the Bio Ilhas project, pilot floating islands were installed in two fluvial systems under distinct anthropogenic pressures: the Fervença River, an urban and heavily modified watercourse, and the Côa River, located in an agricultural-natural landscape but with longitudinal connectivity disrupted by dams. The primary objective of this study is to compare the composition and structure of aquatic macroinvertebrate communities associated with floating islands and adjacent non-island areas in both rivers. Additionally, it aims to compare the species present in each system, identify taxa, and assess differences in richness, relative abundance, and functional feeding groups. To complement the biological analysis, available water-quality data (including physical and chemical parameters such as dissolved oxygen, nutrients, temperature, pH, and conductivity) were integrated to characterize the sampling sites and to contextualize macroinvertebrate sensitivity as bioindicators. Preliminary observations indicate that the macroinvertebrate communities in the Côa River were almost exclusively dominated by Astacidea (invasive crayfish). In contrast, the Fervença River exhibited greater taxonomic variability, primarily represented by organisms from the orders Crustacea, Mollusca, Hirudinea, and Odonata. This approach aims to determine whether floating islands support more diverse and sensitive communities than areas without islands, and to understand how different anthropogenic pressures, urban impacts in the Fervença, and hydromorphological alterations in the Côa influence patterns of colonization and ecological tolerance.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-159033: Quantifying Anthropogenic CO₂ Influence on the Inorganic Carbon Cycle in Cape Cod Bay via Multi-Linear Regression and Machine Learning Models

Jiahao Li ^{1,*} and Ryan Woosley ²

¹ Department of Earth System Science, University of California, Irvine, California, USA

² Department of Earth, Atmospheric, and Planetary Sciences, MIT, Cambridge, Massachusetts, USA

Coastal acidification—the near-shore manifestation of ocean acidification—remains far less constrained than open-ocean chemistry, especially in semi-enclosed systems such as Cape Cod Bay (CCB). As anthropogenic CO₂ emissions continue to rise, resolving local variability in carbonate chemistry has become increasingly important. Compared with the neighboring Gulf of Maine, CCB displays much greater fluctuations in parameters like in situ pH_i, total alkalinity (TA), and dissolved inorganic carbon (DIC), driven by freshwater inputs, submarine groundwater discharge (SGD), and stronger biological and human influences. In this work, we construct predictive models for TA, DIC, and pH at 20 °C using multilinear regression and machine learning algorithms trained on in situ observations. These predictions are then used in CO2SYS to estimate pH_i with very high accuracy (mean residual 0.0001; standard deviation 0.1). Using the modeled carbonate fields, we generate basin-wide maps of calcite and aragonite saturation states for the entire bay through spatial interpolation. Our results indicate that the inorganic carbon system of Cape Cod Bay is governed by the combined effects of seasonal air–sea CO₂ fluxes, terrestrial inputs, and water-mass retention, making it an acidification hotspot that differs markedly from the Gulf of Maine. Locally trained predictive models outperformed ESPER's regional products, underscoring the importance of site-specific approaches. Together, these findings provide new perspectives on coastal carbon dynamics and establish a scalable framework for forecasting carbonate chemistry in other nearshore environments.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-162789: Quantitative assessment of radiocesium transfer processes from soil to plant for appropriate remediation of radioactive contamination in Moroccan semi-arid agricultural areas

Samira El Aoudi ^{1*}, Abdelmourhit Laissaoui ¹, Radouan Saadi ¹, Zineb El Mouridi ² and Moncef Benmansour ¹

¹ National Center for Energy, Sciences and Nuclear Techniques (CNESTEN), Rabat 10000, Morocco

² National Institute of Agricultural Research (INRA), BP 6356, CRRA Rabat, Av. Al Irfane, 10100 Rabat, Morocco

The release of radionuclides during nuclear accidents poses significant environmental risks, with cesium being one of the most critical due to its radiological hazards and potential impacts on agriculture. This study aims to monitor and predict the uptake and fate of radioactive cesium in soils and plants within a Moroccan semi-arid agricultural ecosystem using controlled pot experiments. Soil samples were collected from a semi-arid region in Rabat-Salé. The study involved a diverse range of plants, including carrots, beets, broad beans, green beans, mint, coriander, radishes, zucchini, barley, soft wheat, garlic, celery, parsley, cauliflower, green peppers, and tomatoes. Pots were maintained in a greenhouse under controlled temperature and periodically irrigated. Samples from roots, shoots, flowers, stems, and grains (or seeds) were collected and analyzed by ICP–Mass Spectrometry. The results show that in cereals, soft wheat accumulates more Cs-133 in the roots (TF = 1.14) than in the stems and shoots (TF = 0.08), indicating preferential retention in the root system. Leafy vegetables displayed strong variability: parsley showed extremely high root accumulation (TF = 42.45), while mint accumulated Cs-133 mainly in leaves and stems (TF = 19.93). Conversely, species such as coriander and celery exhibited moderate and more evenly distributed transfer coefficients. Among non-leafy vegetables, zucchini exhibited high Cs-133 accumulation in roots (TF = 20.13), whereas tomato showed very low uptake in all tissues (TF = 0.1). For legumes, white bean showed moderate accumulation in leaves, roots, and stems, but a very high transfer to seeds (TF = 32.36). Finally, among root crops, radish displayed exceptionally high transfer to leaves (TF = 34.9) despite low root uptake (TF = 0.62), while beet and carrot also showed notable transfer, primarily to aerial parts. These findings highlight significant interspecific variability in cesium uptake and translocation, providing essential insights for predicting contamination pathways and guiding remediation strategies in semi-arid agricultural systems.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-158420: Satellite-Based Detection of Oil Spill in Niger Delta Region

Blessing Esther Kadiri

Department of Remote Sensing and GIS, School of Earth and Mineral Sciences, Federal University of Technology Akure (FUTA), Akure 340001, Nigeria

Oil spills in the Niger Delta have caused persistent environmental degradation, affecting ecosystems, water bodies, farmlands, and human livelihoods. This study assessed oil spill vulnerability across the Rivers, Bayelsa, and Delta States using Sentinel-1 Synthetic Aperture Radar (SAR) imagery and Geographic Information Systems (GIS). A specific oil spill incident recorded on December 24, 2024, guided the selection of pre- and post-spill SAR images for analysis. The difference in SAR backscatter values was used to detect oil-impacted areas. Ancillary data, including soil maps (HWSD), land use/land cover (LULC), digital elevation model (DEM), slope, river network, proximity to water bodies, and spill points, were integrated into the analysis.

Each dataset was reclassified into vulnerability levels and weighted using the Analytical Hierarchy Process (AHP). A consistency ratio of less than 0.1 validated the pairwise comparison matrix. A weighted overlay analysis was conducted in ArcMap to generate a comprehensive oil spill vulnerability map. The results revealed that 21.6% of the study area fell under high- and very-high-vulnerability zones, concentrated around southern Rivers State (Bonny axis), central Bayelsa (Yenagoa and Ogbia LGAs), and western Delta State (Warri South and Ughelli). Low-lying regions and areas within 0–2 km proximity to spill points and major rivers such as Nun, Forcados, and Bonny were the most affected. Agricultural lands and wetlands accounted for over 40% of the vulnerable zones, highlighting the risks to food security and biodiversity. Proximity and buffer analyses further emphasized that areas closest to spill sources and water bodies experienced the highest contamination risk.

This study demonstrates the effectiveness of combining SAR imagery with AHP-GIS techniques in assessing oil spill vulnerability and provides critical spatial evidence to support environmental decision-making, targeted remediation, and emergency response planning in the Niger Delta.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-155075: Spatio-Temporal Assessment of NO₂ Pollution in Bangladesh

Sk. Tanjim Jaman Supto, Md. Nurjaman Ridoy and Sabbir Hossain *

Department of Environmental Research, Nano Research Centre, Sylhet, 3114, Bangladesh

Anthropogenic air pollution represents a significant threat to both environmental and human health, with nitrogen oxides (NO_x) playing a substantial role in the formation of photochemical smog, acid rain, eutrophication, and respiratory diseases. In Bangladesh, NO_x emissions primarily originate from combustion sources such as road transportation, power generation, and industrial activities, while natural sources include lightning, wildfires, and soil emissions. Furthermore, ammonia emissions from fertilizers and livestock exacerbate air quality issues in both urban and rural settings. Despite the acknowledgment of vehicular and industrial contributions, comprehensive and systematic assessments of NO₂ trends across the nation remain scarce. This study integrates ground-based NO₂ measurements from the Department of Environment (DoE) with atmospheric NO₂ retrieved from the Sentinel-5P TROPOMI Level-3 product via Google Earth Engine (GEE) for 2024. Spatial distribution patterns of both ground-level and atmospheric NO₂ were analyzed using ArcGIS Pro, along with seasonal and decadal trend assessments from 2015 to 2024. Results indicated pronounced spatial and temporal variability in NO₂ concentrations. The highest levels were consistently recorded over Dhaka and surrounding industrial zones, with moderate accumulation in Chattogram. Winter months (December–February) exhibited hazardous concentrations, including a peak of 212 µg/m³ in Sylhet in 2016, while monsoon periods recorded the lowest levels, such as 0.46 µg/m³ in Khulna in May 2017. Seasonal averages indicated the highest concentrations in autumn (35.13 µg/m³), followed by winter (25.67 µg/m³), with November recording the maximum monthly mean (38.94 µg/m³). Long-term analysis showed peak NO₂ levels in 2018 (34.40 µg/m³) in Chattogram, declining to 6.28 µg/m³ by 2024. These findings underscore the necessity for stricter emission regulations and targeted mitigation measures, including the implementation of NO₂-selective catalytic reduction (SCR) using NH₃ over metal oxide and zeolite catalysts. This study provides evidence-based insights to support cleaner air initiatives and sustainable environmental management strategies in Bangladesh.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-162428: Stray Dogs as Sentinels for Male Infertility: AI-Based Assessment of testicular diseases linked to environmental pollution in the Campania region

Lorenzo Riccio ^{1,*}, Maria De Falco ², Marco Trifuoggi ³, Nicola Ambrosio ⁴, Angelo Spada ⁴, Orlando Paciello ⁵ and Luigi Rosati ²

¹ Università degli Studi di Napoli Federico II - Dipartimento di Medicina Veterinaria e Produzioni Animali

² University of Naples Federico II - Department of Biology

³ University of Naples Federico II - Department of Chemical Sciences

⁴ ASL Napoli 2 Nord, DS 45 Caivano.

⁵ University of Naples Federico II - Department of Veterinary Medicine and Animal Production

Within a One Health perspective, stray dogs provide evidence of shared environmental contamination and emerge as sentinels of pollution-related infertility and carcinogenesis in exposed populations. Our work aimed to evaluate correlations between environmental pollutants, such as heavy metals (HMs), and testicular diseases in dogs. To this end, fifty male stray dogs from highly polluted areas in the Campania Region were enrolled. Testicular samples (n = 100) were processed for histological, cytological, molecular, and chemical analyses. Histopathological lesions were graded according to the Johnsen scoring system, using an EfficientNet-B4 deep learning model for automated assessment. Expression levels of 17- β -HSD and P450 aromatase were evaluated by immunohistochemistry (IHC) and Western blot (WB). Sperm chromatin was assessed by toluidine blue staining using an unsupervised k-means clustering algorithm to automatically classify chromatin status and reduce operator subjectivity. Finally, inductively coupled plasma mass spectrometry (ICP-MS) was carried out to assess HM concentrations in testes. Based on histological examination, samples were divided into three groups: A) normal testes (37%); B) testes with moderate to severe degeneration (54%), and C) testicular neoplasm (9%). Groups B and C showed significant downregulation of 17- β -HSD and upregulation of P450 aromatase compared with Group A, alongside reduced sperm chromatin condensation. ICP-MS results showed higher levels of arsenic, cadmium, lead, mercury, and tin in Group C (100%) compared with Group B (67%) and Group A (27%). Notably, all neoplastic samples displayed aberrant uranium accumulation. Our findings suggest a possible correlation between higher HM accumulation and testicular diseases in dogs from polluted areas in the Campania Region, corroborating current scientific literature indicating that HMs may have negative effects on spermatogenesis. This highlights the important role of dogs as sentinels for human reproductive health, underscoring the need for One Health surveillance to assess the silent threat of HM toxicity in the exposed human population.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-158385: Techno-Economic Optimization of Solar Photovoltaic Systems for Industrial Sustainability: A Case Study of the Kenyan Tea Sector

Eliud Kiprop ^{1,*}, Omid Tajeddini ¹ and Vincent Kipkirui ²

¹ Faculty of Liberal Arts, Lakeland University Japan, Tokyo 101-0064, Japan

² Graduate School of Engineering and Energy, Murdoch University, Murdoch, Western Australia 6150, Australia

In the transition toward a low-carbon economy, the integration of renewable energy (RE) technologies into industrial systems has become an essential component of sustainable development. In developing countries such as Kenya, where energy-intensive manufacturing sectors rely heavily on costly and carbon-intensive grid electricity, renewable energy adoption presents both a strategic and environmental imperative. This study provides one of the first integrated techno-economic analyses of solar photovoltaic (PV) and battery energy storage systems for industrial-scale application in Kenya's tea-processing sector. Using data from the Kepchomo Tea Factory, a 680 kW grid-tied solar PV system was modeled and optimized through the National Renewable Energy Laboratory's REopt platform under three design scenarios: PV only, PV with storage, and an expanded hybrid configuration. Detailed hourly load-matching, financial simulation, and sensitivity analyses on discount rates, degradation parameters, and tariff escalation were conducted to evaluate system robustness and long-term performance over a 25-year project horizon. The results indicate that the optimal configuration—a 1,513 kW PV system combined with a 712 kWh battery—achieves a 35% renewable energy share, reduces CO₂ emissions by approximately 14,387 tonnes, and generates a net present value of USD 1.68 million. Moreover, the levelized cost of energy (LCOE) analysis reveals that the hybrid system is economically competitive with grid electricity under current feed-in tariffs. Beyond site-level benefits, the study contributes a replicable methodological framework for industrial decarbonization, renewable investment appraisal, and policy formulation across sub-Saharan Africa, emphasizing the potential of distributed solar-battery systems to enhance energy security and resilience in emerging economies.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-158114: The Double Face of Gadolinium, a Rare-Earth Element (REE): A Winning Strategy for Human Health or a Potential Defeat for Non-Target Organisms?

Mariachiara Galati ^{1,*}, Sara Falvo ², Tiziana Cappello ¹, Alessandra Santillo ² and Maria Maisano ¹

¹ Department of Chemical, Biological, Pharmaceutical and Environmental Sciences, University of Messina, Messina, Italy

² Department of Environmental, Biological and Pharmaceutical Sciences and Technologies, University of Campania L. Vanvitelli, Caserta, Italy

Gadolinium (Gd), a rare-earth element (REE), has high economic potential due to its natural ferro-paramagnetic properties in electronics as a superconductor and in healthcare as a contrast agent for magnetic resonance imaging. Its exploitation, coupled with the limited capacity of wastewater treatment plants to mitigate its discharge into the environment, has led to its accumulation and persistence in marine areas exposed to human activity. Although Gd commercial forms are not toxic because they are chelated by stable molecules, upon contact with biota, they could undergo dechelation/transmetallation, thereby making Gd bioavailable. This study aims to evaluate the potential cytotoxic effects of GdCl₃ and Gd₂O₃ on the reproductive health of the Mediterranean mussel *Mytilus galloprovincialis*, following a 28-day chronic exposure to 1 and 10 µg/L of both forms, assessing the biological responses time trend (T0, T7, T15, T28) in the female and male gonads. Histological examination by H/E staining revealed intense hemocyte recruitment and early spawning events, whereas the dPAS/PAS reaction highlighted imbalances in glycogen distribution, which is crucial for gametogenesis, in both sexes. Energetic (glucose) and osmotic (betaine) pathways were altered by Gd exposure, as shown by ¹H NMR profiles. Preliminary RT-PCR data suggested that Gd influences the expression of genes critical for maturation (*Vitellogenin*, *Vtg*) and fertilization (*Vitelline Envelope Receptor for Lysin*, *VERL*). This study confirms that Gd is a potential threat to aquatic ecosystem biodiversity, an emerging micropollutant that can interfere with the reproductive capacity and survival of non-target species. It underscores the need to improve environmental policies and biomonitoring programs to protect the health of the only ecosystem of which we are all part: the Earth.

Acknowledgements

This work was supported by PRIN PNRR 2022 - CUP B53D23024710001: "GADolinium (Gd), an emergent contaminant, is a new threat to the living beings: a comparative study to assess its biological TOXcity in animal models (GADOTOX)".



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-163487: The effects of soil depth on the hydrological behaviour of a rain garden

Stefania Anna Palermo *, Michele Turco, Behrouz Pirouz and Patrizia Piro Piro

Department of Civil Engineering, University of Calabria, Rende, CS, Italy

Rain gardens are vegetated depressions that collect runoff discharged from the surrounding impervious areas. Given its specific structural configuration, proper design is crucial to limit the discharge of water from impermeable surfaces to the drainage network. Based on the hydrological processes occurring inside these systems, their capacity to collect water is affected by the soil hydraulic properties, the thickness of the layers, and the site-specific properties. Thus, the main purpose of this study is to examine how soil depth affects the hydrological response of a specific rain garden that is currently under construction in Cerisano, a small town in the Calabria region, Southern Italy. In this regard, a simple predictive SWMM model, which simulates the rain garden as a bioretention cell, was developed, and two scenarios with different soil depths of the rain garden (40 cm and 80 cm) were compared. The results show an increase in the final storage in the rain garden of about 11% and 38.5% as the soil depth increases, in response to 1-hour Synthetic Chicago hyetographs of 5- and 15-year return periods, respectively. This primary finding highlights the crucial function of the design parameters and how they can affect the hydrological behaviour of this nature-based solution. Acknowledgements: This work was funded by the Next Generation EU - Italian NRRP, Mission 4, Component 2, Investment 1.5, call for the creation and strengthening of 'Innovation Ecosystems', building 'Territorial R&D Leaders' (Directorial Decree n.2021/3277) - project Tech4You - Technologies for climate change adaptation and quality of life improvement, n.ECS0000009. This work reflects only the authors' views and opinions; neither the Ministry for University and Research nor the European Commission can be considered responsible for them. We would like to thank the Municipality of Cerisano (town in the province of Cosenza, Italy) for supporting these project activities as stakeholder.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-142737: Tiny plastics, Big impact: *Mytilus galloprovincialis* as a Microplastic Sentinel in the Bulgarian Black Sea

Vesela Yancheva

Department of Ecology and Environmental Conservation, Faculty of Biology, Plovdiv University, 4000 Plovdiv, Bulgaria

The Black Sea suffers from pollution originating mainly from land-based sources. The sea receives plastic waste from three major transboundary rivers – the Danube, Don, and Dnieper. Additionally, plastic debris of all sizes (macro, meso, micro, and nanoplastics) can carry various anthropogenic toxicants, such as heavy metals and persistent organic pollutants, over long distances, and they can also leach hazardous substances like bisphenol A and phthalates. The negative effects of MPs on aquatic organisms, resulting from plastic ingestion or entanglement, are already well documented globally. However, comprehensive studies on the ecological status of the Black Sea in Bulgaria are extremely scarce, especially those that include analysis of MP content in commercially important mussel species, surface waters, and sediments. The scientific hypothesis we have formulated is that the Black Sea and mussels are contaminated with MPs. Therefore, the main goal of this project is, for the first time in Bulgaria, to investigate and assess the quantity and composition of MPs in commercially important mussels, waters, and sediments from the Black Sea area, and their negative impact. Emerging contaminants such as MPs require innovative analysis techniques. The environmental samples will be sent to an accredited laboratory, and quantum cascade laser spectroscopy will be used (the Agilent 8700 Laser Direct Infrared Chemical Imaging System). The mussels will also be studied for a set of biomarkers. Last but not least, an assessment will also be conducted on the potential risk to human health associated with the consumption of Black Sea mussels contaminated with MPs.

Acknowledgements

This study is financed by the Department of Scientific Research of University of Plovdiv, project MUPD25BF001 – “Research and assessment of the quantity, composition, and size of microplastic particles in commercially important mussels from the Black Sea area, their negative impact on specific biomarkers, and the risk to human health”.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-162899: Toxic, Essential, and Rare Earth Element Exposure from Chocolate: A Human Health Risk Assessment

Cinthyia Costa Lopes ^{1,*}, Caroline Cristine Augusto ¹, Maycom Cezar Valeriano ¹,
Mónica Benicia Mamián-López ¹, Vera Slaveykova ², Bruno Lemos Batista ¹ and Tatiana Pedron ¹

¹ Center for Natural and Human Sciences, Federal University of ABC, Santo André, 09280-560, Brazil

² Department F.-A. Forel for Environmental and Aquatic Sciences, University of Geneva, 66 Boulevard Carl-Vogt, CH-1211 Geneva, Switzerland

Cacao (*Theobroma cacao*) serves as the foundational raw material for all chocolate production. The burgeoning scientific interest in chocolate is driven not only by its substantial economic value but also by its complex nutritional profile and the potential benefits associated with its high cacao content. However, the co-occurrence of beneficial bioactive compounds with potentially toxic elements is a food safety concern. Consequently, this study was designed to quantify the concentrations of trace elements across a broad spectrum of commercially available chocolates (ranging from $\leq 40\%$ to 92% cacao content) procured from Brazilian markets, and to rigorously assess the associated human health risk using the estimated daily intake (EDI) and the target hazard quotient (THQ). A total of thirty-two samples were analysed for Al, Mn, Fe, Zn, Se, As, Cd, Pb and Hg, and rare earth elements (REEs) using Inductively Coupled Plasma Mass Spectrometry (ICP-MS). The maximum measured concentrations were observed for Fe ($438.23 \text{ mg kg}^{-1}$), Cd ($672.69 \text{ } \mu\text{g kg}^{-1}$) and Ce ($114.76 \text{ } \mu\text{g kg}^{-1}$) in chocolates with $80\text{--}82\%$ cacao content. The maximum EDI values for the essential and non-essential elements Mn, Fe, Zn, and Se were calculated as 0.02 , 0.78 , 0.15 and $0.03 \text{ mg kg}^{-1} \text{ body weight day}^{-1}$, respectively, while Al reached $0.04 \text{ mg kg}^{-1} \text{ body weight day}^{-1}$. For the toxic elements As, Cd, Hg, and Pb, the maximum EDI values were 0.02 , 0.27 , 0.01 and $0.03 \text{ } \mu\text{g kg}^{-1} \text{ body weight day}^{-1}$, respectively. These elevated levels, particularly high in 70% and 82% cacao samples, suggest potential health risks. Despite these findings, the calculated THQ values for Al, As, Cd, Hg, and Pb remained below the threshold of 1. Principal component analysis (PCA) revealed a clear and significant relationship between cacao content, element levels, and the geographical origin of the samples. These results unequivocally underscore the critical need for simultaneous monitoring of both elemental composition and cacao percentage to effectively mitigate consumer exposure to toxic contaminants and ensure food safety standards.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-157047: Tracing Anthropogenic and Volcanic CO₂ Emissions through Isotopic Monitoring: Insights from Mediterranean Urban and Volcanic Environments

Roberto Di Martino *, Sergio Gurrieri and Marcello Liotta

Istituto Nazionale di Geofisica e Vulcanologia, Sezione di Palermo, Palermo 90146, Via Ugo La Malfa, Italy

Human activities profoundly influence environments, generating multiple impacts and risks at diverse spatial and temporal scales. Among these, climate change—driven primarily by rising atmospheric CO₂—represents one of the most critical global challenges.

The Mediterranean region, already affected by droughts, wildfires, and biodiversity loss, is particularly sensitive to changes in carbon fluxes owing to its dense urbanization and active volcanic zones. Anthropogenic CO₂ emissions dominate the global carbon budget, whereas volcanic degassing contributes a minor but persistent fraction that can locally alter atmospheric composition on short timescales. Disentangling these overlapping sources is essential for accurate environmental impact and risk assessments.

This study presents isotopic investigations of carbon and oxygen in CO₂ ($\delta^{13}\text{C}$ and $\delta^{18}\text{O}$) to distinguish anthropogenic from volcanic and biogenic emissions in both urbanized and remote areas of the Mediterranean region. Data collected within the *Atmospheric Carbon and Oxygen Laboratory (ACO-Lab)* and its *Gradient in Atmospheric Urban Dome (GraDo)* side project—coordinated by the Istituto Nazionale di Geofisica e Vulcanologia—reveal that carbon isotope ratios reveal the origin of CO₂ emissions. In contrast, oxygen isotope variations display moderate dependence on altitude and vegetation cover.

These results highlight the value of isotopic fingerprinting as a suitable monitoring tool for assessing the environmental impact of CO₂ emissions, improving our ability to quantify anthropogenic contributions, investigating dependencies among biogenic cycles, and supporting strategies for mitigation and sustainable urban management in regions influenced by a combination of natural degassing and anthropogenic pollution.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-152680: Tracing Anthropogenic Gadolinium in Portugal: Baseline Survey Across Five Transition Aquatic Systems

Pedro Aboim Brito ^{1,2}

¹ IPMA – Portuguese Institute for Sea and Atmosphere, I.P., Av. Alfredo Magalhães Ramalho 6, 1495-165 Algés, Portugal

² CIIMAR/CIMAR-LA, Interdisciplinary Center for Marine and Environmental Research, University of Porto, Leixões Cruise Terminal, Av. General Norton de Matos s/n, 4450-208 Matosinhos, Portugal

Anthropogenic gadolinium, mainly from gadolinium-based contrast agents (GBCAs) used in magnetic resonance imaging, is increasingly recognised as a persistent contaminant in aquatic environments. These chelated compounds are excreted largely unmetabolized and pass through conventional wastewater treatment systems, leading to detectable anomalies in rivers, estuaries, groundwater, and even tap water. Their high stability ensures conservative transport over large spatial and temporal scales. Still, environmental transformation processes may release toxic-free Gd^{3+} ions, raising concerns about ecological impacts, such as sorption to sediments and bioaccumulation. Despite these risks, Gd anomalies serve as valuable hydrogeochemical tracers, enabling the tracking of wastewater plumes, groundwater–surface water interactions, and urbanisation pressures. This dual role—emerging pollutant and useful tracer—has placed anthropogenic Gd under increasing scientific and regulatory scrutiny, yet it remains largely unregulated in water policy.

Addressing this gap, the present study provides the first Portuguese survey of anthropogenic Gd through a multi-basin sampling campaign across five transition aquatic systems: the River Mondego, River Sado, and River Mira (fluvial), and the Ria de Aveiro and Lagoa de Albufeira (lagoon). Through a multi-basin sampling campaign, rare earth element signatures were analysed across five hydrographic basins to establish baseline anthropogenic Gd concentrations, identify potential hotspots associated with urban and hospital effluents, and evaluate the implications of its presence for both water management and environmental health.

Results reveal marked spatial variability in anthropogenic Gd, ranging from 0.32 to 16.9 ng/L, with the highest anomalies detected downstream of densely populated and hospital-influenced areas ($Gd/Gd^* > 1.5$). In contrast, more pristine regions exhibited background signatures ($Gd/Gd^* < 1.5$). These findings not only establish a baseline for anthropogenic Gd concentrations in Portugal but also highlight its dual role: as a promising management tool for tracing wastewater pathways, and as an emerging contaminant with potential ecological implications.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-157427: Urban River Contamination Case Study: Spatial–Temporal Dynamics of Emerging Contaminants in the Fervença River (Bragança, Portugal)

Alena Voznakova ^{1,*}, Ana Maria Antao-Geraldes ² and Moisés Canle ³

¹ Department of Chemistry, Faculty of Science, Campus de Zapateira, University of A Coruña, A Coruña 15071, Spain

² CIMO, LA SusTEC, Instituto Politécnico de Bragança, Campus de Santa Apolónia, 5300-253 Bragança, Portugal

³ Departamento de Química, Facultade de Ciencias & CICA, Universidade da Coruña, E-15071 A Coruña, Spain

Urban rivers are subject to multiple anthropogenic pressures, particularly those associated with wastewater discharges and diffuse inputs from urbanized catchments. This study investigates the occurrence and spatial-temporal patterns of emerging contaminants in the Fervença River (Bragança, NE Portugal), with a specific focus on the influence of the municipal wastewater treatment plant (WWTP). Three riverine sampling sites were selected to represent upstream rural conditions, urban influence, and downstream areas receiving WWTP effluent. An additional sampling point was included at the WWTP discharge. Water and sediment samples were collected during four campaigns: one dataset from 2018 and three sampling campaigns conducted in March, May, and September 2024.

The analyses targeted a set of pharmaceutical products using HPLC-MS. Physicochemical parameters were also recorded *in situ*. The results show (i) a marked increase in contaminant concentrations in the urban section, (ii) the persistent detection of certain pharmaceutical products downstream of the WWTP, indicating incomplete removal, and (iii) differences in contaminant profiles between water and sediments, suggesting specific partitioning behavior of the compounds and possible long-term accumulation in benthic compartments. Comparison of data from 2018 and 2024 suggests temporal variability potentially related to changes in urban water use patterns and treatment efficiency.

This case study highlights the vulnerability of small urban rivers to wastewater-related contamination and the importance of integrating sediment monitoring to capture the environmental persistence of emerging contaminants. Findings contribute to a better understanding of contaminant dynamics in urban systems and support evidence-based management strategies to mitigate chemical pressures in freshwater environments.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

Session 3. Terrestrial and Marine Biodiversity and Habitat Loss Prevention

sciforum-162630: Sublethal Nitrite Levels Reshape Metabolic Activity and Redox Homeostasis in Zebrafish

Maria Teresa Muscari Tomajoli ^{1*}, Eugenio Geremia ¹, Gianluca Fasciolo ², Adriana Petito ², Claudio Agnisola ², Carlos Gravato ^{3,4}, Paola Venditti ² and Gaetana Napolitano ¹

¹ International PhD Programme, UNESCO Chair “Environment, Resources and Sustainable Development”, Department of Science and Technology, Parthenope University of Naples, 80143 Naples, Italy

² Department of Biology, University of Naples Federico II, Naples, Italy

³ Departamento de Biologia Animal, Faculdade de Ciências da Universidade de Lisboa (FCUL), Campo Grande, 1749-016 Lisboa, Portugal

⁴ Centre for Ecology, Evolution and Environmental Changes (cE3c) & CHANGE–Global Change and Sustainability Institute, Faculdade de Ciências da Universidade de Lisboa FCUL, Campo Grande, 1749-016 Lisboa, Portugal

Nitrite contamination in environments, largely driven by human activity, can disrupt multiple physiological functions in fish. In freshwater species, nitrite is readily absorbed across the gills, accumulating internally and interfering with the oxygen-carrying capacity of blood. Here we evaluated the effects of 72-hour exposure to a moderate environmental nitrite concentration (10 μ M) on zebrafish (*Danio rerio*), a well-established model to study the physiology of freshwater fish. Specifically, the study examined changes in routine metabolism (rMO_2), the oxygen consumption of fish at rest and in a fasted state but with spontaneous basal activity, spontaneous activity, and in the percentages of blood oxyhemoglobin (HbO_2), metHb, and nitrosyl hemoglobin ($HbNO$, an index of NO level in the blood), as well as the effects on mitochondrial respiratory chain activity (ETC), oxidative metabolism, ROS content, lipid peroxidation levels and antioxidant defense responses of the muscle tissue. The amount of nitrite accumulated within the muscle was also measured.

The moderate, environmentally relevant concentration of nitrite reduced rMO_2 and spontaneous activity, while increasing $HbNO$, indicating enhanced NO formation. Nitrite also accumulated in muscle, where it promoted oxidative stress and altered aerobic metabolism, including an increase in mitochondrial efficiency, antioxidant capacity. These changes reflected coordinated metabolic adjustments.

In conclusion, acute exposure to a moderate environmental concentration of nitrite induces nitrite accumulation in skeletal muscle and alters muscular metabolism and the redox state of adult zebrafish. The results underscore the sensitivity of fish to nitrite levels commonly encountered in impacted freshwater habitats.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-158045: Development of a National Reference DNA Barcode Library Integrating Long-Term Taxonomic Records for Korean Native Species

Jumin Jun

Species Diversity Research Division, Biodiversity Research Department, National Institute of Biological Resources 42 Hwangyeong-ro, Seo-gu, Incheon, 22689, Republic of Korea

Reliable species identification is fundamental for biodiversity assessment, ecological monitoring, and conservation management. In Korea, voucher-based taxonomic and genetic information has been accumulated since 2008 through multiple biodiversity survey programs led by the National Institute of Biological Resources (Ministry of Environment). Since 2008, DNA barcode data for native species have been steadily generated through national-scale biodiversity initiatives, enabling continuous expansion of taxonomic and genetic coverage. The project targets taxa that require accurate species-level verification, including endemic and endangered species, legally managed wildlife, industrially important organisms, and CITES-regulated species. DNA barcode sequences are generated using standard regions—COI for animals; *rbcL*, *matK*, and ITS for plants; ITS for fungi; 18S for microalgae and *rbcL* for macroalgae—and sequence records are linked to preserved voucher material curated in national repositories. When standard barcode markers do not provide sufficient resolution, supplementary mitochondrial or nuclear genes are incorporated. To date, more than 11,604 species have been validated through combined morphological and molecular evidence. In several cases, barcode data corrected misidentified records in specimen documentation, including CITES-listed individuals requiring legal verification. The resulting reference library is now supporting biodiversity surveys, forensic species identification, and decision-making in national conservation policies. By integrating expert taxonomy with molecular genetics, this project provides a robust foundation for future applications, including environmental DNA monitoring and genomic-scale biodiversity research in Korea.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-158567: Modelling the tree height–diameter relationship of a riparian species in its limit range: *Alnus glutinosa* (L.) Gaertn

Abdelouahab Sahli

Department of biology, Faculty of Sciences, Abdelmalek Essaâdi University, BP 2062, 93030 Tetouan, Morocco

A deeper understanding of the relationship between height and diameter (H-DBH) is crucial for enhancing forest monitoring and management, as well as for improving forest growth. *Alnus glutinosa* is particularly important ecologically in riparian ecosystems. However, no H-DBH models are currently available for this species. In this paper, we compared the 40 most commonly used models for predicting tree height, as published by various authors, to select the model that best predicts the height of *Alnus glutinosa*. We collected information on every tree in 20 randomly selected plots per population, each measuring 30 x 30 m, from twelve populations. The diameter at breast height and the dominant height of each tree were measured. The results showed that composite models performed better in height estimation. The five models that performed best in predicting tree height (those with the lowest AIC values) were m15 (AIC = 4473.1), m18 (AIC = 4463.9), m19 (AIC = 4425.2), m25 (AIC = 4425.2), and m37 (AIC = 4425.2). These models are recommended for predicting tree height in *Alnus glutinosa* plantations with a DBH range of 6.68–68.43 cm, provided that DBH data are available for each tree, as well as QMD and mean height (H). The analysis showed that reciprocal-transformed models, especially $H=1.3+e^{(a+(b/DBH+1))}$, $H=a/(b+e^{-c \times DBH})$, and $H=2/(a+b \times DBH+c \times DBH^2)$ worked best, with these models doing better than logistic, polynomial, and exponential forms. The parameters of the models varied according to the model. These results help us to select models for forest inventory systems and emphasize the importance of using transformations.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-162908: Trace Metal Bioaccumulation and Redox Imbalance in *Mytilus galloprovincialis* from the Gulf of Pozzuoli (Italy)

Maria Carolina Martone ^{1,*}, Federica Ferrigno ², Luigia Donnarumma ¹, Luca Appolloni ³, Laura Fortunato ⁴, Roberto Sandulli ⁴, Eugenio Geremia ¹, Sara Esposito Marroccella ¹, Maria Teresa Muscari Tomajoli ¹, Gaetana Napolitano ¹, Yuri Cotroneo ⁴, Giorgio Budillon ⁴, Juri Rimauro ⁵, Elena Chianese ⁴ and Paola Venditti ⁶

¹ International Ph.D. Program, UNESCO Chair “Environment, Resources and Sustainable Development”, Department of Science and Technology, Parthenope University of Naples, 80143 Naples, Italy

² Department of Science and Technology, Parthenope University of Naples - LRU CoNISM, Centro Direzionale, Isola C4 - 80143 Naples (NA), Italy

³ Biodiversity and Ecosystems Laboratory ENEA Santa Teresa Research Centre Pozzuolo di Lerici, 19032 San Terenzo (SP), Italy

⁴ Department of Science and Technology, Parthenope University of Naples, Centro Direzionale, Isola C4 - 80143 Naples (NA), Italy

⁵ Laboratory of Impacts on Territory and Developing Countries ENEA Portici Research Centre Piazzale Enrico Fermi, 1 80055 Portici (NA), Italy

⁶ Department of Biology, University of Naples Federico II, 80143 Naples, Italy

Mussel farming is a major sector of Italian aquaculture, primarily based on the Mediterranean mussel *Mytilus galloprovincialis* (Lamarck, 1819). For an ecological perspective, this species is used as a sentinel organism due to its filtration capacity and ability to bioaccumulate contaminants. Within the AMICA project, a multidisciplinary study was conducted at a mussel farm in the Gulf of Pozzuoli, a well-known area under anthropogenic pressure, to investigate mussel physiological stress and metal accumulation. Shell length was measured in mussels collected in June 2024, from three farming ropes (R1, R2, R3). Trace metals (Al, As, Cd, Co, Cr, Cu, Fe, Ni, Pb, U, V, Zn) were quantified by ICP-MS in intervalvar waters and dried soft tissues. These matrices showed distinct patterns: intervalvar waters reflected ambient metal levels, whereas tissues acted as biological accumulators. Zn was markedly enriched in intervalvar waters, consistent with tight regulation, while Fe and V were substantially higher in tissues, suggesting greater retention. To link chemical patterns to physiological status, gill tissues were analysed for redox homeostasis by measuring Reactive Oxygen Species (ROS), lipid hydroperoxides (HPs), protein carbonyls (CO), in vitro susceptibility to oxidation (Δ HPs), and Total Antioxidant Capacity (TAC). ROS levels did not differ significantly among groups, although R3 showed a slight increase accompanied by higher HPs and Δ HPs, indicating enhanced oxidative pressure. CO remained stable, while TAC increased in R2 and R3, suggesting activation of antioxidant defences. These responses align with the elevated accumulation of V, Fe and Zn in R3, pointing to metal-induced oxidative stress. Size-class analyses further showed that larger individuals accumulated higher metal concentrations, confirming size-dependent bioaccumulation. Overall, the mussel farm appears influenced by environmental conditions of the study area, and the integrated chemical-physiological evidence provides a valuable baseline for understanding contaminant dynamics and ensuring the quality and safety of *M. galloprovincialis*.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-147028: Aquatic Flora of Lake Texcoco, Mexico: Diversity, Endemism, Exotic Species, and Conservation Perspectives

Hugo López-Camarillo ^{1,*}, Alexis Josué Sánchez-Lara ² and Isolda Luna-Vega ³

¹ Department of Evolutionary Biology, Faculty of Sciences, Universidad Nacional Autónoma de México, Circuito de la Investigación Científica, Ciudad Universitaria, Coyoacán, 04510 Mexico City, Mexico

² Laboratory of Aquatic Plants, Faculty of Sciences, Universidad Autónoma del Estado de México, Campus El Cerrillo, Supermanzana Carretera Km 15.5, Piedras Blancas, 50200 Toluca de Lerdo, Mexico

³ Department of Evolutionary Biology, Laboratory of Biogeography and Systematics, Faculty of Sciences, Universidad Nacional Autónoma de México, Circuito de la Investigación Científica, Ciudad Universitaria, Coyoacán, 04510 Mexico City, Mexico

Lake Texcoco, located in the State of Mexico, is one of the most distinctive wetlands in the Basin of Mexico due to its brackish, alkaline sediments, which support a highly specialized aquatic flora uniquely adapted to these conditions. Despite its ecological relevance and historical importance, studies on its plant diversity remain scarce and fragmented. To provide an updated perspective, we conducted a taxonomically curated review of the literature published between 1957 and 2022, compiling a comprehensive checklist of aquatic species for this wetland. The survey revealed a richness of 97 species: 40 obligate aquatics, 24 subaquatics, and 33 tolerant taxa. Within this flora, 24 are halophytes, 46 are freshwater species, and 28 are salinity-tolerant; notably, 81 species are native to Mexico (including eight endemics), while 16 are introduced, six of which are recognized as invasive. These results highlight both the ecological richness and the system's vulnerability to environmental change. The absence of a complete hydrophyte inventory underscores the urgent need for further research, particularly on the physiology of halophytes, the restoration potential of native taxa in degraded habitats, and the ecological interactions shaping aquatic communities. Recognizing Lake Texcoco as an ecological refuge emphasizes not only its conservation value but also its role as a natural laboratory for understanding aquatic biodiversity and as a guide for future restoration strategies in central Mexico.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-147029: Aquatic Flora of the Mexico Megalopolis Wetlands: Diversity, Knowledge Gaps, and Conservation Challenges

Hugo López-Camarillo ¹, Alexis Josué Sánchez-Lara ^{2,*}, Nadia Elizabeth Siordia-González ³ and Isolda Luna-Vega ⁴

¹ Department of Evolutionary Biology, Faculty of Sciences, Universidad Nacional Autónoma de México, Circuito de la Investigación Científica, Ciudad Universitaria, Coyoacán, 04510 Mexico City, Mexico

² Laboratory of Aquatic Plants, Faculty of Sciences, Universidad Autónoma del Estado de México, Campus El Cerrillo, Supermanzana Carretera Km 15.5, Piedras Blancas, 50200 Toluca de Lerdo, Mexico

³ Centro Universitario de Ciencias Biológicas y Agropecuarias, Universidad de Guadalajara, Camino Ramón Padilla Sánchez 2100, Las Agujas, 44600 Zapopan, Jalisco, Mexico

⁴ Department of Evolutionary Biology, Laboratory of Biogeography and Systematics, Faculty of Sciences, Universidad Nacional Autónoma de México, Circuito de la Investigación Científica, Ciudad Universitaria, Coyoacán, 04510 Mexico City, Mexico

Within the Mexico Megalopolis, there are wetlands of high hydrological, historical, cultural, and ecological value, yet their role has often been relegated in the face of urban and human demands. Knowledge of their aquatic flora is limited and even scarcer regarding the species that once inhabited the great lakes now covered by cities. The aim of this contribution is to provide a synthesis that broadens the perspective of the wetlands of the Megalopolis, considering them not only as water reserves, but also as functional and dynamic ecosystems that sustain a diversity of hydrophytes currently threatened by climate, water, and urban crises. In the region, 537 wetlands have been recognized, although only 34 have reports on their aquatic flora, equivalent to less than 7%. These environments, often small or seasonal, constitute biodiversity oases and are essential for numerous species. However, of the 23 Protected Natural Areas located within the Megalopolis, only 13 include wetlands with documented floristic richness, among them the Ciénegas de Lerma, the Xochimilco Canals, and Lake Texcoco, some of which are designated Ramsar Sites. In total, 270 records of aquatic, subaquatic, and tolerant plants were compiled, including 206 native species (five endemic) and five listed as threatened, such as *Gentiana spathacea* and *Sagittaria macrophylla*. These results reflect both the richness and vulnerability of the Megalopolis wetlands and highlight the urgent need to strengthen their study and conservation as key biodiversity refuges in central Mexico.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-158924: Biodiversity Protection and Pollinator Conservation: An Integrated Approach of the Medibeas Project

Adjlane Nouredine ^{1,*}, Soumeys Kaouche ¹ and Raquel Martín-Hernandez ²

¹ Faculty of Science, University of Boumerdes, Boumerdes, Algeria

² Centro de Investigación Apícola y Agroambiental, Marchamalo 19180, Spain

The MEDIBEES project focuses on the preservation of bees and the protection of biodiversity in Mediterranean terrestrial ecosystems. Bees play a crucial role in pollination, maintaining plant diversity, and ensuring food security. However, they face multiple threats, including habitat loss, intensive pesticide use, climate change, and diseases. In this context, Medibeas aims to develop integrated conservation strategies to protect these pollinators and prevent the degradation of their natural habitats.

Methods

The project adopts a multidisciplinary approach that integrates ecology, environmental science, and community engagement. Monitoring programs were implemented to track bee and pollinator populations through regular surveys and innovative tracking technologies. Ecological restoration actions included planting nectar-rich flowers, creating ecological corridors, and improving nesting habitats. Simultaneously, awareness and training workshops were organized for farmers and local communities to promote sustainable agricultural practices that support biodiversity.

Results

Preliminary results show a significant increase in pollinator diversity and abundance within restored areas. The establishment of ecological corridors improved connectivity between fragmented habitats, facilitating species dispersal. Community engagement activities strengthened local commitment, leading to the gradual adoption of environmentally friendly agricultural practices and a better understanding of pollinators' ecological and agricultural importance.

Conclusion

The Medibeas project demonstrates how integrated conservation and ecological restoration strategies can help prevent habitat loss and support the resilience of terrestrial ecosystems. By combining scientific research with community participation, Medibeas provides a replicable model for bee protection and biodiversity preservation, addressing critical sustainability and ecosystem conservation challenges in the Mediterranean region



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-158995: Changes in the macrozoobenthic community across coastal lagoons in the Po River Delta (Northern Adriatic Sea, Italy) during the outbreak years of the blue crab *Callinectes sapidus* (Rathbun, 1896)

Valentina Bernareello ^{1,*}, Federica Oselladore ¹, Federica Cacciatore ¹, Michele Cornello ¹, Marta Novello ², Alessandra Girolimetto ², Andrea Bonometto ¹ and Rossella Boscolo Brusà ¹

¹ CN-COS/Tides and Lagoons Area, ISPRA, Italian Institute for Environmental Protection and Research, Chioggia – Venice 30015, Italy

² Marine and Lagoon Water Monitoring Department, ARPAV – Environmental Prevention and Protection Agency of Veneto Region, Padua 35131, Italy

The Po River Delta, situated in the Northwestern Adriatic Sea, is the largest river delta in Italy. It covers an area of 685 km² and includes seven coastal lagoons. Since spring 2023, the presence of the alien invasive species *Callinectes sapidus* has increased rapidly in the area, causing damage, especially to the shellfish sector.

The blue crab is an opportunistic predator known to feed on macrozoobenthic organisms. Since macrozoobenthos is one of the biological quality elements used in the ecological classification of transitional waters under the Water Framework Directive (2000/60/EC), its monitoring is essential to assess potential impacts of the blue crab invasion, mostly through analysis of changes in benthic community composition and abundance. To this aim, two sampling campaigns were carried out in 2024 and 2025 at 11 stations across five lagoons of the Po River Delta.

The results were compared with data from previous years (2021-2023), collected within the WFD network.

The analysis of diversity and ecological indices showed variable trends over the years, with differences only identified for density, with lower values in 2024 and 2025 compared to the previous years.

Multivariate analyses also confirmed differences between 2024-2025 and 2021-2023 (ANOSIM for Factor “Year” Global R: 0.429; p=0.1%).

SIMPER analysis showed a different distribution of common species over the years, including *Heteromastus filiformis*, and species of the genus *Streblospio*, *Gammarus insensibilis* and *Nephtys hombergii*.

Also, the M-AMBI index confirmed a deterioration in ecological quality status over the last two years.

Even though the environmental status of the Po River Delta lagoons is influenced by multiple anthropogenic pressures and shows interannual variability, the results suggest that, considering market data showing a sharp increase in blue crab catches since July 2023, the blue crab may have affected the biodiversity of the macrozoobenthic community during the past two years.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-162606: Characterization and Sampling of Local Plant Species from the Puruándiro Region (Mexico) as Options for the Restoration of the Local Agroecosystem

Juan Esteban Trinidad Huerta *, Yesenia Juárez Andrade, Ana Rosa Valdez Aadame, Cristian Alexis Villegas Bedolla, Margarita Martínez García and Gabriela Marquez Delgado

Department of Community Development Engineering, TecNM Puruándiro Campus, Puruándiro, Michoacan 58500, Mexico

In the Puruándiro region, there is an ecological transition zone, known as an ecotone, between pine–oak–madrone forests and grasslands, as well as areas with vegetation typical of tropical deciduous forest. This region supports a wide variety of tree and shrub species with high ecological and ethnobotanical value and significant potential for human and environmental use, primarily due to the unique characteristics and conditions found in the area. The main objective of this project was to identify the main species facing a high risk of disappearing from the local ecological zone. To achieve this, a series of ecological transects were established in five zones of the Puruándiro region through sampling and zoning of the area, along with field surveys; these areas were located in the following coordinates: zone 1- Lat 20° 2'53.92"N Lon 101°32'52.43"W; Zone 2 - Lat 20° 1'43.53"N Lon 101°32'35.64"W; zone 3 - Lat 20°14'5.58"N Lon 101°35'56.87"W; zone 4 - Lat 20° 0'56.46"N Lon 101°35'46.83"W; zone 5 - Lat 20°12'26.52"N Lon 101°32'1.05"W. Data such as geographic coordinates, soil types, surrounding vegetation, tree canopy height, phytosanitary status of the species of interest, and the number of specimens located in the area were collected. These findings allowed for an initial assessment of the conditions of the species located, identifying the following: *Rhus aromatica* var. *schmidelioides* (Schlecht.) Engl.; *Bursera fagaroides*, *Ceiba aesculifolia*, *Erythrina coralloides*, *Neltuma laevigata*, *Pistacia mexicana*, and *Condallia vetulina*. This marked the beginning of the implementation of strategies for collecting plant material and a series of germination potential tests conducted within the institution's facilities. Through these identification processes at the local, regional, and community levels, as well as through the characterization and identification of each species using botanical criteria, a first step is being taken in the conservation of these species, which hold significant ethnobotanical, environmental, and ecosystemic value within the region.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-158078: Climate-Driven Vulnerability of Island Ecosystems: Quantitative Evidence of Precipitation Decline Leading to Mammoth Extinction on St. Paul Island

Jinhui Wei ^{1*}, Huanhuan Peng ¹, Yonggang Ou ², Haofeng Lai ² and Yashu Zhou ²

¹ Laboratory for Coastal Ocean Variation and Disaster Prediction, College of Ocean and Meteorology, Guangdong Ocean University, Zhanjiang, China

² College of Ocean and Meteorology, Guangdong Ocean University, Zhanjiang, China

Global climate change poses a significant threat to vulnerable island ecosystems, jeopardizing biodiversity and habitats, and potentially leading to species extinction. The paleoenvironmental history of St. Paul Island (Bering Sea), the last refuge for woolly mammoths (*Mammuthus primigenius*), exemplifies this threat during the 6–4 kyr BP interval. Existing research posits that, unlike mainland extinction attributed to hunting, St. Paul mammoths likely perished during the mid-Holocene due to climate-driven habitat loss, resulting in food scarcity and critical freshwater depletion. This crucial qualitative inference demands robust, direct quantitative evidence from paleoclimatic proxies. To address this need, we compiled and analyzed palynological records from over 20 sediment cores collected from St. Paul Island and the adjacent Bering Sea coastal mainland. Utilizing the Modern Analogue Technique (MAT), we reconstructed the island's biome evolution and quantitatively derived monthly (January and July) and annual precipitation throughout the Holocene. Focusing on 6–4 kyr BP, we performed a quantitative reconstruction of spatiotemporal precipitation patterns across the Bering Sea region, mapping annual precipitation isolines for five key time slices: 6, 5.5, 5, 4.5, and 4 kyr BP. Results show that before 6.6 kyr BP, the island had high annual precipitation (~600 mm/yr) and a biome oscillating between shrub tundra and cold coniferous forest, sustaining a stable relict mammoth population. However, between 6.6 and 4.1 kyr BP, precipitation consistently declined to 400~450 mm/yr, forcing the biome to transition into an arid, desert-like type. This desiccation directly induced critical food and freshwater stress that led to the extinction of the mammoths. Furthermore, annual precipitation along the western Bering Sea coastal regions plummeted to ~240 mm by 4 kyr BP. This quantitative reconstruction provides more direct paleoclimatic evidence (precipitation decline) that supports the freshwater depletion hypothesis, offering a climatic mechanism to supplement the sea-level rise driver.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-160302: Conserving Terrestrial Diversity with Natural Pesticides: Insights from *Inula viscosa* Applications

Jana Rammal ^{1,2*}, Wassef Al Khatib ² and Akram Hijazi ²

¹ Research Platform for Environmental Science (EDST-PRASE), Doctoral School, Lebanese University, Beirut 1003, Lebanon

² Department of Chemistry, Faculty of Science, Lebanese University, Beirut, Lebanon

Post-harvest losses, dwindling biodiversity, and the extensive use of synthetic pesticides in grain storage systems pose a growing threat to global food security. There is an urgent need for natural solutions that protect terrestrial ecosystems and guarantee safe and efficient food preservation. Bioactive native plants are an underutilized resource, particularly in areas where local species and traditional ecological knowledge have not been thoroughly studied. This study assessed the Mediterranean native plant *Inula viscosa*'s biopesticidal potential for protecting stored grains. Shade-dried leaf powder and essential oil obtained by hydrodistillation using a Clevenger-type apparatus and diluted in 70% ethanol were the two formulations that were tested. Three replicates of each treatment, each containing ten adult insects, were used to apply three dose levels in a hierarchical design. A 70% ethanol solvent control and an untreated control were used to compare the treatments. Repellency was evaluated using two-choice preference tests, and mortality was measured after 24, 84, and 5 days. Within the first 24 hours, the essential oil treatments caused rapid toxicity, which increased by 84 hours and five days. Later on, the powder performed well, achieving extremely high mortality values. These findings align with published research on the insecticidal and repellent properties of essential oils and extracts from *Inula viscosa*. Overall, *Inula viscosa* shows great promise as a sustainable botanical agent for lowering post-harvest losses. Its combined effects of repellency and mortality offer an eco-friendly substitute for synthetic pesticides.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-158256: Contribution of environmental interpretation activities to the Sustainable Development Goals in Mazatlán, Sinaloa (Mexico)

Guillermina Bautista Gomez * and Pedro Lina Manjarrez

Interdisciplinary Center for Research and Studies on Environment and Development (CIEMAD) of the National Polytechnic Institute (IPN), Mexico City, Mexico

An informed society can contribute to the conservation of nature. Environmental interpretation encompasses experiences and topics that involve direct interaction between visitors and nature, and such interaction promotes ecological awareness. Exhibits in public places constitute educational settings that complement traditional institutions, promoting learning that involves not only teachers and students but also society at large, including visitors and tourists. The city of Mazatlán, Sinaloa (Mexico), presents a landscape dominated by wetlands, which are a representative ecosystem of this city. However, their conservation requires the active participation of the population. Currently, Mazatlán has 501,441 inhabitants, who affect the wetlands. By 2030, it is expected to have around 756,823 inhabitants, and by 2050, 1,306,423. Additionally, Mazatlán receives 3,872,691 tourists per year. The objective was to evaluate the themes in the interpretation of Ambiental activities and determine their contribution to the Sustainable Development Goals. Three sites were analyzed to collect information on the topics and develop a correlation matrix. The results showed that the information provided contributes to 13 of the 17 Sustainable Development Goals: 1. End of poverty, 2. Hunger and food security, 3. Health, 4. Education, 6. Water and sanitation, 8. Economic growth, 9. Resilient infrastructures, 11. Cities and settlements, 12: Sustainable production and consumption, 13. Climate change, 14. Ocean Conservation, 15: Forests, desertification, and biodiversity, and 17. Partnerships.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-162837: Developing a tool to monitor water use efficiency and vegetation greenness in hyper-arid desert using multiple satellite remote sensing data records

Youngwook Kim

Biology Department, College of Science, United Arab Emirates University, Al Ain 15551, United Arab Emirates

Efficient water management is essential for sustaining vegetation in the arid environment of the United Arab Emirates (UAE), where high temperatures and limited freshwater resources intensify the need for optimized irrigation strategies. This study develops a remote-sensing-based monitoring framework to assess water use efficiency (WUE) across the sparsely vegetated landscape of the Al Ain in the UAE. The vegetation of Al Ain is characterized by date palm cultivation and xerophytic species that are physiologically adapted to the desert, wadi, and mountainous environments. Multi-source satellite datasets—including 30 m vegetation indices from Landsat and Sentinel-1 and 1-km evapotranspiration (ET) estimates from the Simplified Surface Energy Budget (SSEBop)—were integrated to quantify spatiotemporal patterns in vegetation productivity and water fluxes. Vegetation greenness and productivity were evaluated using the Normalized Difference Vegetation Index (NDVI) and Radar Vegetation Index (RVI), while ET data captured seasonal variations in soil evaporation and transpiration. Water use efficiency (WUE), expressed as the ratio of GPP to ET, served as a metric for evaluating biomass production relative to water consumption under hyper-arid conditions. Time-series analyses revealed marked seasonal dynamics in NDVI, RVI, GPP, and ET associated with rainfall pulses and irrigation activities. Spatial mapping highlighted variability in vegetation performance and identified zones with potential for improved water-use optimization. The findings demonstrate the value of Earth-observation-driven analyses in characterizing vegetation responses to extreme precipitation events and irrigation practices. The proposed monitoring tool provides a practical foundation for advancing sustainable irrigation planning, enhancing vegetation carbon uptake, and promoting long-term water resource sustainability in Al Ain, UAE.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-158106: Does beta diversity influence species structure and composition? A study on limenitinae butterflies (Family: Nymphalidae) along an elevational gradient in the Eastern Himalayan Landscape of West Bengal, India.

Panchali Sengupta

Department of Zoology, West Bengal State University, Berunanpukaria, Malikapur, Barasat, West Bengal, India

Beta diversity facilitates the comparison of difference in species composition among communities across different ecosystems. It varies along environmental gradients, and this understanding helps in exploring the well-being of different butterfly communities within a landscape. The present study investigates the community composition (beta diversity patterns) of limenitinae butterflies along an elevational gradient. Six elevational belts (≤ 1500 masl, 1501-2000 masl, 2001-2500 masl, 2501-3000 masl, 3001-3500 masl, ≥ 3501 masl) were established in the surrounding regions outside the jurisdiction of the protected areas of Eastern Himalayas. Bray-Curtis dissimilarity was used for estimating species abundance due to its high sensitivity to relative abundance and species composition. Euclidean distance metrics represented dissimilarities between data points. UPGMA was employed for grouping similar communities hierarchically based on shared characters such as environmental variables of habitat. The turnover component of beta-diversity demonstrated species replacement from one site to another, while nestedness highlighted the occurrence of species-poor assemblages as subsets of more species-rich communities. Additionally, Sorenson similarity measured the degree of overlap in species composition between two communities across the elevational gradient. Significantly, beta diversity was estimated at two levels: stepwise beta diversity and pairwise beta diversity. Stepwise beta diversity formed a peak between 3001-3500 masl (0.360), indicating the highest species dissimilarity. However, pairwise beta diversity showed a consistent increase in dissimilarity with an increase in distance between two elevation bands, favoring the distance-decay hypothesis. These higher values are probably indicative of the substitution of species components, suggesting species occurrence exclusively in each elevation belt. Euclidean distance metrics reached the highest value between 2001 to 2500 masl (40.575). The highest species turnover (7.000), nestedness in species occurrence (0.621), and Sorenson's similarity (0.318) were recorded between 3001 to 3500 masl. Besides beta diversity, turnover due to environmental constraints could be associated with changes in community structure across the study site.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-147044: Ecological and Cultural Value of *Buddleja cordata*: A Native Resource for Biodiversity Conservation and Climate-Resilient Restoration

Alexis Josué Sánchez-Lara ^{1*}, Carmen Zepeda-Gómez ¹, Hugo López-Camarillo ² and Armando Sunny ³

¹ Laboratory of Aquatic Plants, Faculty of Sciences, Universidad Autónoma del Estado de México, Campus El Cerrillo, Supermanzana Carretera Km 15.5, Piedras Blancas, 50200 Toluca de Lerdo, Mexico

² Department of Evolutionary Biology, Faculty of Sciences, Universidad Nacional Autónoma de México, Circuito de la Investigación Científica, Ciudad Universitaria, Coyoacán, 04510 Mexico City, Mexico

³ Center for Research in Applied Biological Sciences (CICBA), Faculty of Sciences, Universidad Autónoma del Estado de México, Carretera Toluca-Ixtlahuaca Km 14.5, San Cayetano de Morelos, 50200 Toluca de Lerdo, Mexico

Buddleja cordata Kunth, commonly known as tepozán, is a dioecious shrub or tree widely distributed in temperate and sub-humid regions of Mexico. Beyond its ecological role, this species holds strong cultural significance, being recognized by Indigenous groups under multiple vernacular names and traditionally used to treat renal, digestive, inflammatory, and skin disorders. Phytochemical research has demonstrated antioxidant, antimicrobial, and neuroprotective properties, underscoring their importance for human well-being. Ecologically, *B. cordata* demonstrates remarkable plasticity, thriving in degraded soils, xeric conditions, polluted environments, and under hydric stress. Its dense pubescence, phenological adaptations, and deep root system enable it to colonize disturbed areas, functioning as both a pioneer and a secondary species in successional processes. Moreover, it provides habitat and resources for diverse associated organisms—including insects, birds, lichens, and epiphytes—underscoring its role as a biodiversity-supporting microhabitat. From a restoration perspective, *B. cordata* enhances soil fertility through litter input, biomass production, and carbon sequestration, while tolerating hydrocarbons and heavy metals. These features, coupled with its attractiveness to pollinators, position it as a strategic native species for ecological restoration, urban forestry, and climate adaptation initiatives across Mexico. Recognizing *B. cordata* as a keystone native resource emphasizes the need to integrate traditional knowledge, ecological function, and climate resilience into restoration policies. Its multifunctionality illustrates how native species can serve as nature-based solutions to safeguard biodiversity, ecosystem services, and human well-being amid climate and land-use change.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-158253: Freshwater quillworts of Greece: Updated distribution patterns and conservation threats

Konstantinos Stefanidis * and Eva Papastergiadou

Department of Biology, University of Patras, Patras, Greece

Freshwater plants remain understudied relative to other biotic groups, resulting in substantial gaps in knowledge of their distribution and ecology. One such group is the aquatic quillworts (*Isoetes* spp.), with many species found mainly in freshwater ecosystems, including temporary ponds, lakes, and estuaries. Particularly in Greece, *quillworts* are among the most undercollected plant groups, revealing significant knowledge gaps in their distribution and conservation status.

Methods

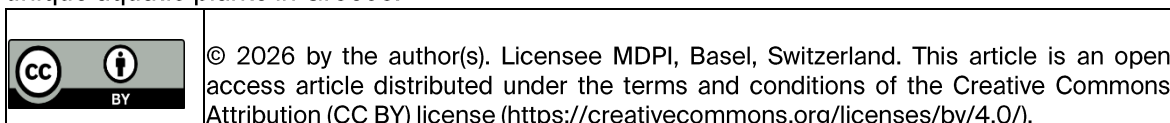
Extensive field surveys were conducted in freshwater habitats with historical records of *Isoetes* occurrence, including Lesvos, Crete, and western Greece. Habitat conditions were documented, potential threats were recorded, and population sizes were estimated to assess species status and establish conservation priorities.

Results

Survey results revealed a substantial decline in *Isoetes* populations and occurrence over recent decades. The two Greek endemic species, *I. heldreichii* and *I. haussknechtii*, were absent from their previously reported localities. The primary threats identified were hydrological changes driven by climate change, which accelerate the drying of temporary ponds, as well as overgrazing and general habitat degradation.

Conclusions

These findings underscore an urgent need for targeted conservation and restoration actions focused on freshwater habitats, particularly temporary ponds, to safeguard remaining *Isoetes* populations. Conservation efforts should prioritize the Greek endemic species, the Pindus quillwort (*I. heldreichii*) and the Greek quillwort (*I. haussknechtii*), both facing a high risk of extinction, with the Pindus quillwort likely already extinct. Strengthened monitoring, habitat management, and water regulation policies are essential to ensure the long-term survival of these unique aquatic plants in Greece.



sciforum-158128: Habitat Loss and Pesticide Impacts on Honeybee (*Apis mellifera*) Populations: Evidence from Botoșani, Romania

Maria Crina Isac

Department of Biology, Faculty of Biology, Alexandru Ioan Cuza University, Iași, 700506, Romania

Honeybees (*Apis mellifera*) are critical pollinators that support biodiversity and agricultural productivity, yet their populations have been declining globally. This paper presents a conceptual review of the main drivers of honeybee decline, focusing on habitat loss and pesticide exposure, and incorporates local observations from an apiary in Botoșani, Romania. Habitat fragmentation, urban expansion, and intensive monoculture farming reduce the availability of floral resources and nesting sites, limiting foraging efficiency and colony health. Exposure to neonicotinoids and other systemic pesticides further impairs honeybee navigation, immunity, and reproduction. Data from the Botoșani apiary indicate local colony losses over recent years, consistent with trends reported in international studies. The review also discusses mitigation strategies, including pollinator-friendly habitats, organic farming, integrated pest management, and community engagement, emphasizing the role of local practices in enhancing bee survival. Challenges such as limited monitoring, financial constraints, and public awareness are considered. Additionally, climate variability may further exacerbate the decline in honeybees by affecting seasonal foraging patterns. Findings suggest that combining global evidence with local observations provides a more comprehensive understanding of honeybee decline and underscores the need for coordinated action. Collaborative efforts among scientists, policymakers, farmers, and communities are essential to protect honeybee populations, sustain pollination services, and maintain ecosystem stability, both locally and globally.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-153760: How could environmental conditions shape the outcome of a mitigation strategy? A short-term study in marinas of the NW Iberian Peninsula

Jesús Fernández-Gutiérrez ^{1,2,3,*}, Marcos Rubal ³, Diego Carreira-Flores ⁴, Fran Ramil ⁵, Isabel Sousa-Pinto ^{1,2} and Puri Veiga ^{1,2}

¹ CIIMAR/CIMAR LA, Interdisciplinary Centre of Marine and Environmental Research, University of Porto, Terminal de Cruzeiros do Porto de Leixões, 4450-208 Matosinhos, Portugal

² Department of Biology, Faculty of Sciences, University of Porto, Rua do Campo Alegre s/n, 4169-007 Porto, Portugal

³ Centre of Molecular and Environmental Biology (CBMA/ARNET), Department of Biology, University of Minho, 4710-057, Braga, Portugal

⁴ IBADER - Institute for Agrarian Biodiversity and Rural Development, Biodiversity Lab (GI-1934 TB), Campus Terra, University of Santiago de Compostela, 27002 Lugo, Spain

⁵ CIM-UVigo - UVigo Marine Research Centre, Faculty of Marine Science, University of Vigo, E-36310 Vigo, Spain

Recreational marinas are among the fastest-growing types of artificial structures in coastal urban areas. However, their construction and functioning are linked to habitat loss and fragmentation, increased pollutant levels, and the introduction of non-indigenous species (NIS). All these impacts affect native biodiversity and reduce ecosystem services. In line with the recently approved Nature Restoration Law (EU 2024/1991), marinas could be key areas for developing mitigation strategies to mitigate the impacts of these artificial structures/infrastructures on ecosystems. Increasing habitat complexity through the addition of artificial structures has been shown to promote colonization by native habitat-forming species (HFS), thereby reducing NIS and restoring ecosystem services in degraded urban areas such as marinas. However, the effectiveness of these interventions is highly context-dependent, as environmental conditions could influence mitigation outcomes.

To investigate this, a short-term colonization experiment was conducted in four marinas on the NW Iberian Peninsula under two environmental conditions: two in a non-upwelling area in northern Galicia and two in a high-upwelling area in northern Portugal. At each marina, four artificial substrates were submerged for three months, and the colonizing sessile fouling communities were examined. Our results showed that upwelling conditions significantly shaped both the abundance and multivariate structure of colonizing assemblages. Fouling communities under high-upwelling conditions exhibited lower levels of dispersion, suggesting greater homogeneity, likely driven by the dominance of two native HFS: the mussel *Mytilus galloprovincialis* and the barnacle *Perforatus perforatus*. In contrast, the abundance of these native HFS was significantly lower in non-upwelling areas, where fouling communities were dominated by the spirorbid *Janua heterostropha*, along with cryptogenic and NIS bryozoans such as *Cryptosulla pallasiana*, *Tricellaria inopinata*, and *Watersipora subatra*. Overall, our findings demonstrate that the effectiveness of mitigation strategies varies across environments, highlighting the need to adapt interventions to local environmental conditions.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-162213: Integrating Land–Sea Connectivity to Prevent Global Biodiversity and Habitat Loss in Mangrove and Coral Reef Systems

Nidhi Dewangan

Independent Researcher, Raipur 492016, India

Introduction

Across many tropical coastlines, mangroves and coral reefs support each other in ways that are often overlooked. Mangroves trap sediments, reduce erosion, and serve as breeding and feeding grounds for marine species, while coral reefs safeguard shorelines and host exceptionally rich biodiversity. Since these ecosystems rely on one another, disturbances affecting one system inevitably influence the other. However, conservation practices around the world still tend to treat land-based and marine habitats as separate entities. With increasing pressures from climate change and coastal development, recognizing this ecological link is more urgent than ever. This study argues that effective global biodiversity protection requires conserving mangroves and coral reefs through a land–sea connectivity approach.

Methods

This research develops a conceptual model for conservation that views mangroves and coral reefs as an interconnected ecological unit. It compiles insights from global literature, remote sensing observations, and examples from various coastal regions to illustrate how these ecosystems interact and collectively support biodiversity. Policy analysis and evaluations of community-driven conservation initiatives were conducted to identify strategies that strengthen ecological linkages, enhance resilience, and promote unified land–sea management practices.

Results

The findings indicate that restoration strategies connecting mangroves and coral reefs produce stronger outcomes than projects managed separately. Integrated conservation leads to faster ecosystem recovery, higher species retention, and greater ecosystem service benefits. Long-term resilience improves when scientific monitoring, community participation, and supportive policy frameworks work together. Coastal regions applying connectivity-based management report healthier fisheries, reduced shoreline degradation, and enhanced carbon sequestration.

Conclusion

Preventing global habitat and biodiversity loss requires viewing mangroves and coral reefs as one interconnected system. Coordinated policies, ecological restoration, and community stewardship can sustain biodiversity, support climate resilience, and protect coastal livelihoods. Effective conservation must safeguard ecosystems along with the ecological relationships that keep them functioning.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-158872: Limnological characterization and phytoplankton structure in a stone tank located on an inselberg in the semiarid region of Paraíba, Brazil

Lais Souto Lira * and Lethicia Margarida Lira da Silva

Department of Agronomy and Environmental Sciences, Federal University of Paraíba (UFPB), Areia, 58397-000, Brazil

Introduction

Inselbergs, also known as rocky outcrops, represent unique ecological formations within the Brazilian semiarid region, characterized by intense solar radiation, limited water availability, and shallow, nutrient-poor soils. These environments often contain natural rock pools that accumulate rainwater and serve as temporary microhabitats for aquatic communities. This study aimed to characterize the limnological conditions and phytoplankton structure of a rock pool located on Pedra do Touro, in the municipality of Queimadas, Paraíba, Brazil.

Methods

Physicochemical parameters of the water (pH, electrical conductivity, temperature, and dissolved oxygen) were measured using a multiparameter probe, while water transparency was determined with a Secchi disk. Phytoplankton and zooplankton samples were collected using 20 µm and 50 µm plankton nets, respectively, and preserved with Lugol's solution and formaldehyde.

Results

A total of 16 phytoplankton species were identified, distributed across five classes, with a marked dominance of Euglenophyceae (48.6%), followed by Chlorophyceae (27.4%) and Zygnematophyceae (16.4%). The most abundant species, *Trachelomonas ovata* (212.10 cells/mL), commonly associated with environments enriched in organic matter, suggests initial stages of organic accumulation within the reservoir.

Conclusions

Overall, the findings indicate that rock pools function as ecologically relevant freshwater microecosystems that support diverse phytoplankton communities. These systems warrant greater attention regarding biodiversity conservation, ecological monitoring, and the management of water resources in semiarid landscapes.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-146319: Modeling the ecological niche of *Buddleja cordata* Kunth under climate change scenarios and its ecological restoration potential in the face of four exotic species

Alexis Josué Sánchez-Lara ^{1*}, Armando Sunny ², Carmen Zepeda-Gómez ¹ and Hugo López-Camarillo ³

¹ Laboratory of Aquatic Plants, Faculty of Sciences, Universidad Autónoma del Estado de México, Campus El Cerrillo, Supermanzana Carretera Km 15.5, Piedras Blancas, 50200 Toluca de Lerdo, Mexico

² Center for Research in Applied Biological Sciences (CICBA), Faculty of Sciences, Universidad Autónoma del Estado de México, Carretera Toluca–Ixtlahuaca Km 14.5, San Cayetano de Morelos, 50200 Toluca de Lerdo, Mexico

³ Department of Evolutionary Biology, Faculty of Sciences, Universidad Nacional Autónoma de México, Circuito de la Investigación Científica, Ciudad Universitaria, Coyoacán, 04510 Mexico City, Mexico

In Mexico, ecological restoration faces major challenges arising from the expansion of exotic species, land-use change, and the impacts of climate change. *Buddleja cordata* Kunth (tepozán) is a native species with functional traits that enable it to tolerate disturbed environments and colonize areas less accessible to other native species. However, its potential future distribution may be significantly altered under different climate change scenarios. This study evaluated the current and future distribution of *B. cordata* in Mexico under four global climate models—BCC-CSM2-MR, CMCC-ESM2, HadGEM3-GC31-LL, and MPI-ESM1-2-HR—projected for the SSP5-8.5 scenario, using Ecological Niche Modeling (ENM) in Maxent. Areas of persistence, expansion, contraction, and risk of invasion by exotic species were identified. Occurrence records and bioclimatic variables were integrated with vegetation, land-use layers, and Priority Sites for Restoration (PSRs). Results show that the distribution of *B. cordata* will be reshaped by changing climatic conditions, with a general trend of persistence in higher-altitude areas. Overlap with exotic species such as *Casuarina equisetifolia* L., *Eucalyptus camaldulensis* Dehnh., *Ligustrum lucidum* W.T. Aiton, and *Populus alba* L. indicates that some regions may be increasingly susceptible to invasion, potentially undermining restoration efforts. Our findings suggest that adaptive restoration strategies should prioritize persistence areas and PSRs less vulnerable to extreme climatic conditions, thereby enhancing restoration success. The ecological implications underscore the importance of incorporating the regeneration capacity and environmental tolerance of *B. cordata* into the design of effective management and restoration strategies under climate change scenarios.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-158370: Phytoplankton Community Shifts in a Mediterranean Lagoon Under Combined Shellfish Farming and Climate Pressure

Francesco Bolinesi ^{1,2,*}, Emanuele Rossetti ³ and Olga Mangoni ^{1,2}

¹ Dipartimento di Biologia, Università degli Studi di Napoli Federico II, Complesso di Monte Sant'Angelo, via Cinthia 21, Napoli 80126, Italy

² CoNISMa, Piazzale Flaminio 9, Roma 00196, Italy

³ Consorzio Cooperative Pescatori del Polesine O.P. S.C.Ar.L., Scardovari, Rovigo 45018, Italy

Mediterranean coastal lagoons are increasingly vulnerable to the impacts of climate change, including rising temperatures, altered precipitation regimes, and shifts in hydrological connectivity. These pressures are particularly pronounced in deltaic systems such as the Po River Delta, where the balance between freshwater input, marine intrusion, and anthropogenic activities—especially intensive shellfish farming—plays a critical role in shaping ecosystem structure and function. Phytoplankton communities, as the primary trophic resource for filter-feeding bivalves and sensitive indicators of environmental change, respond rapidly to fluctuations in salinity, light, and nutrient availability. In this study, we investigate the functional traits of phytoplankton—specifically size structure and photosynthetic efficiency (Fv/Fm)—as diagnostic tools to assess ecological responses to aquaculture pressure and climate-driven variability in the Sacca degli Scardovari lagoon, one of the most productive shellfish farming areas in Europe. Our findings highlight how filter-feeding activity and climate-induced stressors interact to modulate phytoplankton biomass and community composition, with implications for carbon cycling, food web dynamics, and the resilience of transitional coastal ecosystems. By adopting a trait-based approach, this study contributes to a deeper understanding of the ecological functioning of Mediterranean lagoons under multiple stress regimes, offering insights relevant for sustainable aquaculture management and climate adaptation strategies in the Po Delta region.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-162879: Redox State and Metabolic Changes in Gill and Muscle Tissues of the Invasive Alien Species *Pinctada Radiata* from Heat-Impacted Environments

Sara Esposito Marroccella ^{1,*}, Eugenio Geremia ¹, Maria Teresa Muscari Tomajoli ², Alan Deidun ³, Alessio Marrone ³, Gianluca Fasciolo ⁴, Adriana Petito ⁴, Paola Venditti ⁴ and Gaetana Napolitano ²

¹ International PhD Programme, UNESCO Chair “Environment, Resources and Sustainable Development”, Department of Science and Technology, Parthenope University of Naples, 80143 Naples, Italy

² Department of Science and Technology, Parthenope University of Naples, Naples, Italy

³ Department of Geosciences, University of Malta, Msida, Malta

⁴ Department of Biology, University of Naples Federico II, Naples, Italy

Climate-driven ocean warming is facilitating the expansion of thermophilic invasive species such as *Pinctada radiata* in the Mediterranean Sea. This study examined the species' physiological responses to thermal gradients near the Delimara Power Station (Malta) to evaluate its potential as an early climate-change bioindicator. Specimens were collected from three sites along a temperature gradient (26.3 °C, 27.1 °C, 28.5 °C), and gill and adductor muscle tissues were analyzed for redox state biomarkers (ROS, oxidative damage to lipids—HPs and proteins—CO), antioxidant capacity (in vitro susceptibility to oxidants—ΔHPs, total antioxidant capacity—TAC, glutathione peroxidase—GPx, and glutathione reductase—GR activity), and aerobic metabolism (cytochrome c oxidase, COX). Data were statistically analyzed by one-way ANOVA followed by Tukey's post hoc test. Gill and muscle tissues responded differently to warming. The gills showed little change at 27.1 °C, but at 28.5 °C their antioxidant defenses declined, resulting in higher HP content and reduced antioxidant enzyme activity. Muscle showed a dual response. At 27.1 °C it was more resilient, with lower oxidative damage and ΔHPs and stronger antioxidant defense. At 28.5 °C it remained well adapted but exhibited higher ΔHPs and reduced TAC and GR activity with respect to the muscles of oysters collected at 27.1 °C, indicating a decline in antioxidant capacity. COX activity, which remains unchanged in the gills at both elevated temperatures, showed a significant reduction in the muscles of oysters collected from hottest waters, suggesting a shift toward anaerobic metabolism. Overall, *P. radiata* exhibited high thermal tolerance and physiological plasticity, supporting its persistence in heat-impacted environments. Although the presence of the invasive species *P. radiata* reflect climate-related ecological pressure, its physiological responses as a climate sentinel indicate that even near optimal temperatures its redox balance is altered, potentially threatening its survival as Mediterranean Sea temperatures continue to rise. These findings are relevant for predicting ecosystem changes under global warming.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-162872: Time-dependent response of the animal model *Mytilus galloprovincialis* to water hypoxia: oxidative status and antioxidant enzyme modulation

Alessia Caferro ^{1,*}, Maria Assunta Iovine ¹, Mariacristina Filice ¹, Alfonsina Gattuso ¹,
Federica Impellitteri ², Caterina Faggio ³, Maria Carmela Cerra ¹ and Sandra Imbrogno ¹

¹ Department of Biology, Ecology, and Earth Sciences, University of Calabria, Arcavacata di Rende (CS) 87036, Italy

² Department of Veterinary Sciences, University of Messina, 98168 Messina, Italy

³ Department of Chemical, Biological, Pharmaceutical and Environmental Sciences, University of Messina, 98166 Messina, Italy

Water hypoxia, a condition of reduced dissolved oxygen (DO), is one of the most pervasive and increasing stressors linked to climate change, eutrophication, and anthropogenic impacts. Sessile species, such as mussels, are naturally exposed to these fluctuations in oxygen availability since their immobile lifestyle prevents escaping, and this makes them particularly vulnerable to stress. We here aimed to clarify the influence of different periods of exposure to water hypoxia on crucial physiological and biochemical responses of *M. galloprovincialis*. To this purpose, mussels were exposed to 4 (short) and 10 (prolonged) days of hypoxia (DO at 2.5 mg L⁻¹) and both gills and digestive gland (DG) were used to evaluate the tissue oxidative status in terms of lipid peroxidation and protein oxidation, the expression and the activity of the antioxidant enzymes superoxide dismutase (SOD) and catalase (CAT), the expression of the stress-related protein HSP70, together with cell viability, and the cell response to volume changes. We found that, under prolonged hypoxia, lipid peroxidation increased in both DG and gills, while no changes in protein oxidation were observed. In the DG, exposure to both short and prolonged hypoxia is accompanied by the activation of the antioxidant response, with both SOD activity and transcriptional levels markedly upregulated. In the gills only, SOD gene expression increased at 10 days of treatment. In contrast, CAT activity and gene expression, as well as HSP70 expression levels, remained stable across tissues and treatments. Overall, these responses point to a tissue-specific and time-dependent modulation of both oxidative status and antioxidant defenses in mussels challenged by hypoxic stress.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

Session 4. Urban Systems and Ecosystems: Dynamics and Functioning

sciforum-154796: Towards a Green City in the Face of Climate Change: Biodiversity Restoration of an Urban Park in a North African Mediterranean Context

Rania Ajmi ^{1*}, Hana Mani ² and Faiza Khebour Allouche ³

¹ Department of Horticulture Sciences and Landscape, High Institute of Agronomic Science of Chott Mariem (ISA-CM), Sousse University, Sousse, Tunisia

² High Institute of Agronomic Science of Chott Mariem (ISA-CM), Sousse University, Sousse, Tunisia

³ Department of Engineering and Landscape Planning, High Institute of Agronomic Science of Chott Mariem (ISA-CM), Sousse University, Sousse, Tunisia

One of the biggest environmental challenges facing the world today is climate change, which has led to an increase in international initiatives to promote sustainable urban development, such as those run by the United Nations. The goals for eco-responsible urban areas and green cities have taken center stage within this framework. Through the planning and construction of multipurpose green infrastructure in the city of northeastern Tunisia, this study seeks to improve climate resilience and restore local biodiversity. The approach included surveys of residents, Geographic Information Systems (GIS) methods, and landscape feature analysis. Within this combined approach, three principal redevelopment scenarios were recommended in park "Sahloul 4" in Sousse, based on identified recommendations: (i) Climate Change, Renewable Energy & Recycling; (ii) Climate Change and Biodiversity; and (iii) Climate Change, Biodiversity and Sustainable Development Goals (SDGs). The third option was chosen for implementation based on its overall applicability to both multi-functionality and ecological resilience. This proposal includes a suite of innovative design features: a botanical garden; water play; stormwater reuse; pet-friendliness; habitats for birds; and solar panels. This study finds that the integration of geospatial analysis and community-based approaches successfully offers a framework for designing resilient urban green spaces. The redevelopment proposal of Sahloul IV park illustrates how multi-functional green infrastructure can provide services simultaneously for biodiversity enhancement, climate adaptation, and contribution to the SDGs in Mediterranean urban areas.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-155142: Air Pollution Correlation and Seasonal Variability in Chattogram's Urban Ecosystem

Md. Nurjaman Ridoy * and Sk. Tanjim Jaman Supto

Department of Environmental Research, Nano Research Centre, Sylhet, 3114, Bangladesh

Due to rapid urbanization and industrial growth, Chattogram has become a major industrial and maritime hub in Bangladesh, with a dynamic new urban ecosystem. The rise in vehicle numbers and manufacturing industries has made particulate matter (PM_{2.5} and PM₁₀) and nitrogen dioxide (NO₂) the primary pollutants of concern. This study evaluates Department of Environment (DoE) records from 2013 to 2024, analyzing monthly extremes and decadal trends. The results revealed that the winter months (December–February) consistently recorded the highest hazard levels, with mean PM_{2.5} of 122.77 µg/m³, PM₁₀ of 216.15 µg/m³, and AQI near 188. In contrast, the monsoon months showed the lowest concentrations (PM_{2.5}: 17–25 µg/m³; PM₁₀: 43–51 µg/m³; AQI: 43–55). Annual means remain well above WHO guidelines, with PM_{2.5} at 44.08–76.4 µg/m³ and PM₁₀ at 106.78–162.83 µg/m³, respectively. NO₂ exhibited episodic peaks, with a maximum of 280 µg/m³, and a minimum of 0.2 µg/m³. The highest seasonal mean for NO₂ occurred in autumn (35.13 µg/m³), while the decadal peak appeared in 2018 (34.4 µg/m³) before declining to 6.3 µg/m³ by 2024. The monthly maxima occurred in November at 38.94 µg/m³. It peaked in 2018 at 34.40 µg/m³, dropping to 6.28 µg/m³ in 2024. These trends show how urban structure, meteorology, and industrial activity jointly shape ecological functions. These findings highlight the need for ecosystem-based management that incorporates green buffer zones, emission zoning, and seasonal control strategies to maintain air quality. This study provides a case model of sustainable air quality management in rapidly developing coastal ecosystems.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-158222: Analysis of the Growth of Economic Units and Their Influence on the Water Quality of Wetlands receptors Wastewater in Mazatlán, Sinaloa (Mexico)

Guillermina Bautista Gomez * and Pedro Francisco Rodríguez Espinosa

Center for Research and Studies on Environment and Development (CIIEMAD) of the National Polytechnic Institute (IPN), Mexico City Mexico

Introduction

The growth of productive and commercial establishments in urban areas affects the type and quantity of wastewater they generate and discharge into wetlands, which affects the water quality depending on whether the discharged water is treated or untreated.

Methods

The methodological design used was mixed, exploratory and descriptive, and involved the collection and analysis of qualitative and quantitative data, which was carried out via primary and secondary sources through field trips and review and analysis of documents, records, and cartography. Therefore, this study analyzed the growth of industrial, mining, construction, commercial, electricity generation, water, natural gas, agriculture, livestock, fishing, and aquaculture establishments from 2010 to 2025. The analysis was based on the records of economic units registered in the National Statistical Directory of Economic Units (DENUE) of the National Institute of Statistics and Geography (INEGI) of Mexico and the water quality in the wetlands where wastewater from the urban area of Mazatlán is discharged, based on information from the reports of the National Water Quality Monitoring Network (RENAMECA) of the National Water Commission (CONAGUA).

Results

It was found that there are a total of 26,949 operating economic units, with only 8 Wastewater Treatment Plants currently discharging into the urban wetlands.

Conclusions

It is concluded that the current wastewater treatment capacity is insufficient for the growth of the economic units that have been operating over the past 15 years.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-158526: Assessing the Impact of Urban Events on Social Sustainability in Transit-Oriented Spaces

Ali Pourjafar ^{1,*} and Elham Khazaei ²

¹ Department of Urban Design, Faculty of Architecture and Urban Design, Shahid Rajaei Teacher Training University, Tehran 1678815811, Iran

² Department of Urbanism, Ma. C., Islamic Azad University, Mashhad 9187147578, Iran

This study investigates the influence of urban events on social sustainability within transit-oriented development (TOD) zones, specifically focusing on areas surrounding metro stations. As cities increasingly adopt TOD principles to enhance accessibility and reduce environmental impact, understanding how public gatherings and events contribute to social dynamics becomes essential. The research explores how urban events affect public transportation usage, environmental conditions, and patterns of social interaction.

Data were gathered through a combination of online surveys, user-generated feedback from urban mobility applications, and environmental indicators such as noise levels and air quality. Quantitative analysis was conducted using SPSS to identify correlations between event frequency and transit ridership, while Python-based sentiment analysis provided insights into public perception. Additionally, qualitative data were analyzed using MAXQDA to extract recurring themes from user comments, revealing key concerns and preferences related to urban events.

Prominent themes included environmental safety, ease of access via public transportation, presence of families, and a strengthened sense of urban belonging. These findings suggest that well-planned urban events can foster inclusive social environments and encourage sustainable transit behaviors. Events located near metro stations not only promote the use of public transportation but also serve as catalysts for community engagement and interaction.

The study concludes that integrating urban events into TOD strategies can significantly enhance social sustainability by creating vibrant, accessible, and socially cohesive urban spaces. Policymakers and urban planners are encouraged to consider the strategic placement and design of events to maximize their positive impact on both transit systems and community well-being.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-163492: Building Shared Futures: Scenario Planning for Transboundary WEF Governance in the Tigris–Euphrates Basin

Elham Sedighi ^{1,*} and Brian D. Fath ^{1,2,3}

¹ Advancing Systems Analysis (ASA) Program, International Institute for Applied Systems Analysis (IIASA), Laxenburg, Austria

² Department of Biological Sciences, Towson University, MD, USA

³ Department of Environmental Studies, Masaryk University, Brno, Czechia

Transboundary water–energy–food (WEF) interactions present complex governance challenges, particularly in multi-country river basins where environmental, political, and socio-economic dynamics intersect. In such highly uncertain and interdependent systems, identifying key drivers and exploring alternative future scenarios is essential for developing a shared understanding of system behavior, reducing ambiguity, and supporting coherent and adaptive planning across national and sectoral boundaries. This study aims to identify and characterize the key drivers shaping WEF nexus dynamics within the Tigris–Euphrates basin, shared by Turkey, Syria, Iraq, and Iran, through a scenario-planning framework informed by morphological analysis. The scenarios were co-developed with stakeholders from multiple countries and sectors to ensure that diverse perspectives, priorities, and knowledge systems were explicitly represented. A systematic literature review identified 27 relevant influencing factors, from which experts selected six critical drivers for future-oriented analysis. For each driver, at least five plausible future states were defined and subsequently evaluated by basin stakeholders using structured surveys to assess both perceived likelihood and desirability. These assessments enabled the development of a set of alternative WEF scenarios—including the most probable, most acceptable, and most desirable trajectories—illustrating potential futures for the basin. The results also enable a comparative analysis of stakeholder responses across countries and sectors, revealing areas of convergence and divergence in perceptions of future risks and opportunities. By integrating morphological scenario planning with active stakeholder participation in a transboundary setting, this study offers a rigorous analytical foundation for collaborative resource management and long-term strategic planning across the Tigris–Euphrates basin. A central achievement of this research is the creation of a structured, participatory framework for assessing the WEF nexus in a shared river basin, designed to illuminate complex interdependencies and equip policymakers from multiple sectors and riparian countries with actionable insights for informed, coordinated decision-making.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-159793: Can Phytoremediation Mitigate Eutrophication in Urban Streams? Insights from Costa-Couros Stream

Ana Rita Martins ^{1,*}, Carolina Rodrigues ², Simone Morais ¹ and Clara Grosso ¹

¹ REQUIMTE/LAQV, ISEP, Polytechnic of Porto, Rua Dr. António Bernardino de Almeida 431, 4249-015 Porto, Portugal

² Landscape Laboratory, Rua da Ponte Romana, Creixomil, 4835-095 Guimarães, Portugal

Urban streams are increasingly threatened by eutrophication driven by anthropogenic pressures, particularly nutrient inputs from diffuse and point pollution sources. This study assessed the effectiveness of macrophyte-based phytoremediation as a Nature-based Solution for improving water quality in urban aquatic systems. Three native species – *Typha latifolia* L., *Juncus effusus* L., and *Iris pseudacorus* L. – were evaluated under controlled laboratory conditions for their capacity to remove nitrate (NO_3^-), ammonium (NH_4^+), phosphorus (P) and phosphates (PO_4^{3-}), followed by in situ application in the Costa/Couros Stream (Guimarães, Portugal), an urban stream historically affected by industrial and urban discharges.

During 8-week laboratory assays, all species achieved complete nitrate removal (100%), whereas the control achieved only 33.4%. Phosphorus removal efficiencies reached 100% for *J. effusus*, 98.5% for *I. pseudacorus*, and 96.0% for *T. latifolia*, outperforming the control (71.1%). Similar trends were observed for phosphate removal – 100%, 98.5%, and 96.1%, respectively – significantly exceeding the 65.7% recorded in the control. Significant differences were confirmed for *I. pseudacorus* and *J. effusus*. Ammonium removal ranged 85–88%, with no significant statistical differences. Plants exhibited normal growth, particularly for *T. latifolia* and *I. pseudacorus*.

Field implementation demonstrated the feasibility of phytoremediation in an urban context, though invasive species and human disturbances locally constrained plant establishment. Monitoring general physico-chemical parameters indicated stable water quality, with no deterioration trends. Overall, the results indicate that macrophyte-based phytoremediation holds strong potential to mitigate eutrophication in urban streams, provided that proper management and long-term monitoring are ensured.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-163709: Carbon Storage Assessment of Urban Street Trees Using Terrestrial LIDAR and Satellite-Based Remote Sensing Data

Milena V. Sokolova ^{1*}, Severino Romano ¹, Mauro Viccaro ¹, Fabrizio Pedes ², Costantino Sirca ², Donatella Spano ² and Mario Cozzi ¹

¹ Department of Agricultural, Forestry, Food and Environmental Sciences, University of Basilicata, Viale dell'Ateneo Lucano, 10, 85100 Potenza, Italy

² Department of Agricultural Sciences, University of Sassari, Viale Italia 39/a, 07100 Sassari, Italy

Urban trees provide a wide range of ecosystem services (ESs), notably including carbon storage and sequestration, which are increasingly important in the context of climate change. Urban forests store carbon in woody biomass, sequester additional carbon during growth phases, and may release stored carbon back into the atmosphere after tree mortality. Moreover, urban trees influence local microclimates, air temperatures, and building energy consumption, indirectly affecting carbon emissions from urban energy systems.

The rapid growth of anthropogenic carbon emissions and ongoing urbanization have increased the need for reliable assessments of carbon storage in urban green infrastructure. Street trees, characterized by their linear and spatially dispersed distribution, require individual-level analysis, which is traditionally based on labor-intensive field surveys. Additionally, the United Nations Framework Convention on Climate Change's (UNFCCC) Paris Agreement has set a target to ensure the global mean temperature increase below 2 °C by controlling carbon emission. With this policy concept, quantifying carbon storage and sequestration has gained significant attention as a vital regulating service provided by urban green spaces.

This study aims to evaluate the ES of carbon storage provided by urban parks in the Basilicata region (Southern Italy). The dataset includes 803 urban parks, covering a total area of 4.28 km², corresponding to approximately 0.043% of the overall regional territory and about 0.12% of the region's forested area. Individual park sizes exhibit a high degree of variability, ranging from 1.18 m² to 1.62 km². A median park size of 427 m² highlights the prevalence of small urban green spaces across the region.

Two complementary approaches are employed: 1) satellite-derived aboveground biomass (AGB) products from ESA Earth observation data, and 2) terrestrial Light Detection and Ranging (LiDAR)-based measurements of tree structural parameters. LiDAR data are used to estimate Diameter at Breast Height (DBH), tree height (H), and AGB, which are subsequently converted into carbon stock using species-specific allometric equations with For-est model. A comparative analysis of these methods will assess their consistency, plausibility, and effectiveness of remote sensing-based parameters at different spatial scales. The proposed methodology is demonstrated through a case study conducted in an urban area of the Basilicata region, Southern Italy.

Expected results include quantitative estimates of carbon storage and aboveground biomass, expressed in biophysical and monetary terms (EUR/ha/yr) for both approaches. The final result will include an assessment of the consistency and applicability of terrestrial LiDAR-derived and satellite-based biomass estimates for urban street trees.

By comparing these modeling approaches and their ES monetary outputs, the study aims to support informed decision-making by identifying appropriate methods for carbon stock assessment and enabling comparison of quantitative ES values.

This approach will serve as a foundation for future assessments of carbon sequestration.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-158329: Climate-Induced Phenological Dynamics in Tropical Dry Deciduous Forests: Insights from India's Gir Ecosystem

Dhruvi M Sedha ^{1,*}, Chandra Prakash Singh ² and Hitesh A Solanki ¹

¹ Department of Environmental Sciences, Gujarat University, Ahmedabad 380009, India

² Department of Space, IN-SPACe, Ahmedabad 380058, India

Tropical dry deciduous forests are among the most climate-sensitive ecosystems globally, yet their phenological responses to environmental change remain poorly documented, particularly in South Asia. This study addresses a critical knowledge gap by providing the first comprehensive phenological assessment of India's Gir Forest National Park, a globally significant tropical dry deciduous ecosystem, using high-temporal resolution PhenoCam technology. We deployed systematic near-surface remote sensing over 19 months (October 2022–May 2024), extracting green chromatic coordinates (GCC) from strategically defined regions of interest to quantify canopy-level phenological transitions with unprecedented precision. Our analysis revealed distinct asymmetric phenological patterns: an extended green-up period of 164 days contrasted with a rapid senescence phase of only 39 days. Median GCC values ranged from 0.332 to 0.368, demonstrating remarkable seasonal stability and providing robust phenological metrics for leaf emergence, peak greenness, and senescence timing. These findings establish critical baseline data for a previously unmonitored ecosystem and reveal phenological characteristics that may indicate adaptive responses to patterns in moisture availability in water-limited tropical environments. The pronounced asymmetry in green-up versus senescence periods suggests complex interactions between monsoon dynamics and vegetation physiology, with significant implications for carbon cycling, water balance, and ecosystem resilience under climate change scenarios. Our methodological framework offers a replicable, cost-effective approach for long-term phenological monitoring in data-sparse tropical regions. As climate change accelerates phenological shifts globally, this research provides essential reference data for predictive ecosystem modeling, biodiversity conservation planning, and climate adaptation strategies in tropical dry forests. The insights generated are particularly timely given the vulnerability of tropical deciduous ecosystems to altered precipitation regimes and projected temperature extremes in South Asia. This study advances our understanding of tropical forest phenology and establishes a foundation for examining climate-vegetation interactions in understudied ecosystems facing unprecedented environmental pressures.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-162168: Decoupling Traffic Growth and Air Pollution: Evidence-Based Strategies for Sustainable Urban Mobility in Jakarta

Bayu Maulana

Graduate School of Frontier Science Initiative, Kanazawa University, Kanazawa 920-1192, Japan

Rapidly growing megacities face the challenge of sustaining economic activity without exacerbating air pollution. This study examines Jakarta, Indonesia, to identify the specific traffic behaviors and time periods that offer the greatest potential for reducing pollution with minimal economic impact. Using a full year (2023) of traffic counts, air-quality measurements, and weather data from the city's central business district, we constructed an Economic Activity Index and calculated the pollution intensity to measure emissions per unit of economic activity. Cluster analysis was applied to categorize hourly conditions into distinct traffic–pollution patterns.

Results reveal a four-hour lag between peak traffic volume (17:00) and peak PM_{2.5} concentration (13:00), indicating substantial pollution buildup. Heavy vehicles generated disproportionately high PM_{2.5} intensity, particularly in evening hours, while midday periods dominated by motorcycle traffic produced unexpectedly elevated pollution levels. Six characteristic traffic–pollution patterns emerged, with the “Congested Midday Mix” representing the most polluting condition. The association between economic activity and pollution was present but weaker than anticipated, suggesting meaningful opportunities for policy intervention.

The findings demonstrate that economic productivity and air pollution can be partially decoupled through targeted strategies. Recommendations include shifting heavy-vehicle freight to nighttime; accelerating the electrification of motorcycles and buses, especially for midday trips; and applying real-time traffic management during high-pollution periods. This framework offers an evidence-based pathway for megacities seeking to balance economic growth with cleaner and more sustainable urban mobility.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-162483: Energy in Public Administration

Christina Pourani^{1,2}

¹ School of International Studies, Department of International and European Studies, Panteion University of Social and Political Sciences, Athens 132 31, Greece

² Department of Legal services, Hellenic Regulatory Authority for Waste, Energy and Water, Athens 132 31, Greece

reported to align with the global guidelines above (relevance to the eight national priorities, Greek Green Deal, "Energy Efficiency First", European Green Deal Risk Radar).

Simultaneously, assessing the desirable and undesirable results of upcoming systemic changes, differences between conservative (fossil fuels) and contemporary (heat pumps) energy sources are stressed.

In conclusion, a diverse range of solutions about renewable sources and smart systems through circular and blue economy is proposed. Indicatively, such means refer to thermal insulation, flexible heat pumps and electrification, prefabricated standardized panels for facades and roofs, PV and thermal solar systems, batteries, waste management (recycled vehicle tires, such as Ecoelastika), sustainable urban mobility plans, private cars with green hydrogen, electric vehicles' charging and parking infrastructure, local initiatives against climate change, and smart measurers, self-consumption system or virtual synchronized energy netting (digitalized innovations).

Results

- It is important to encourage a sense of unity and cooperation in relation to public administration factors and individuals.
- We must raise awareness for constructive contributions of recovery and resilience for a more sustainable and harmonious planet.

Conclusions

By exploring the deep obstacles that hinder free and just access to clean energy for everyone through detailed regulatory investigation and simultaneous examination of set goals and expected results, this research seeks viable solutions to combat climate and energy challenges efficiently.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-159070: Moderating Mechanism of Green Space Patterns on Urban Heat Island Effect under the Background of Urban Intensification: A Case Study of Nanjing

Lin Sun * and Ge Shi

¹ School of Geomatics Science and Technology, Nanjing Tech University, Nanjing 211816, China

² Observation Research Station of Land Ecology and Land Use in the Yangtze River Delta, Ministry of Natural Resources, Nanjing 210000, China

Under the background of urban intensification, the moderating role of green space patterns on urban heat island (UHI) effects has become a significant topic in urban planning and ecological management. This study uses Nanjing as a case study. It analyzes data from the Urban Density Index (UDI), Land Surface Temperature (LST), Green Space Index (GSI), and Landscape Pattern Index for 2012, 2016, and 2020. We employ Moran's I spatial autocorrelation analysis and a coupling coordination degree model to systematically explore the moderating mechanisms of green space patterns on the UHI effect and their temporal-spatial evolution. The findings demonstrate that urban intensification significantly exacerbates the UHI effect, with a positive correlation between UDI and LST. Meanwhile, GSI shows cooling potential through spatial optimization. Green spaces mitigate UHI effects mainly through evapotranspiration, shading, and continuous distribution, with areas like Zijin Mountain showing low LST and high GSI distributions, which validate their cooling effect. Landscape pattern analysis indicates that the negative correlation between the Largest Patch Index (LPI) and LST has strengthened, while fragmented green spaces limit cooling effects. The coupling coordination degree increased from 0.5 in 2012 to 0.6 in 2020, indicating a gradual improvement in the coordination between green spaces and the thermal environment. However, the coordination in the central urban area remains low. To optimize green space layout and enhance its cooling effectiveness, this study suggests improving green connectivity, expanding contiguous green areas, and promoting green roofs, providing a scientific basis for UHI mitigation in Nanjing and similar cities.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-156869: Phenological and Aesthetic Dynamics of Urban Trees: Implications for Landscape Planning

Thiago Allain Martins Siqueira Moura *, Angeline Martini and Hiago Felipe Cardoso Pacheco

Department of Forestry, Federal University of Viçosa, Viçosa 36570-900, Brazil

Phenological dynamics shape the visual appearance of trees across seasons, serving as recurrent stimuli that influence the symbolic and emotional value of urban landscapes. This study examined how stages of the phenological cycle affect the aesthetic perception of trees, aiming to integrate temporal dynamics into landscape planning. Research was conducted on the main campus of the Federal University of Viçosa (MG, Brazil), where 12 tree species were monitored biweekly for one year. Phenophases of flowering, fruiting, and leafing were recorded along with standardized photographs. These images were evaluated in an online questionnaire (January–April 2025) completed by 306 participants, who assessed visual attributes such as flower color, crown shape, foliage density, and tree size. The Scenic Beauty Estimation (SBE) method was applied, with scores standardized using z-scores and aggregated to estimate monthly variation in aesthetic perception. The validity of this approach was tested by comparing estimated scores with SBE results from real images of *Handroanthus serratifolius* at distinct phenological stages. Results revealed clear patterns of aesthetic fluctuation. Species such as *Ceiba speciosa*, *Handroanthus* spp., and *Erythrina mulungu* displayed aesthetic peaks associated with intense flowering and partial leaf loss, resulting in strong chromatic contrasts. In contrast, *Lagerstroemia indica* and *Spathodea campanulata* maintained stable attractiveness due to prolonged blooming, while *Moquilea tomentosa* and *Filicium decipiens* remained visually consistent with dense evergreen crowns. Fruiting also contributed to variation, particularly in species with conspicuous or persistent fruits. The strong correspondence between estimated and observed SBE scores supports methodological reliability. Overall, perceived aesthetics in urban landscapes are closely modulated by tree phenology. Considering these dynamics in planning may enhance visual diversity and strengthen cities' ecological identity.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-162731: Predictive Urban Ecologies: Integrating AI, Environmental Sensing and Adaptive resilience strategies

Giulia Fernanda Grazia Catania

Department of Engineering and Architecture, University of Enna Kore, Viale delle Olimpiadi, 94100 Enna, Italy

Urban districts affected by social fragility and environmental degradation increasingly require predictive and adaptive tools capable of addressing intensifying climate pressures and complex ecological dynamics. This contribution presents a multilayer framework for assessing and enhancing urban environmental resilience by integrating AI-driven environmental analysis, distributed sensing networks and predictive ecological modelling. The proposed approach correlates real-time data on air quality, urban microclimate, mobility flows, land use and public-space conditions with socio-territorial indicators, enabling the early detection of environmental stress patterns in vulnerable neighbourhoods. Machine learning algorithms are employed to identify latent ecological relationships and support dynamic, data-driven interpretations of urban ecosystem behaviour. Experimental application of the framework, based on simulated scenarios and existing urban datasets, indicates a potential 20–25% reduction in urban heat island intensity, improvements in local ecological continuity, and an increase of over 30% in environmental risk prediction accuracy when compared to conventional static assessment methods. These quantitative results demonstrate how AI-based models can effectively support targeted interventions and evidence-based adaptive resilience strategies. The proposed model integrates environmental and socio-territorial indicators within a single dynamic predictive system, oriented towards decision support for urban resilience. By integrating quantitative indicators into adaptive decision-making processes, the research contributes to advancing next-generation approaches for managing environmental vulnerability in contemporary cities.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-158364: Quantifying Dignity in Urban Ecosystems: A Framework for Inclusive and Sustainable Aging in Indian Cities

Mithila Mattoo * and Virendra Kumar Paul

Department of Building Engineering and Management, School of Planning and Architecture, Delhi, New Delhi, 110002, India

According to the UNFPA, India's ageing population is expected to reach **347 million by 2050**. Despite these demographic changes, the urban systems continue to prioritise "planning for the car" and digital efficiency over empathy, accessibility, social inclusion, and human-centred design. This study introduces **dignity as a quantifiable indicator** of the urban ecosystem functioning, bridging sustainability, spatial justice, and the lived experience of the ageing population. By building upon available age-friendly frameworks, the research develops an assessment tool to measure how urban ecosystems collectively sustain or impede dignity.

The study focuses on Jammu, a Smart City under India's Smart City mission, with a higher life expectancy than the national average, as a representative case study of infrastructural modernisation, in contrast to the socio-spatial inequalities.

A mixed-methods design combines qualitative interviews with the ageing population (n~ 30) to capture their lived experiences with quantitative surveys (n~ 150) that operationalise these perceptions into measurable indicators such as mobility, accessibility, walkability, safety, social participation, urban green spaces, digital inclusion, and more. Spatial mapping and correlation analyses are employed to examine how these indicators interact to shape the **perceived dignity** and ecosystem functioning across Jammu's various neighbourhoods.

Findings suggest that dignity can be **quantified and spatially represented** through these determinants. In Jammu, despite progress in digital infrastructure, accessibility, safety, and citizen participation remain largely overlooked, resulting in isolated "pockets of inclusion" and widespread inequity. The proposed framework advances age-friendly design by (i) establishing dignity as an equitable and quantifiable construct, (ii) integrating subjective lived experience with spatially explicit indicators, and (iii) embedding dignity metrics within the city-scale Smart City paradigm by assessing how technology and infrastructure collectively shape older adults' autonomy, safety, and dignity, rather than limiting technology to smart homes. This provides a replicable framework for assessing and shaping compassionate, inclusive, and truly ageless cities.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-162836: Stated choice for sustainable mobility at different stages of behavior: A vignette stated choice experiment based on mental accounting interventions

Chayasmita Deka

Advancing Systems Analysis- Cooperation and Transformative Governance (ASA-CAT) Group, IIASA, Laxenburg, Austria

As regions around the world have transitioned towards sustainability at varying pace, the adoption of low-carbon mobility technologies like electric vehicles (EVs) remains greatly uneven. While infrastructure, costs and technological readiness plays a crucial role in adoption decision; people's experiences, expectations and existing habits also shape mobility transition decisions. Given the urgent need to decarbonize the transport sector, behaviorally informed interventions can reduce the stickiness of existing habits and speed up sustainability transitions. Drawing on Bamberg's Stage Regulated Behavior Change (SRBC) model, this study administers interventions based on the mental accounting framework (decision budgeting), using a vignette (hypothetical scenario)-based stated choice experiment. Such an approach can be particularly suitable for regions with very limited exposure to EVs or with underdeveloped charging infrastructure at present, as in several rapidly urbanizing smaller cities in India. Mental accounting principles were embedded in the experiment to capture how current psychological resource allocation-consumption mechanisms are associated with future mobility choices. The experiment was administered to 787 participants, aged 18-25, sampled through convenience sampling, and randomly assigned to a control group or three intervention groups. Using multinomial logit regression, this study finds that the violation of key mental accounting principles is associated with differentiated behavioral stages towards sustainability. Violation of the fungibility principle for spending towards necessity is 5.36–7.83 times more likely to be associated with the pre-decision stage, while those violating the fungibility principle for indulgence has a 59.59 times higher likelihood of being in the action stage of behavior. Violation of the labeling principle decreases the likelihood of pre-decision or pre-action, except when indulgence involves green investments, which increases the likelihood of the pre-action stage by 5.26–7.679 times. Such interventions based on mental accounting principles can help identify potential early adopters of EVs in the near future for presently lesser developed but rapidly urbanizing smaller cities in India.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-161730: Ten-Year Dynamics of Water Surface and land use in La Marjal de Gandia (2015–2025) Using Sentinel-2 Satellite Imagery and Google Earth Engine

Jakub Kadlec ^{1,*}, Maria-Teresa Sebastia-Frasquet ² and Javier Estornell ³

¹ Department of Applied Ecology, Czech University of Life Sciences Prague, Prague, Czech Republic

² Department of Hydraulic Engineer and Environment, Universitat Politècnica de Valencia, Valencia, Spain

³ Department of Cartographic Engineering, Geodesy and Photogrammetry, Universitat Politècnica de Valencia, Valencia, Spain

La Marjal de Gandia is a protected Mediterranean wetland characterized by high hydrological variability and increasing environmental pressure. This study quantifies the temporal dynamics of open water within the official wetland boundary over 2015–2025 using Sentinel-2 multispectral imagery processed on the Google Earth Engine platform. Water surfaces were automatically extracted through spectral index-based classification (e.g., NDWI/MNDWI), enabling the generation of an annual flooded-area time series. Historical orthophotographs from 2015 were used to derive reference land-use information and support training data selection, while land-use conditions for 2025 will be validated through field observations during 2026.

The study also analyses how hydrological fluctuations relate to seasonal rainfall, agricultural water management and vegetation cycles. The incorporation of multi-temporal imagery enables the detection of short-term flooding and long-term trends, offering a consistent overview of the wetland's functional dynamics. By integrating remote sensing, land-use data and in situ verification, the methodology provides a robust framework for assessing wetland condition.

Previous studies indicate that open water in Mediterranean wetlands can vary by 20–50% across seasons and years. Preliminary inspection of Sentinel-2 data suggests that flooded surfaces in La Marjal may range from below 10 ha during dry months to more than 40 ha after intense precipitation events, consistent with patterns observed in similar coastal wetlands.

The expected results will support hydrological interpretation and conservation planning and demonstrate the value of Sentinel-2 monitoring for Mediterranean wetlands.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

Session 5. Shared Responsibility in Resource Use and Impact Generation

sciforum-154733: Reserve Areas in Public Agrarian Reform Settlements as a Potential for Carbon Credit in the State of Pernambuco, Northeastern Brazil

Emanuel Rodrigo Silva

Department of Higher Education - Graduate and Extension Programs - Distance Learning Center, FACUMINAS
POSTGRADUATION EAD LTDA - ME. End, Duque de Caxias, 366 - Centro, Cel. Fabriciano - MG 35170-009, Brazil

The preservation of reserve areas in rural public settlements plays a fundamental role in maintaining ecosystem services, mitigating climate change, and promoting sustainable development. Given the growing interest in the carbon credit market, the conservation and restoration of these areas have become strategic instruments for environmental and economic development. This article discusses the relevance of preserving legal reserves and permanent preservation areas (PPAs) in public settlements under the jurisdiction of the state of Pernambuco, highlighting their ecological, social, and financial benefits. It also analyzes the potential of these territories for participation in carbon offsetting and credit generation mechanisms. The methodology adopted is based on descriptive research with an individual analysis of each area, a literature review, and an analysis of Brazilian experiences with carbon sequestration and offset projects in collective use areas. The conclusion is that the proper management of these reserves constitutes not only a legal obligation but also an opportunity to integrate environmental conservation with the improvement of the socioeconomic conditions of the settlers. Preserving reserves in public settlements is essential to conserving biodiversity, ensuring ecological balance, and contributing to tackling climate change. With proper management, these areas can generate carbon credits and strengthen the sustainability of settled communities, especially when supported by integrated environmental management policies, forest restoration, and payment for environmental services.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-157585: Agricultural Resource Management Through Shared Responsibility: Combining Technology, Policy, and Community Initiatives to Reduce Transboundary SMOG Across the Indo-Pak Border Region

Hafiz Muhammad Safdar Khan ^{1,*}, Imran Shauket ¹, Muhammad Yamin ², Azhar Ali ³, Furqan Muhayodin ² and Rao Husnain Arshad ⁴

¹ Department of Structures and Environmental Engineering, Faculty of Agricultural Engineering and Technology, University of Agriculture, Faisalabad 38000, Pakistan

² Department of Farm Machinery and Power, Faculty of Agricultural Engineering and Technology, University of Agriculture, Faisalabad 38000, Pakistan

³ Department of Food Engineering, Faculty of Agricultural Engineering and Technology, University of Agriculture, Faisalabad 38000, Pakistan

⁴ Department of Irrigation and Drainage, Faculty of Agricultural Engineering and Technology, University of Agriculture, Faisalabad 38000, Pakistan

Seasonal SMOG across the Indo-Pak border has become one of South Asia's most critical environmental and public health challenges. More than 50 million tons of rice and wheat residues are burned openly, which releases millions of tons of greenhouse gases, particulate matter (PM_{2.5} and PM₁₀), and notable amounts of black carbon. Severe respiratory illnesses and transboundary haze episodes that extend from Punjab to Delhi and Lahore are driven by these emissions, which also degrade regional air quality and visibility. Farmers continue to burn residues despite prohibitions and awareness campaigns because no accessible or reasonably priced management options are available. To investigate shared environmental responsibility in the management of agricultural residues, this study combines field data and policy analyses. It examines technological solutions such as biomass briquetting, bio-composting, and community-level residue collection that can lead to circular, low-emission rural economies. Briquetting alone can convert 25–30% of annual crop waste into renewable fuel, reducing CO and NO_x emissions by up to 80% and providing additional income to rural households compared with open burning. The findings demonstrate that, to address SMOG as a shared resource-use issue rather than merely an agricultural one, integrated policies involving farmers, local governments, industries, and regional institutions are required. By converting residue burning from a source of pollution into a circular bioeconomy opportunity through incentive-based policies, coordinated technology adoption, and regional air quality frameworks, the Indo-Pak border region can benefit from cleaner air and sustainable livelihoods.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-159497: Deploying Renewables: Trends, Overlaps and Impacts

Mengyao Han

Chinese Academy of Sciences, Beijing 100101, China

The transition to renewable energy plays an essential role in mitigating climate change; however, the deployment of renewables may pose substantial impacts on ecosystems. To date, a quantitative literature review has comprehensively investigated the characteristics and potentials of renewable energy deployment, while a substantial installed capacity was estimated to overlap with ecologically fragile land types. Although phasing out fossil fuels can significantly mitigate climate change, a rapid shift towards renewable energy deployment may bring new challenges. More sustainable pathways tend to exhibit land-intensive dispatch, while stricter regulations lead to more concentrated spatial layouts with higher energy intensities. The considerable overlaps between renewable energy installations and ecologically fragile areas indicated that the effectiveness of ecological regulations and barriers in preventing ecological habitat losses and human activity interventions needs to be re-examined. Through multiple spatial-temporal scenario projections, this study attempts to offer practical insights into the synergistic effects of the renewable energy transition on surrounding areas and emphasizes the significance of ecological regulations that may promote a sustainable and renewable energy transition worldwide. In this context, this study underscores the importance of promoting renewable energy deployment that not only supports climate mitigation but also aligns with ecological conservation, ensuring a more sustainable and ecologically responsible transition to renewable energy.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-158847: From Degradation to Restoration: Nature-Based Solutions for Environmental Recovery

Hina Qasim Shaikh

Department of Chemistry, Wilson college, Mumbai -400007, India

Rapid industrialization, urban expansion, and unsustainable exploitation of natural resources have intensified environmental degradation, resulting in biodiversity loss, soil erosion, water scarcity, and climate instability. In this context, Nature-Based Solutions (NbS) have emerged as a transformative framework for addressing environmental challenges through the sustainable management and restoration of natural ecosystems. This assessment highlights the environmental benefits of NbS in promoting environmental recovery across terrestrial, aquatic, and coastal ecosystems. Key strategies such as reforestation, wetland rehabilitation, green infrastructure, sustainable agriculture, and coastal ecosystem restoration are discussed in relation to their ecological, social, and economic impacts. The study also emphasizes the integration of traditional ecological knowledge and modern technologies to enhance restoration efficiency and long-term resilience. Furthermore, it explores the role of NbS in achieving global sustainability goals, particularly in climate adaptation, carbon sequestration, and disaster risk reduction. Despite their growing recognition, the implementation of NbS remains challenged by limited policy support, inadequate funding, and insufficient cross-sector collaboration. Strengthening governance frameworks, public awareness, and scientific innovation is essential to scale up their effectiveness. Overall, this study highlights the critical role of NbS as a bridge between environmental conservation and socioeconomic development, offering a sustainable pathway from degradation to ecological restoration.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-154858: From Kyoto to Paris: Evolving Legal Regimes and the Role of Emerging Technologies in Climate Adaptation

Shefali Vinod Ramteke

Department of Applied Sciences, Indian Institute of Information Technology, Allahabad, India

Over the past three decades, the international climate governance framework has evolved from the rigid, top-down structure of the Kyoto Protocol to the adaptive, country-driven mechanisms of the Paris Agreement. This transformation marks a decisive legal and political shift—from uniform emission obligations to differentiated yet cooperative action grounded in shared responsibilities. Within this evolution, adaptation has gained recognition as a legally grounded and indispensable pillar of the climate response. Article 7 of the Paris Agreement establishes a global goal on adaptation—to enhance adaptive capacity, strengthen resilience, and reduce vulnerability within the context of sustainable development and the Agreement's temperature goals.

This paper examines how the architecture of the Kyoto and Paris regimes can integrate emerging technologies to enable effective adaptation governance. Digital and data-driven innovations such as remote sensing, Internet of Things (IoT) systems, and geospatial mapping are discussed as instrumental in strengthening national adaptation planning, vulnerability assessment, and evidence-based policy formulation. Drawing on examples from climate-smart agriculture and natural resource management, the analysis highlights how these tools reinforce transparency, enhance cooperation, and expand adaptive capacity in line with the Enhanced Transparency Framework (Article 13).

By embedding technology transfer and digital cooperation within the evolving legal architecture of climate governance, the paper advocates a forward-looking interpretation of global climate law—one that links adaptation, equity, and innovation through shared responsibility and differentiated capability.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-157431: Hydrological and Economic Benefits of Sustainable Urban Drainage in an Allotment from Northeastern Portugal

Ana Maria Antão-Geraldes¹, Gabriel Hack Hack^{2,3} and Flora Silva^{2,4,*}

¹ Centro de Investigação de Montanha (CIMO), Instituto Politécnico de Bragança, 5300-253 Bragança, Portugal

² ESTiG, Instituto Politécnico de Bragança, Campus de Santa Apolónia, 5300-253 Bragança, Portugal

³ Campus Pato Branco, Universidade Tecnológica Federal do Paraná, 85503-390 Pato Branco – Brazil

⁴ GICoS, Instituto Politécnico de Bragança, Campus de Santa Apolónia, 5300-253 Bragança, Portugal

In the context of climate change and accelerated urban growth, the adoption of effective strategies for sustainable stormwater management has become essential. Excessive soil sealing increases surface runoff, leading to frequent urban floods and overloading conventional drainage infrastructures. This study assessed the influence of green roofs and permeable pavements on stormwater runoff and the design of a public drainage network in a 2.1-hectare urban allotment located in Portugal's Pluviometric Region B. Six drainage scenarios were simulated with different combinations of roof typologies and pavement types: (i) pitched roofs with conventional pavements ($C_m = 0.70$), (ii) pitched roofs with sustainable pavements ($C_m = 0.61$), (iii) flat roofs with conventional pavements ($C_m = 0.65$), (iv) flat roofs with sustainable pavements ($C_m = 0.55$), (v) green roofs with conventional pavements ($C_m = 0.59$), and (vi) green roofs with sustainable pavements ($C_m = 0.50$), being C_m the weighted average runoff coefficient that expresses the fraction of rainfall converted into surface runoff. The corresponding peak discharges were 380.06, 328.49, 350.62, 298.67, 320.53, and 268.68 L/s, respectively. A progressive reduction in runoff and peak flow was observed across scenarios, with the most sustainable configuration (Scenario 6) achieving a 29.31% decrease relative to the conventional configuration (Scenario 1). From an economic perspective, the most sustainable scenario had the lowest drainage network cost (EUR 32,092.76 + VAT), compared with EUR 35,919.82 + VAT in the conventional scenario. These findings demonstrate that sustainable drainage measures not only reduce surface runoff and mitigate urban flooding but also enable more cost-effective and resilient stormwater management systems, thereby contributing to the transition towards climate-adaptive cities.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-150286: Life as a Race of Survival in the Environment: Balancing Human Progress, Ecological Interdependence and Human Health

Mohammed Shoaibul Islam ^{1*} and Farhana Chowdhury ²

¹ Department of Environment, Earth and Ecosystems, The Open University, Milton Keynes MK7 6AA, UK

² Respiratory Department, Queen Elizabeth Hospital Birmingham, Birmingham B15 2TH, UK

Life is a race of survival within the environment, where every species depends on others through complex ecological interdependence. Yet, human civilisation has increasingly reshaped natural systems for comfort and progress, often disrupting the balance that sustains biodiversity, climate, and health. Urbanisation and industrial growth create artificial ecosystems that consume vast resources and emit pollutants back into the environment.

This study examines how human development can maintain full living standards while reducing environmental imbalance. It focuses on the carbon and nitrogen cycles as indicators of ecosystem stability and evaluates how urban design affects these fluxes.

A model city ("Flux City") was developed to simulate a fully supplied urban environment with 100% provision of food, water, power, housing, and waste services. Changes in carbon and nitrogen fluxes were analysed against natural baseline values to quantify human impact. Supporting examples from deforestation in the Amazon, fertilizer-driven greenhouse gas emissions, acid rain in industrial zones, and ocean oxygen decline were also considered to contextualise the findings within global environmental patterns.

Burning of fossil fuels increased from 0.6 to 7.5×10^9 g C y⁻¹, reflecting industrial and transport energy demand. Plant assimilation declined ~18% ($163 \rightarrow 134 \times 10^9$ g C y⁻¹), and soil carbon inputs fell ~17%, indicating vegetation loss and soil sealing. Industrial nitrogen fixation rose from 0 to 102×10^6 g N y⁻¹, while leaching and runoff grew >3 times, signaling eutrophication risk. Despite a 100% urban supply, ecosystem resilience decreased, and atmospheric CO₂ rose sharply.

Maintaining human needs without degrading the environment requires integrated solutions: electrification, low-carbon materials, precision agriculture, nutrient recovery, and urban greening. Sustainable survival demands partnership, not dominance over the environment.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-157087: Nueva Esperanza rural settlement: Challenges of a public policy for environmental and territorial Development in the peri-urban area of Neuquén (1993–2018), Argentina

Luis Eduardo Ferrari Irisarri *, Marcos Mare and Hugo Pailalo

Facultad de Humanidades - Departamento dev Geografía, Universidad Nacional del COMAHUE - Neuquén, Neuquén Capital, Código Postal 8300, Argentina

Introduction

This paper analyzes the process of a municipal public policy for the peri-urban area (Order No. 5843/93), aimed at the comprehensive approach to social vulnerability and the final disposal and management of urban solid waste (USW). The significance of this case lies in the collective construction of transition objectives from an informal "scavenging" economy to a community-based organization on farms for food production: "Colonia Rural Nueva Esperanza", located on the arid plain north of Neuquén city.

Methods

A historical periodization of the institutional management process and the formation of a new territoriality is developed using normative and documentary analysis (files, press personal archives). Applied methods include stakeholder analysis, key informant interviews, testimonial analysis, life histories, and fieldwork.

Results

Four stages are identified: 1974–1992, 1993–2000, 2001–2006, and 2007–2018. In the first two stages, the local government stands out for its role in the design and operational implementation; the new community organization emerges as a key actor; and there is a synergistic convergence of multiple institutions and actors in the fragmented peri-urban area of the city. The third stage corresponds to the outcome of the following:

- Strategic actions;
- Institutional consolidation;
- Management of productive infrastructure.

In the fourth stage, the project faces its greatest challenges due to the discontinuity of political intentions and pressures stemming from the transformation of the area into one of the most complex zones in Patagonia: accelerated urban expansion, development of local infrastructure, and regional coordination with the hydrocarbon activity in "Vaca Muerta".

Conclusions

The case demonstrates the importance of the State as a key actor in the practice of territorially and environmentally sustainable development. It reveals a process of territorialization and comprehensive refunctionalization of the peri-urban area, along with identity construction and a social conception of environmental problems. Current difficulties highlight the need for long-term governance instruments.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-162732: Shared Responsibility in Urban Environmental Regeneration

Celestina Fazio, Giulia Fernanda Grazia Catania * and Federica Sortino

Department of Engineering and Architecture, University of Enna Kore, Viale delle Olimpiadi, 94100 Enna, Italy

Contemporary cities increasingly face intertwined forms of environmental degradation and socio-spatial fragility, intensified by climate change, infrastructure deficits and unequal access to ecosystem services. This contribution advances an integrated perspective on shared responsibility in urban environmental regeneration, combining ecological assessment, socio-territorial vulnerability analysis and sustainability-oriented policy frameworks. The study interprets urban environments as complex adaptive systems in which environmental quality, settlement morphology, service accessibility and social marginalisation interact to produce differentiated exposure to environmental risks. Through a multidisciplinary analytical approach, this contribution identifies how limited ecological infrastructures, fragmented green systems and insufficient environmental monitoring exacerbate vulnerability in disadvantaged neighbourhoods. Particular attention is devoted to the role of governance structures and institutional accountability, emphasising how coordinated policies and participatory processes can mitigate impacts, prevent ecological deterioration and promote equitable resource management. The proposed framework outlines operational criteria for designing regeneration strategies capable of restoring ecosystem functions, reducing environmental pressures and strengthening the resilience of urban communities. The results highlight the importance of integrating environmental data, local knowledge and policy instruments to support long-term sustainability transitions. By bridging ecological understanding with policy-making, this research provides a methodological foundation for rethinking environmental responsibility in vulnerable urban contexts and encourages collaborative approaches to urban regeneration. The work contributes to current international debates on sustainability by proposing actionable pathways for environmentally balanced and socially inclusive urban development.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-155228: Spatiotemporal dynamics and drivers of an Italian reclamation landscape: the Piana di Sibari (Calabria, Italy)

Rosalucia Mazzei ¹, Gaetano Pellicone ², Tommaso Caloiero ³ and Giuseppe Tagarelli ^{1,*}

¹ National Research Council - Institute for Studies on the Mediterranean (CNR-ISMed), Naples, Via G. Sanfelice, 8 - 80134, Italy

² National Research Council - Institute of Agricultural and Forest Systems in Mediterranean (CNR-ISAFoM), Rende, Via Cavour, 4/6 - 87036 - Italy

³ National Research Council - Research Institute for Geo-Hydrological Protection (CNR-IRPI), Rende, Via Cavour, 4/6 - 87036 - Italy

Introduction

The reclamation of marshland has significantly reshaped the landscape of many regions across the Italian peninsula. A paradigmatic example of this transformation is the Piana di Sibari (Calabria, Southern Italy), the largest plain in Calabria, extending over approximately 475 km² and including six municipalities with a total population of around 112,000 inhabitants. As a critical interface between terrestrial and marine systems, the landscape of the *Piana di Sibari* represents an area of high ecological vulnerability and economic intensity, characterized by a mosaic of agricultural zones, wetlands, archaeological heritage sites, industrial areas, and urban expansion. This paper examines the evolution, status, and future perspectives of three case studies (a citrus rural area, Magna Graecia and Roman archaeological site, and wetland) in the context of ongoing climate change and the occurrence of increasingly intense and aggressive daily precipitation

Methodology

The NEX-GDDP-CMIP6 dataset of daily downscaled climate projections from CMIP6 models was used to evaluate future climate change impacts at the local scale by providing high-resolution climate scenarios for research. In particular, Walter–Lieth diagrams were applied to represent the climatic conditions observed in the recent past (1981–2020) and those projected for the near future (2026–2050) and distant future (2051–2076) in the Piana di Sibari. Moreover, to assess potential risks associated with extreme rainfall events, an analysis of daily precipitation concentration was performed.

Results

The analysis of Walter–Lieth climatic diagrams and precipitation concentration reveals clear evidence of ongoing and projected climatic shifts. Current trends suggest a rise in mean annual temperatures accompanied by a decline in mean precipitation in both the near and long term. At the same time, an increase in precipitation concentration has been detected. These alterations are likely to have significant implications for the management of the heterogeneous landscape of the Piana di Sibari.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-157223: The Evolution and Challenges of Water Governance in Morocco

Chahid Sadiki *, Abdelkrim Bouasria, Rachid Boutafoust and Abdelmejid Rahimi

Geodynamics and Geomatics Laboratory, Faculty of Sciences, Chouaib Doukkali University, El Jadida, 24000, Morocco

Morocco stands as a compelling case study of a water-stressed nation confronting a deepening crisis. Driven by inherent aridity, climate variability, population growth, agricultural expansion, and the accelerating impacts of climate change, the country's water security is under severe threat. In response, Morocco has progressively established a sophisticated water governance framework designed to navigate these mounting hydrological challenges. This paper provides a comprehensive examination of this evolving system, analyzing its legislative foundations, institutional architecture, and policy instruments, with a specific focus on the landmark Water Law 36-15 and the decentralization of management to basin-level agencies (*Agences de Bassin Hydraulique*, ABHs) to implement Integrated Water Resources Management (IWRM). Drawing on a synthesis of policy documents, academic literature, and recent empirical studies, our analysis reveals a complex and dualistic governance landscape. On one hand, Morocco has developed a robust legal base and has strategically promoted non-conventional water resources, such as desalination and wastewater reuse, as pillars of its water security strategy. On the other hand, significant implementation gaps persist. Key findings highlight persistent fragmentation across sectors—notably agriculture, energy, and municipalities—and governance scales; critical weaknesses in groundwater management and stakeholder participation; and enduring challenges related to data monitoring and informal water use practices. The paper concludes that bridging the gap between legislative intent and on-the-ground effectiveness is paramount. We thus offer targeted recommendations for enhancing basin-level integrity, fostering cross-sectoral coordination, and strengthening socially inclusive, adaptive governance to build a more resilient and equitable water future for Morocco.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-142386: The impacts of producing bio briquettes made from organic waste as an alternative source of fuel

Musaida Mercy^{1,2,3,*}, Walter Stinner⁴ and Charles Mbohwa⁵

¹ Sustainable Tech Environmental Management Company, Harare, Zimbabwe

² Sustainability and Future Technologies Research Center, University of South Africa, Pretoria, South Africa

³ Germany Biomass Research Center, Leipzig, Germany

⁴ Bioenergy System Department, DBFZ German Biomass Research Center gGmbH, Torgauer Str. 116, 04347 Leipzig, Germany

⁵ College of Science, Engineering and Technology, University of South Africa, Florida Campus, Roodepoort 1709, South Africa

This work investigates the potential benefits of using bio briquettes made from organic waste as an alternative source of fuel in sub-Saharan Africa. Over 80 million tons of organic waste is generated in Sub-Saharan Africa per annum, and this waste has potential to be valorized to other bioproducts. Currently, unmanaged organic waste poses serious landfilling challenges, causes health problems, and contributes to greenhouse gas emissions, which are harmful to the environment. This organic waste can be converted to bio briquettes through the process of carbonization and then briquetting to form bio briquettes that have the same heating value as coal. In addition to these bio briquettes providing an eco-friendly opportunity to reduce the amount of sulfur contaminants that are generated by coal during heating, they also have the potential to reduce the effects of climate change by reducing methane and carbon dioxide emissions through waste valorization. A sustainable and renewable source of energy which has the same burning effect as coal can also be obtained from these bio briquettes, since waste is generated daily by communities, agriculture processes, industries, wastewater treatment plants, and businesses. In addition, the usage of bio briquettes as an alternative source of fuel will help to prevent problems such as deforestation that are negatively impacting the African environment.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-170259: Responsibility allocation to producers and users in the global industry and trade chain “energy-minerals-electric vehicles”: An Emergy Accounting approach

Yanxin Liu ^{1,*} and Sergio Ulgiati ^{2,3}

¹ School of Management and Engineering, Capital University of Economics and Business, Beijing 100070, China

² University of Naples “Parthenope”, Department of Science and Technology, Naples, Italy

³ State Key Joint Laboratory of Environment Simulation and Pollution Control, School of Environment, Beijing Normal University, Beijing, China:

Production of electric vehicles (EVs) is expected to promote sustainability by decreasing fossil fuel use in the mobility sector. However, the rapid development of a global industry chain for the production of electric engines and batteries has exacerbated the inequality of resource utilization. New environmental impacts linked to material flows associated with the industry chain (steel, lithium and other minerals) are a source of huge concern and upstream, midstream and downstream (extraction, production, trade and use) shared responsibility. This study developed a multi-layer trade network model of “steel-minerals-electric vehicles” industry chain and provided a scientific framework for resource flow and responsibility allocation based on Odum’s Emergy Accounting (EmA) approach. Results firstly show that the worldwide trade volume and the number of involved countries increased enormously from 2017 to 2021 and keep growing. Secondly, in spite of the aim of mobility decarbonization, non-renewable energies (mainly coal) are still used in upstream countries. Finally, trade patterns mostly flow from upstream to midstream steel and other minerals producing and refining countries, and then to downstream EVs’ manufacturers and users, from which trade flows go back to midstream and upstream countries. Environmental impacts can be differently allocated to these countries, among producers and users. This reflects the huge imbalance among production and use in the different stages of the worldwide “steel-minerals-electric vehicles” industry chain. By means of EmA-based indicators (Environmental Loading Ratio, Emergy Sustainability Index and other valuation indicators), we can quantify the sustainability of each stage of the industry chain, in so allocating both impacts and responsibility according to different types of production and patterns of electric vehicle use. Based on these results, our study proposes policy implications for promoting regional industrial ecological sustainability from the perspectives of industry chain, trading partners and countries.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

Session 6. Ecological, Environmental and Circular Economics

sciforum-162707: Closing the Loop: Feasibility of Sustainable Organic Food Waste Management in a Circular Economy

Khurram Shahzad ^{1,*}, Muhammad Imtiaz Rashid ¹ and Arshid Mahmood Ali ²

¹ Center of Excellence in Environmental Studies, King Abdulaziz University, Jeddah, Saudi Arabia

² Department of Chemical & Materials Engineering, Faculty of Engineering, King Abdulaziz University, Jeddah, Saudi Arabia

In many regions, including the Kingdom of Saudi Arabia, municipal solid waste is still landfilled without energy or material recovery, resulting in environmental degradation and economic losses. This study evaluates the feasibility and economic potential of integrating composting of organic food waste (OFW) into a circular economy framework, using the City of Jeddah as a case example. The analysis quantifies the financial and environmental benefits of diverting OFW from landfills to a composting facility, including savings from avoided tipping fees, carbon credit gains from reduced methane emissions, and revenues from compost sales and its nutrient substitution value (carbon, nitrogen, phosphorus, and potassium). OFW generation in Jeddah is projected to rise to 1.30 Mton by 2030 due to rapid population growth and urbanization, providing the capacity to produce approximately 0.27–0.32 Mton of compost annually between 2015 and 2030. The proposed system not only mitigates ecological impact but also contributes substantial economic value, with estimated compost sales revenues of MSAR 284–341, environmental savings of MSAR 728–875, and fertilizer replacement benefits of MSAR 87–105 over the study period. By 2030, the composting strategy demonstrates the potential to deliver a net contribution of MSAR 1321 to the national economy. These findings highlight composting as a viable circular economy solution capable of closing material loops, reducing environmental burdens, and generating sustained economic returns for Saudi Arabia's waste management sector.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-157211: A Digital Circular MRO Model for Mining: Qualitative Evidence and Framework Design

Nelson Lawrence

Independent Researcher, 214 Brookview, Borrowdale, Harare +263, Zimbabwe

Introduction, Background, and Objectives

Mining operations continue to depend on linear Maintenance, Repair, and Operations (MRO) structures, limiting the ability to regenerate value from high-capital equipment and intensifying material consumption and carbon emissions. This study investigates how MRO systems can transition toward a digitally enabled circular model that extends component life and reduces material intensity across the equipment lifecycle.

Methods

A qualitative research design was applied using purposive sampling and semi-structured interviews with 22 specialists in reliability engineering, remanufacturing, supply chain, logistics, and sustainability across major mining firms and Original Equipment Manufacturers (OEMs). Interview data were coded and analysed using thematic analysis to identify operational, digital, and contractual constraints that shape the feasibility of circularity in current MRO systems.

Results

The analysis revealed four categories of barriers: (1) fragmented asset-health visibility, (2) inconsistent remanufacturing standards, (3) misaligned OEM–operator incentives, and (4) limited digital traceability for component provenance. Using these empirical insights, the study synthesizes engineering reliability principles, circular-economy logic, digital architecture, and supply-chain coordination theory to propose a **Four-Loop Circular MRO Structure**. The model formalises four value-regeneration pathways—**Reuse, certified material Recovery, load-sensitive Reduction, and OEM-governed Return**—each supported by explicit digital enablers: IoT-based condition telemetry, AI-driven remanufacturing candidate identification, Digital Twins for predictive simulation, and blockchain-secured material passports for authenticated component flows.

Contributions

The study provides:

A qualitatively validated conceptual model that operationalises circular MRO in heavy-equipment environments. A digital-systems blueprint that integrates reverse logistics, reliability engineering, and OEM–operator coordination. Empirical insights into the real-world organisational and contractual dynamics that influence circularity adoption in mining supply chains.

Conclusion and Future Work

Future research will quantitatively test the model through simulation and digital twin experiments to evaluate its potential impact on emissions reduction, component reliability, and supply chain performance.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-162097: Reframing Nature-based Solution Valuation through Complexity and Life-Cycle Planning: Evidence from Raingarden Performance in Auckland, New Zealand

Sue Ira ^{1,*}, Robyn Simcock ² and Iresh Jayawardena ¹

¹ Faculty of Engineering and Design, Architecture and Planning, University of Auckland, Auckland 1142, New Zealand

² Manaaki Whenua - Landcare Research Group, Bioeconomy Science Institute, Auckland 1072, New Zealand

Urban Nature-based Solutions (NbSs) offer multiple hydrological, ecological, cultural, and wellbeing benefits, yet their uptake remains constrained by economic appraisal frameworks that prioritise monetised, short-term outcomes and overlook wider co-benefits. Building on a recently developed economic valuation Decision Support Framework (DSF), this doctoral research advances a holistic approach that integrates measurable and non-measurable benefits across the life cycle of stormwater infrastructure. The framework is applied to a detailed raingarden typology case study in Auckland, New Zealand. Four raingarden typologies were identified across greenfield developments through field surveys, distinguished by size, configuration, and location. The DSF's complexity-aware decision pathway (adapted from Cynefin) was used to identify the appropriate valuation methods. This led to a combined qualitative and semi-quantitative assessment of benefits using the More Than Water (MTW) framework, alongside a life-cycle cost (LCC) evaluation. The DSF enabled explicit alignment of benefit types with decision-making contexts, revealing where monetised assessment is suitable (e.g., avoided material costs) and where semi-quantitative or qualitative valuation is required (e.g., biodiversity enhancement, urban cooling, shading, safety, placemaking). MTW results showed that raingarden typology strongly influences both the type and magnitude of multi-benefit outcomes, with media depth, vegetation complexity, and surface area emerging as dominant drivers of non-water benefits. While hydraulic and water-quality performance was broadly comparable across typologies, more complex designs generated markedly greater ecological, resilience, and wellbeing outcomes – benefits typically overlooked in conventional cost-efficiency analysis. LCC results further indicated that larger typologies achieve lower life-cycle costs due to economies of scale. The case study demonstrates that the DSF offers a practical, transferable method for embedding plural valuation and complexity-aware decision-making into stormwater planning. Its application reveals patterns of benefit realisation not captured by traditional cost-benefit analysis, supporting a shift toward more resilient, equitable, and system-aligned NbS investment in New Zealand and internationally.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-147922: Regeneration and Conservation Challenges of *Alnus glutinosa* (L.) Gaertn in riparian forests

Abdelouahab Sahli

Department of biology, Faculty of Sciences, Abdelmalek Essaâdi University, 93 000 Tetouan, Morocco

Alnus glutinosa (L.) Gaertn, a riparian forest species in Morocco, is declining due to habitat fragmentation and human disturbances. The Moroccan populations of *Alnus glutinosa* represent a climatic relic. These populations are isolated and threatened by both climate change and human activities. The status of this species in Morocco has been classified in the regional red list. Understanding its structure, regeneration dynamics, and vegetation composition is crucial for developing effective conservation strategies. This study assessed twelve populations, with 20 plots (30 x 30 m) sampled per population. In each plot, the density and diameter of all individuals were recorded, and vegetation composition was analyzed using thirty-six relevés. Significant variation in density and diameter was observed among populations (P<0.001). Although the regeneration status appeared satisfactory, population structure analysis identified five distinct patterns: a reverse-J shape, a broken reverse-J shape, a J-shape model, a bell shape, and an irregular shape, reflecting different demographic trends. A total of 218 species, from 161 genera and 74 families, were documented in *Alnus glutinosa* populations, with herbaceous species comprising 69% of the flora. The dominance of herbaceous vegetation may hinder seedling recruitment and survival, posing a challenge to population sustainability. These findings underscore the need for targeted conservation efforts, such as habitat restoration and seedling protection, to measure the long-term viability of *Alnus glutinosa*.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-162475: Agro-industrial waste from pineapple (*Ananas comosus* L. Merr) in the Papaloapan basin: enzymes, a link in the value chain

Nelda Xanath Martínez-Galero ^{1,*}, Rocio Guadalupe Franco-Fabian ², Valeria Ruiz-Valencia ³, Azul Buenaventura Pérez-Estrada ³, Esther Carbajal-Alejandro ³ and Adolfo Amador-Mendoza ⁴

¹ Organic Synthesis Laboratory, Scientific Research Center, Applied Chemistry Institute, Universidad del Papaloapan, Tuxtepec, 68301, México

² Medicine Faculty Chief, Universidad del Papaloapan, Tuxtepec, Oaxaca 68301, Mexico

³ Biotechnology Engineering, Universidad del Papaloapan, Tuxtepec, Oaxaca 68301, Mexico

⁴ Instituto de Agroingeniería, Universidad del Papaloapan, Loma Bonita, Oaxaca 68400, Mexico

Pineapple cultivation and processing generate large volumes of agro-industrial residues, including peels, crowns, cores, leaves, and fibrous fractions. These residues pose both an environmental challenge and an opportunity for value recovery. The Papaloapan Basin, located in the Lower Papaloapan region of Oaxaca and Veracruz, Mexico, accounts for a significant portion of the country's pineapple production. However, regional waste management practices are uneven and often rely on open-air disposal or low-value applications. This manuscript reviews the composition variation and environmental impacts of pineapple residues and enzyme variation in 2022.

Four cysteine endopeptidases are known from the pineapple plant: fruit bromelain, stem bromelain, ananain, and comosain. Since bromelain is of natural origin, different sources of biological material may exhibit variability in its proteolytic or physiological activity. This work presents the results of monitoring the quantification of protein concentration, proteolytic activity of the cysteine enzymes, and physicochemical parameters (°Brix, pH) of the extracts from pineapple plant residues of the Smooth Cayenne variety in two growth stages. This is intended to explore the potential commercialization of agricultural and agro-industrial residues from whole pineapple plants, a cultivar used in Mexico for canning. The overall correlation between protein concentration and proteolytic activity during May for the four residues (Cs, Cr, Cz, Pu), two maturity levels (G2 and G5), and thirty days of storage at 4 °C (t0, t15, and t30) was $r = +0.9358$. The correlation values on the day of collection (t0) were $+0.9788 \pm 1.0$ for all residues at both maturity levels. This data is extremely important for a pineapple producer's decision making, as it could determine, according to the degree of ripeness, which sector it will be most feasible to sell their product to. It also proposes an integrated circular-economy framework tailored to the socio-economic and agro-ecological context of the Papaloapan region.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-158320: Biomass-Activated Carbons in the Removal of Crystal Violet

Pedro Francisco Geraldo ^{1,2,*}, Isabel Pestana da Paixão Cansado ^{1,3} and Arlindo Mendes ³

¹ MED—Mediterranean Institute for Agriculture, Environment and Development & Change – Global Change and Sustainability Institute, Polo da Mitra 7000-083 N^o Sr^a da Tourega, Évora, Portugal

² Campus de Coalane, University of Licungo, Avenida Julius Nverere, Bloco II, n^o 1621, R/C, CP. 106, Mozambique

³ Chemistry and Biochemistry Department, School of Sciences and Technology, University of Évora, Rua Romão Ramalho n^o 59, 7005-671 Évora, Portugal

The increase in industrial production and the use of synthetic dyes has become one of the main sources of water pollution in recent decades. The textile industry, in particular, is responsible for discharging large volumes of wastewater with a high pollutant load, with estimates indicating that around 14,000 tons of dyes are released annually into the environment without proper treatment. These compounds exhibit high chemical stability and resistance to biodegradation, allowing them to accumulate in aquatic organisms and affect the entire food chain. Furthermore, they alter the physicochemical properties of water, such as pH and turbidity, and may contain toxic, mutagenic, or carcinogenic substances.

In this context, the development of sustainable wastewater treatment technologies has become essential to minimize environmental risks and preserve water resources. This study aimed to produce activated carbons (ACs) from Mozambican agricultural waste through chemical activation with potassium hydroxide (KOH), evaluating their efficiency in removing crystal violet (CV) dye from aqueous solutions. To optimize their adsorptive properties, ACs were simultaneously activated with KOH and a nitrogenous compound (urea) to increase porosity and specific surface area.

Three natural precursors were used, with a ratio of 1:2:1 (precursor: activating agent: urea). Kinetic adsorption tests were carried out at 298 K and pH 6 for 168 hours. Adsorption isotherms were determined using 10 mg of modified ACs added to 25 mL of CV solution (0–250 mg/L) under constant stirring at 20 rpm for 24 hours, ensuring equilibrium between the liquid and solid phases. The results showed high efficiency in removing the dye, with the sample prepared at a 1:2:1 ratio displaying the best adsorptive performance, a more porous structure, and a larger surface area. In contrast, the 1:2:0.5 ratio presented a lower adsorption capacity, likely due to reduced incorporation of nitrogen functional groups in the material matrix.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-157824: Can WWTPs become biorefinery centers for producing green hydrogen? A simulation case integrating sludge gasification and water electrolyzers

Ebtihal Abdelfatah-Aldayyat ¹, Alvaro Martínez-Sánchez ² and Xiomar Gómez ^{1,*}

¹ Department of Chemistry and Applied Physics, Chemical Engineering Area, University of León, Campus de Vegazana, 24071 León, Spain

² Manufacturing Process Engineering, TAFI research group, EIIIA, University of León, Campus de Vegazana, 24071 León, Spain

Wastewater treatment plants (WWTPs) can serve as hubs for converting waste into energy, thereby supporting a city's energy needs. Sewage sludge can be converted into valuable products through thermal processes. In gasification, energy-rich syngas is produced, which can be further valorized to generate electricity. However, the use of air introduces nitrogen as a diluent, thereby reducing the energy density. Integrating electrolyzers for hydrogen production into the process offers an added advantage: the use of oxygen as a gasification agent, thereby reducing dilution. The present work assesses the simulation of a conventional WWTP using Superpro Designer V13. Using pure oxygen in the gasification unit reduces the thermal energy requirements of the process. It increases the energy content by 4% when the system is operated under a CO₂ atmosphere and a 25% equivalence ratio (ER: 4.0) for both cases. Water electrolysis is integrated as an energy storage system; therefore, the scenarios analyzed assumed intermittent hydrogen production. This document highlights the importance of advancing research on the use of reclaimed water for hydrogen production, as well as the efficient integration of processes to reduce the energy and water footprints of technologies supporting a green transition.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-158168: Carbon footprint related to municipal solid waste management in upper middle-income countries: a multi-factorial study based on composition, operations and management strategies

Kaouthar Kerboua ^{1,2,*} and Hamza Cheniti ^{3,4}

¹ Department of Process and Energy Engineering, National Higher School of Technology and Engineering, 23005 Annaba, Algeria

² Laboratory of Mining, Metallurgy and Materials L3M, National Higher School of Technology and Engineering, Annaba, Algeria

³ Environmental Research Center, 23000, Annaba, Algeria

⁴ Department of Mining Engineering, National Higher School of Technology and Engineering, 23005 Annaba, Algeria

The geographic and economic contexts play a major role in the decision making when it comes to municipal solid waste management. In the present study, simulations are carried out using Waste and Resource Assessment Tool for Environment (WRATE) software academic version 3.0.1, based on the Ecoinvent database (version 2), to assess the greenhouse gas emissions released by 1 M tonnes of municipal solid waste with typical compositions characterizing upper middle-income countries, with an organic fraction around 50% in weight. The variation over time (2000 to 2022) with no intended transformation in the management strategy is first analysed, and then several transformations are applied by varying the waste management routes (open dumping, landfilling, recycling and composting) as well as the energy recovery integration. The results are then discussed based on the waste categories and the performed operations (landfilling, recycling, transportation, treatment and recovery). The results revealed that the most promising scenario involves limited open dumping that does not exceed 10%, landfilling with at least 20% energy recovery, and major fractions that address composting and recycling. Overall, this scenario returns a negative carbon footprint with a value surrounding -0.35 tons of CO₂-Eq/ton of MSW. The results serve as a decision tool in similar contexts to plan for the most affordable transformations according to the parameters covered by the study.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-159283: Challenges and Strategies for Implementing the Circular Economy in Modular Construction: Evidence from Germany

Yaseen Yaseen * and Alexander Malkwitz

Institute for Construction Operations and Construction Management, University of Duisburg-Essen, Universitätsstraße 2, 45141, Essen

The shift to sustainability and the circular economy (CE) in the construction industry is essential for reducing its environmental impact, especially in resource-intensive industries such as buildings. Prefabrication, especially modular construction, is gaining popularity in Germany because of its benefits, which include reduced on-site waste production and quicker assembly. It is supported by strong EU and national policies, such as the Circular Economy Act and the EU Circular Economy Action Plan. Studies on the practical implementation of the principles of the circular economy (CE) and the 10R model in the context of German modular construction are particularly scarce. However, emerging studies from other countries, such as Australia, have begun to explore these areas more extensively in recent years. The proposed systematic literature review (SLR) will be used to synthesize the available academic literature, industry reports, and case studies published between 2015 and 2025 to determine the most critical challenges and approaches related to the implementation of the 10R framework in modular construction. In accordance with PRISMA, extensive searches will be performed via Scopus, Web of Science, and German-specific databases, including the BMU reports. The literature retrieved will be subjected to thematic analysis to categorize the findings based on short-, medium-, and long-loop circular applications so that the operationalization of the principles of the circular economy in the modular construction environment can be structured. This study aims to address gaps in the existing literature to identify the barriers to integrating policy, technical, and industry awareness and suggest strategies for integrating them, including the design for disassembly (DfD), collaboration among stakeholders, and tracking materials with digital tools. Finally, it adds to both theory and practice by informing policy developments based on the National Circular Economy Strategy of Germany, capacity building, and future empirical research as a basis for facilitating the transformative adoption of CE in modular construction.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-162906: Circular Approaches in Aquaculture: Fishmeal Replacement and Algal Bioremediation

Eugenio Geremia ^{1*}, Maria Teresa Muscari Tomajoli ¹, Gianluca Fasciolo ², Adriana Petito ², Federica De Rosa ², Marco Pacileo ², Paola Venditti ², Claudio Agnisola ², Giovanna Salbitani ² and Gaetana Napolitano ¹

¹ International PhD Programme, UNESCO Chair “Environment, Resources and Sustainable Development”, Department of Science and Technology, Parthenope University of Naples, 80143 Naples, Italy

² Department of Biology, University of Naples Federico II, Naples, Italy

This project investigates two strategies to improve the sustainability of aquaculture: replacing part of the fishmeal in goldfish diets with protein-rich brewing by-products (brewer's spent grain and yeast, BSG and BSY) and assessing the ability of *Arthrospira platensis* (Spirulina) to bioremediate aquaculture wastewater while producing valuable biomass.

Fish were assigned to three dietary treatments: a control and two diets with 10% of fishmeal protein replaced by BSG or BSY. Growth performance, specific growth rate (SGR), weight gain ratio (WGR); feed conversion ratio (FCR), condition factor (CF), and protein efficiency ratio (PER) were assessed. Fish In: Fish Out (FIFO) was calculated to quantify reliance on marine-derived ingredients.

The bioremediation capacity of *A. platensis* was evaluated using wastewater from the control fish tanks. Algal growth was tested under three conditions: Zarrouk medium (control, C); wastewater (WW); and bicarbonate added wastewater (WWB). Biomass production, biochemical composition, and nutrient removal efficiency were measured. A life cycle assessment (LCA) was also performed using ISO 14040 standards and the ReCiPe method.

Replacing fishmeal with BSG or BSY did not affect growth performance, SGR, or FCR compared with the control diet. Fish fed the BSG diet showed a significantly higher PER ($p < 0.05$). FIFO values decreased from 5.39 (control) to 2.90 (BSG) and 3.27 (BSY). Spirulina cultivated in WW and WWB achieved biomass yields and protein contents comparable to the control treatment, while phycocyanin levels increased significantly. Nutrient removal efficiencies exceeded 94% for nitrogen and 99% for phosphorus in WW-based systems. The LCA identified WW-based cultivation as the most sustainable scenario due to the elimination of synthetic fertilisers and the additional benefits associated with wastewater bioremediation.

Integrating brewery by-products into aquafeeds and growing Spirulina on aquaculture wastewater provides a circular-economy approach that reduces reliance on marine ingredients, recycles nutrients, and lowers environmental impacts, promoting sustainable aquaculture intensification.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-152579: Digital Platform, Green Tech Solutions, and Economic, Social, and Ecological Resilience in Innovation Ecosystems

Selma Oliveira *, Lucas Sampaio Motta and João Pedro Passos

Fluminense Federal University

While prior research suggests that digital platforms can strengthen innovation, the escalation of sustainability challenges indicates that we still do not fully understand what a platform structure should look like to bolster green tech innovations while simultaneously strengthening economic, social, and ecological resilience in an innovation ecosystem in the face of extreme climate events. To address this situation, we propose a framework that focuses on digital platforms as a driver of green technology development. Our research sheds light on innovation intermediaries (such as incubators, technology parks, and accelerators) and deep tech startups in an emerging economy in the Global South—in this case, Brazil. We aim to address the following question: What should the platform structure be to share resources and strengthen green technology solutions while strengthening the economic, social, and ecological resilience of an innovation ecosystem? Our research is structured into four macro-phases: 1—systematic literature review; 2—mapping the demands of deep-tech startups and innovation intermediaries to identify potential solutions; 3—mapping the main innovation intermediaries; and 4—development and validation of the proposal. Our proposal is original, fills a gap in the literature, and makes significant contributions: (a) it presents a digital platform framework to strengthen the development of green tech innovations in an innovation ecosystem; (b) it identifies strategic resources offered by innovation intermediaries for the prosperity of green tech innovations and green technology entrepreneurship; and (c) it serves as a guide for deeptech ventures seeking to strengthen the development of green tech solutions and strengthen economic, social, and ecological resilience in the face of major challenges in the context of an emerging economy in the Global South, Brazil, state of Rio de Janeiro. Acknowledgement to the Rio de Janeiro State Research Support Foundation - FAPERJ, Technological Initiation Scholarship, Notice No. 10/2023.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-155670: Dynamic perspective of the evolution of the environmental Kuznets curve in Ecuador and Mexico

Rosa Llerena ¹, Roger Yela ¹, Hugo Galarza ¹, Giojan Aguirre ², Evelyn Vergara ¹ and Abril Herrera ^{3,*}

¹ Faculty of Social, Economic, and Financial Sciences, Quevedo State Technical University, Quevedo 120301, Ecuador

² Faculty of Educational Sciences, Quevedo State Technical University, Quevedo 120301, Ecuador

³ Faculty of Economic and Social Sciences, Autonomous University of Sinaloa, Culiacán 80010, México

The Kuznets Environmental Curve (EKC) hypothesis posits that environmental degradation intensifies during the early stages of economic development and subsequently declines once a critical income threshold is reached, resulting in an inverted-U-shaped relationship between income and environmental pressure. Ecuador and Mexico provide contrasting empirical contexts for examining these dynamics. The Ecuadorian economy remains heavily dependent on natural resource extraction, particularly oil and mining. In contrast, Mexico's economy is more diversified, combining industrial, service, and agricultural activities, yet it still faces persistent environmental challenges. This study assesses the empirical validity of the EKC in both countries over 2007-2024 by analyzing the relationship between economic growth and CO₂ emissions using spatial autoregressive (SAR) and spatial error (SEM) models. Recent subnational data, transformed in logarithmic form, were used to capture regional heterogeneity and improve the interpretation of spatial economic-environmental linkages. The results suggest that Ecuador remains in the ascending phase of the EKC. In contrast, Mexico exhibits a trajectory that approximates the expected inverted-U shape, indicating that some regions may have reached their tipping point. In addition, spatial dependence in Ecuador is strong and concentrated in extractive areas, while in Mexico, it is weaker and reflects a more diffuse and heterogeneous pattern of emissions



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-157836: Influence of the harvesting season on the yield and composition of biofuels from microalgae cultivated in raceway mode

Ailin Rasaie ^{1,*}, Indira Tobío ^{1,2}, Gabriela B.C. Leal ³, David Bolonio ¹, Magín Lapuerta ², Jorge Vieira ³ and Laureano Canoira ¹

¹ Department of Energy & Fuels-Tecminergy, ETS Ingenieros de Minas y Energía, Universidad Politécnica de Madrid, Ríos Rosas 21, 28003 Madrid, Spain

² Grupo de Combustibles y Motores, ETS Ingeniería Industrial. Universidad de Castilla-La Mancha. Avda. Camilo José Cela s/n, 13071 Ciudad Real, Spain

³ Laboratory of Biochemical Engineering, Microalgae Food Processing & Innovation Center, Federal University of Rio Grande, Rio Grande, Brazil

The utilization of microalgae for renewable biofuel production offers a promising alternative to fossil fuels mainly because of their rapid growth and high lipid content. Moreover, cultivating microalgae can help capture carbon dioxide and recycle nutrients, especially when integrated into waste management systems. However, environmental conditions significantly affect the productivity and chemical composition of algal biomass. Among these, the harvest season plays a major role, affecting the physiological conditions of the cells and the accumulation of energy-rich compounds. Understanding how seasonal changes affect the biofuel potential is essential for improving production efficiency and ensuring stable large-scale operations.

In this study, we evaluate how the harvesting season affects the yield and composition of biofuels obtained from naturally occurring microalgae grown in an open raceway pond at a biogas producing facility in Sauquillo de Boñices (Soria, Spain). The carbon dioxide from the biogas upgrading and the nutrients from the digestate liquids were used to stimulate microalgae growth. The algal species primarily consisted of *Chlorella sp.*, *Scenedesmus sp.*, and *Ankistrodesmus sp.* Samples were collected during four distinct seasons and processed under variable drying conditions. Oil extraction was carried out using the Soxhlet method, and the oils were converted to fatty acid methyl esters (FAMES) through esterification and transesterification. Our findings show that microalgae collected in winter contained the highest lipid levels and energy yields, while samples from warmer months resulted in lower-quality biofuels due to oxidative degradation and limited lipid accumulation. These observations highlight the importance of seasonal control and integrated biorefinery approaches for achieving efficient and sustainable microalgae-based biofuel production.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-157301: Integrating Technological Innovation and Legal Governance: A Proposal for a Waste Management and Resource Recovery Facility in the Circular Bioeconomy Era

Mayank Pratap

Faculty of Law, Varanasi Hindu University, Varanasi 221005, India

Amid rising volumes of municipal and agricultural waste, our initiative outlines a unified Waste Management and Resource Recovery Hub (WMRRF) designed to advance circular bioeconomy strategies through cutting-edge technology and regulatory frameworks. Leveraging cross-field partnerships in eco-engineering, biotech, and jurisprudence, the project seeks to repurpose challenging waste streams—such as organics, synthetics, and toxics—into premium assets, including renewable fuels, organic soil boosters, eco-polymers, and carbonized amendments, while reducing ecological harm and carbon emissions. Near-term aims include building compact setups for sorting, aerobic breakdown, gas fermentation, and element reclamation, alongside probes into bio-based solutions and community practices shaping local handling networks. Over the horizon, plans include expanding pilot areas, catalyzing business ventures through industry-academia partnerships, and embedding inclusive decision-making to drive fair job creation.

In handling refuse, the hub integrates smart computing to streamline operations and enable full-cycle audits, boosting material reuse and reducing reliance on dumping, aligning with national zero-emission pledges. On the rules side, it emphasizes data-driven rule-making, incorporating maker accountability schemes (EPR), adherence to national disposal codes, and a framework for ongoing oversight. Linking tech breakthroughs to people-focused law, this blueprint promises tougher safeguards, knowledge sharing, and cross-sector collaboration, paving the way for robust waste networks that balance environmental solutions, cost-effectiveness, and fair legal footing.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-155177: Investigating an Applied Bio-Sustainability Praxis (ABP) Higher Education Model to Support Green Jobs in the ASEAN region

Ariel Toh ^{1,2}

¹ Sustainability and Technology, Marcharh Initiative Centre for Sustainable Solutions (MICS), London E14 5AA, UK

² Strategy and Management, Kedge Business School, Talence 33405, France

ASEAN nations such as Malaysia, the Philippines, and Thailand represent a globally significant nexus of biodiversity and ecological vulnerability. This posits that a fundamental gap exists within the higher education institutions (HEIs) of these nations. Despite the charted policy in the workforce to prepare for green jobs, many ASEAN HEIs often fail to equip both current and future graduates with the interdisciplinary competencies required to tackle complex ecological challenges, along with a strong foundation in biological sciences. This research proposes the Applied Bio-Sustainability Praxis (ABP) model, a novel curriculum model grounded in Mezirow's Transformative Learning Theory. The model provides a structured methodology for HEIs to systematically integrate advanced biological sciences with key sustainability domains, including environmental assessment, circular economics, and biodiversity policy. The research uses a multi-level validation approach that includes a comparative study of the curriculum and semi-structured interviews with prominent scholars in the three countries. Through such triangulation of data, the study aims to define the ABP model as a versatile higher education template of re-engineering biological science education. Empirical research points to a trend of greater education establishments displaying an aura of environmental worry, a kind of greenwashing, as opposed to taking the radical, more systemic, and profound alterations that would be necessary to integrate ESD meaningfully. It is agreed by most high-ranking leaders in the education field that successful ESD requires an interconnected, multidisciplinary, and holistic approach that is not added as an option or siloed curriculum, but instead is embedded in the heart of other disciplines, including biology.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-162875: Life Cycle Evaluation of Next-Generation Photovoltaic Systems with Emphasis on Material Flows and Circular Economy

Patryk Leda ^{1,*}, Izabela Piasecka ² and Anna Leda ³

¹ Faculty of Mechanical Engineering, Faculty of Mechatronics, Kazimierz Wielki University, Mikołaja Kopernika 1, 85-074 Bydgoszcz, Poland

² Faculty of Mechanical Engineering, Bydgoszcz University of Science and Technology, al. Prof. S. Kali-skiego 7, 85-796 Bydgoszcz, Poland

³ Faculty of Political Science and Administration, Kazimierz Wielki University, J. Poniatowskiego 12, 85-671 Bydgoszcz, Poland

This study presents a comprehensive life cycle evaluation of next-generation photovoltaic (PV) systems, with particular emphasis on material flows, environmental impacts, and their alignment with circular economy principles. The analysis compares mono-crystalline silicon and perovskite photovoltaic technologies, assessing the environmental burdens associated with the production, operation, and end-of-life management of their materials, components, and structural elements. Environmental performance was quantified using the ReCiPe 2016 method for human health, ecosystem quality, and resource depletion, supplemented by the IPCC approach to evaluate life-cycle greenhouse gas emissions.

The results indicate that manufacturing and end-of-life stages are the most environmentally intensive phases of both PV technologies, primarily due to high energy requirements and the use of resource-intensive materials. Mono-Si modules were identified as the dominant contributors to overall environmental impacts, whereas perovskite-based systems exhibited notably lower burdens, including reduced greenhouse gas emissions and diminished pressures on mineral and fossil resources.

Two end-of-life scenarios—landfill and recycling—were evaluated, demonstrating that recycling significantly reduces total environmental impacts and improves material recovery efficiency. These findings confirm the importance of circular design strategies, resource-efficient manufacturing, and advanced recycling technologies in enhancing the sustainability of emerging photovoltaic systems. The study provides valuable insights to support the development of cleaner, more resilient PV solutions that align with long-term circular-economy goals.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-158159: Linking spatial convergence and circular economy transitions: evidence from waste-sector emissions in Sub-Saharan Africa

Josephine Andrea Niangue

Graduate School of Global Environmental Studies, Sophia University, Tokyo, Japan

Inefficient waste management across Sub-Saharan Africa contributes substantially to greenhouse gas emissions, disrupting ecological nutrient cycles and accelerating environmental degradation in rapidly expanding urban peripheries. This study investigates spatial patterns, regional trends, and convergence in waste-sector CO₂-equivalent emissions, adjusted for organic waste fractions, across Kenya, Uganda, Tanzania, Ghana, and Nigeria from 2014 to 2023. The analysis highlights the interlinkages between waste management practices, emission intensities, and transitions toward a circular economy. Spatial dependence was examined using Moran's I statistics and spatial lag regressions, while convergence was assessed through σ -variation, unconditional β -regression, and the Phillips-Sul (2007) club convergence approach. A life-cycle assessment conducted in OpenLCA with the ReCiPe 2016 method simulated the potential emission reductions from anaerobic co-digestion of organic wastes. Ecological network mapping was performed using the enaR package in R. Spatial analysis indicated significant clustering of waste-sector emissions (Moran's I = 0.42, p = 0.01), highlighting emission hotspots in East Africa. Mean emission intensity was 0.97 t CO₂-eq per tonne of waste, with σ -dispersion declining from 0.26 in 2014 to 0.23 in 2023. Convergence was strongest among West African countries, particularly Ghana and Nigeria. The findings demonstrate that anaerobic digestion can accelerate the convergence of emissions and restore nutrient cycles, thereby reducing soil erosion and biodiversity loss. Coordinated regional policies promoting shared infrastructure for digestion can reshape emission clusters and strengthen nature-based resilience in African urban ecosystems.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-162727: Microbial production of biodegradable polymers using toxic compounds and CO₂

Young-Cheol Chang

Course of Chemical and Biological Engineering, Division of Sustainable and Environmental Engineering, Muroran Institute of Technology, Muroran 050-8585, Japan

The integration of harmful-substance biodegradation with the synthesis of value-added biopolymers such as polyhydroxyalkanoates (PHA) offers a promising strategy to reduce production costs and address environmental challenges. As interest grows in CO₂ capture, storage, and utilization, captured CO₂ is increasingly recognized as an economical carbon source for producing biocompatible plastics. In this study, *Cupriavidus* sp. CY-1 was investigated for its ability to degrade trichloroethene (TCE) and *cis*-1,2-dichloroethene (cDCE) while simultaneously producing biodegradable polymers. CY-1 showed robust growth when supplied with TCE and co-substrates such as phenol or Tween 80, achieving a maximum cell dry mass of 0.68 g L⁻¹. The highest poly-β-hydroxybutyrate (PHB) accumulation, 350 mg g⁻¹ CDM, was observed with cDCE, phenol, and Tween 80. The strain degraded up to 100 mg L⁻¹ TCE. To further enhance detoxification efficiency, an electrochemical dehalogenation approach is being developed to reduce the toxicity of chlorinated compounds under mild, environmentally benign conditions. To assess PHB production from CO₂, cultures were incubated under various gas mixtures, including H₂/O₂/CO₂ and combinations with N₂ or CO. CY-1 was pre-cultured in nutrient broth, washed, and reinoculated into mineral medium before gas replacement. Under H₂/O₂/CO₂ conditions, the strain achieved a maximum PHB content of 90%, demonstrating effective CO₂ conversion. Although non-combustible gas mixtures yielded lower PHB levels, CY-1 consistently utilized CO₂ as a carbon source. These findings highlight the potential of CY-1 as a dual-function bacterium capable of degrading pollutants and synthesizing CO₂-based bioplastics. Continued development of CO₂-driven PHA production could provide low-cost substrates and contribute meaningfully to global sustainability goals.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-162866: Multivariate Analysis of Toxic Contaminants: A Data-Driven Approach to Evaluating Harmful pollutants Accumulated in fish species

Nusrat Jahan Ema ^{1,*}, Tanvir Ahmed ², Mosammat Mustari Khanaum ³, Farzana Ferdoush ⁴ and Mohammed Ali Nause Russel ⁵

¹ Department of Biostatistics, Augusta University, Augusta, GA 30912, USA

² School of Computer & Cyber Science, Augusta University, Augusta, GA 30901, USA

³ Environmental and Conservation Sciences Program Civil, Construction and Environmental Engineering North Dakota State University Fargo, ND, USA

⁴ Department of Arts and Sciences, Ahsanullah University of Science and Technology, Dhaka, Bangladesh

⁵ School of Social and Environmental Sustainability, University of Glasgow, Glasgow, UK

Sustainable fish resources are essential for ecological and economic stability, yet many freshwater fish species accumulate toxic contaminants that threaten human health, environment and regional economies. This study analyzes a multi-variable dataset from the Michigan Fish Contaminant Monitoring Program, containing 37 variables across numerous fish species and including key pollutants, such as mercury, perfluorooctane sulfonic acid (PFOS), polychlorinated biphenyls (PCBs), dichlorodiphenyltrichloroethane (DDT), chlordane, and toxaphene. After rigorous preprocessing, including missing-value treatment, outlier removal using the 3-sigma rule, and z-score standardization, principal component analysis (PCA) was applied to characterize contamination patterns. The principal component analysis revealed that the first three principal components explain approximately 55% of total variance, with PC1 reflecting overall contamination and fish size, while PC2 and PC3 distinguish pesticide-driven pollutants from industrial chemicals. These statistically derived contamination regimes highlight biophysical pressures that carry economic consequences. Notably, species such as Lake Whitefish and Lake Trout, which support a \$5.1-billion Great Lakes fishery, exhibit contamination patterns with direct implications for market stability and food safety. The findings illustrate how multivariate statistical methods can inform ecological and environmental economic assessments, identifying pollution pathways and supporting circular-economy strategies aimed at reducing contaminant inputs, improving resource efficiency, and safeguarding economically and ecologically valuable fish populations.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-162408: Regeneration of Modified *Abies marocana* Biosorbents for Methylene Blue Removal: Advancing Circular Economy in Sustainable Wastewater Treatment

Malak Zirari ^{1,*}, Driss Hmouni², Nouredine El Mejdoub¹

¹ Laboratory of Organic Chemistry Catalysis and Environment, Department of Chemistry, Faculty of Sciences, Ibn Tofail University, BP 133, Kenitra 14000, Morocco

² Laboratory of Natural Resources and Sustainable Development, Department of Biology, Faculty of Sciences, Ibn Tofail University, BP 133, Kenitra 14000, Morocco

Methylene blue (MB) is a widely used cationic dye whose persistence, strong coloration, and potential toxicity pose significant environmental threats when discharged into aquatic ecosystems. Natural biosorbents have gained attention as cost-effective materials for dye remediation. Among them, modified *Abies marocana* biomass has demonstrated promising adsorption performance, achieving an initial MB removal efficiency of 96.5% under optimized conditions. To ensure its practical applicability in wastewater treatment, evaluating the regeneration and reusability of the biosorbent is essential. This study focuses on assessing the regeneration behavior of sulfuric-acid-treated *A. marocana* needles (AMNS) following MB saturation. Chemical regeneration was carried out using an acid-elution approach, in which the effects of eluent concentration and contact duration were examined. The regenerated biosorbent underwent several adsorption-desorption cycles, and its performance was monitored using UV-Vis spectrophotometric measurements to determine the recovery of adsorption efficiency after each cycle. The AMNS biosorbent exhibited strong regeneration capacity, maintaining a substantial proportion of its initial performance after repeated reuse. Over three successive cycles, the regenerated material retained 80–90% of its original adsorption capacity, indicating efficient desorption of MB molecules and limited degradation of surface functional groups. These results suggest that the chemical modification applied to *A. marocana* enhances its structural stability and resilience during regeneration. The findings highlight the potential of modified *Abies marocana* biomass as a durable and reusable adsorbent for the treatment of MB-contaminated wastewater. Its high initial removal efficiency, combined with strong regeneration performance, supports its integration into sustainable, low-cost water treatment systems. The regeneration behavior confirms that AMNS can be effectively reused over several cycles without significant loss of adsorption capacity, reinforcing its value as an environmentally friendly biosorbent.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-158232: Sustainable Production of Antimicrobial Peptides from Fruit Waste Using Genetically Modified Yeast for Pathogen Control

Patrícia Branco *, Rúben Marques, Sofia Terpstra and Elisabete Muchagato Maurício

¹ BIORG - Bioengineering and Sustainability Research Group, Faculty of Engineering, Lusófona University, Campo Grande 376, 1749-024, Lisbon, Portugal

² CBIOS - Research Center for Biosciences & Health Technologies, School of Health Sciences and Technologies, Lusófona University, Campo Grande 376, 1749-024, Lisbon, Portugal

Fruit and vegetables are among the food groups with the highest post-harvest losses, with an estimated 40% of production discarded worldwide. This organic waste significantly contributes to greenhouse gas emissions, particularly methane, during decomposition, emphasising the need for sustainable and circular strategies to valorise resources. This study aimed to develop a sustainable method for producing antimicrobial peptides (AMPs) from fruit peel waste using genetically modified *Saccharomyces cerevisiae* expressing the Ethanol Red TDH1 (ER TDH1) gene and to evaluate their potential against microbial pathogens.

Waste peels of mango, pineapple, banana, and apple were processed into must. The musts underwent acid hydrolysis, followed by alcoholic fermentation with *S. cerevisiae* ER TDH1. After fermentation, peptides 10 kDa were extracted from the cell-free supernatant by ultrafiltration and tested against microbial pathogens, including *E. coli*, *P. aeruginosa*, *S. aureus*, and *C. albicans*. Glucose, fructose, and ethanol levels were monitored throughout. For peptide production comparison, alcoholic fermentation of a synthetic must was performed, yielding higher ethanol (14 g/L) than fermentation of fruit must (3 g/L). The 10 kDa peptide fraction from fruit must showed strong inhibition of *S. aureus* and *C. albicans* (MIC = 1.47 mg/mL), while synthetic must peptides performed better against *E. coli* and *P. aeruginosa* (MIC = 1.47 mg/mL). AMPs derived from fruit waste via fermentation show promising antimicrobial activity, particularly against Gram-positive bacteria and yeast, highlighting their potential as sustainable, natural antimicrobial agents for pharmaceutical or food product applications, while contributing to circular economy principles by transforming underutilized biomass into high-value bioactive compounds.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-162920: Sustainable Single-Use Plastic Management in Morocco: Analysis and Environmental Policy Recommendations

Chouaib Benqlilou

Sustainability, Energy and Mathematical Modeling, Ecole Nationale Supérieure des Mines de Rabat,
Rabat 10000, Morocco

Plastic pollution remains a pressing environmental issue, with significant implications for ecosystems, biodiversity, and public health. Morocco's reliance on imported plastics, particularly in the agrifood sector, exacerbates these challenges. This study presents a holistic analysis that integrates data, policy frameworks, and environmental considerations to address the growing SUP challenge in the HORECA ecosystem and agrifood. It highlights the critical need for strategic interventions, including the implementation of Extended Producer Responsibility and eco-tax systems, to enhance recycling infrastructure and incentivize sustainable practices. The research also emphasizes the adoption of Best Available Techniques and Best Environmental Practices to mitigate the impacts of microplastics and Persistent Organic Pollutants. Furthermore, a Theory of Change framework is proposed to align institutional collaboration, technological innovation, and public engagement, providing policymakers with actionable insights to transition toward a circular economy. This study offers a comprehensive roadmap for tackling Morocco's plastic waste challenges, emphasizing the importance of sustainable practices and long-term policy reforms to support the country's development goals.

By presenting a comprehensive perspective that aligns policy reforms, technological innovation, and public engagement, this research provides policymakers with a robust framework to tackle Morocco's plastic waste challenges effectively. Future efforts should prioritize evaluating the implementation of these recommendations and exploring innovations in plastic alternatives, further supporting Morocco's sustainable development goals.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-162133: Sustainable Stabilization of Expansive Soils Using Lime Sludge and Sodium Chloride: A Circular Economy Approach

Mohamed Hamdy Sharaf^{1,*}, Elias Afif khouri^{2,3} and Mohie el din Elmashad⁴

¹ Building and Construction Engineering Department, Arab Academy for Science, Technology and Maritime Transport (AASTMT) Alexandria 21937, Egypt

² Polytechnic School of Mieres, University of Oviedo, 33600 Mieres, Asturias, Spain

³ Institute of Natural Resources and Territorial Planning, University of Oviedo, 33600 Mieres, Asturias, Spain

⁴ Geotechnical Department, National Water Research Center – Construction Research Institute, Delta Barrage 13621, Egypt

Expansive soils represent one of the major challenges in geotechnical engineering due to their unpredictable shrink-swell behavior, which compromises the structural stability of buildings and complicates their use in construction projects. This phenomenon, influenced by seasonal climate variations, is expected to worsen under projected climate change, which is characterized by extreme precipitation and greater thermal variability, significantly increasing the risk of structural damage.

Conventional stabilization methods, such as the exclusive use of lime or salts, present limitations: they require large quantities of material, generate environmental impacts, and do not always guarantee sustainable improvements. This study proposes an innovative approach that combines sodium chloride (NaCl) and lime sludge (LS), a by-product from water treatment plants, to improve the properties of expansive soils while aligning with circular economy principles. Mixtures were prepared with 3%, 6%, and 9% NaCl and 5%, 10%, and 15% LS. Laboratory tests—including Atterberg limits, free swell, swelling pressure, swelling percentage, and infiltration—were conducted to evaluate changes in the soil's swelling characteristics.

The results show reductions of up to 35% in liquid limit and 65% in free swell. Furthermore, the reduction in plasticity index was up to 36%. In addition, infiltration was 40 mm at the beginning and became 25mm, contributing to better hydraulic stability. Many tons of lime sludge were utilized in the project. By incorporating the lime sludge directly into the treated soil, the material was diverted from potential landfill disposal, thereby reducing the volume of waste generated and lowering the emissions normally associated with conventional waste management practices.

This approach offers a more efficient, cost-effective, and sustainable technical solution, distinguished by its dual action (chemical and recycling) and its contribution to waste valorization. Future research will focus on validating the method at the pilot scale and assessing its performance under extreme climatic conditions, consolidating its applicability in resilient infrastructure projects.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-157589: Terminological inconsistencies in German construction waste law and their impact on separation practices in the context of the circular economy

Alina Zdankina * and Alexander Malkwitz

Institute of Construction Management, University of Duisburg-Essen, Essen 45141, Germany

Circular economy in the construction sector is significantly hindered by the lack of terminological consistency in German waste legislation. In particular, the Waste Catalogue Ordinance (AVV) does not provide consistent definitions for key terms such as “construction debris” or “mixed construction waste.” This leads to inefficient separation processes and unnecessary mixing of uncontaminated and contaminated materials, which undermines efforts to implement closing-the-loop strategies and effective recycling practices. Container services responsible for the disposal of construction debris and mineral construction and demolition waste apply their own operational definitions. As a result, environmental economic challenges arise, especially for private individuals who, due to inconsistent terminology, are unable to separate waste correctly, often incurring additional costs after disposal. A website-based benchmarking analysis was conducted to examine and compare the terminology used on the websites of German container services. This was complemented by a systematic literature review to identify relevant characteristics of mineral construction and demolition waste and to formulate definition proposals that could be applied within German waste legislation. The study reveals a clear discrepancy in terminology and its negative impact on circular material flows. The newly developed definitions enable transparent and systematic separation processes. These definitions form a foundation for more efficient resource use and pollutant reduction in the construction sector. They may serve as a reference for other countries seeking to improve the regulatory basis for a functioning circular economy in the handling of construction and demolition waste. In the long term, terminology in this field could be harmonized across Europe or globally to enhance connectivity, transparency, and the statistical tracking of material flows.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-158392: Transforming local waste into value: Activated carbon from brewery sludge for sustainable phosphate removal

Tewodros Nigatu Bitaw ^{1*}, Emilia Konował ², Habtamu Engdaw Bizuneh ¹, Abrham Bayeh Wassie ¹ and Mequanent Esubalew Nigatu ¹

¹ Department of Chemical Engineering, University of Gondar, Maraki Sub-city, P.O.Box: 196, 6200 Gondar, Ethiopia

² Institute of Chemistry and Technical Electrochemistry, Poznan University of Technology, Berdychowo 4, 60-965 Poznan, Poland

Introduction

Phosphate pollution from industrial wastewater remains a critical threat to aquatic ecosystems due to eutrophication and nutrient imbalance. Addressing this challenge requires sustainable and locally adaptable solutions. This study presents an environmentally conscious approach to converting brewery sewage sludge—an abundant local waste in Gondar, Ethiopia—into activated carbon for phosphate removal. The concept integrates waste valorization with circular water management, reducing disposal burdens while producing efficient adsorbent materials.

Materials and Methods

Sewage sludge was chemically activated using phosphoric acid (H_3PO_4) and sodium hydroxide (NaOH), followed by controlled thermal treatment. Physicochemical properties were analyzed using FT-IR, BET surface area, pH_{pzc} , and proximate analysis. Batch adsorption tests were optimized via Response Surface Methodology (Design Expert 13.0.5) under varied pH (3–10), contact time (60–120 min), and adsorbent dosage (1–3 g).

Results

The H_3PO_4 -activated carbon exhibited a highly porous structure ($427.32\text{ m}^2/\text{g}$) and achieved 80.3% phosphate removal with an adsorption capacity of 13.6 mg/g at optimal conditions (pH 3, 120 min, 2.6 g). Adsorption followed the Langmuir isotherm and pseudo-second-order kinetics, indicating chemisorption on a uniform surface. The regenerated adsorbent retained over 50% efficiency after three reuse cycles, confirming its operational stability.

Conclusions

This work demonstrates that brewery sludge—a problematic local waste—can be transformed into a high-value, reusable adsorbent for water purification. The approach supports both environmental protection and resource efficiency, offering a scalable, low-cost pathway toward cleaner water and circular economy practices. It exemplifies how local waste can become a local solution to global environmental challenges.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-158173: Transitions Toward a Circular Economy in Protected Agriculture Across the Americas: A Bibliometric Analysis of Trends, Approaches, and Research Gaps

Edwin Villagran ^{1*}, Jhon Javier Espitia ², Fabian Velasquez ², Jader Rodriguez ² and Andres Sarmiento ²

¹ Colombian Corporation for Agricultural Research—Agrosavia, Central Headquarters, Km 14, Mosquera–Bogotá. Mosquera 250040, Colombia

² Colombian Corporation for Agricultural Research—Agrosavia, Tibaitatá Research Center, Km 14, Mosquera–Bogotá. Mosquera 250040, Colombia

The transition toward a circular protected agriculture in the Americas represents a strategic challenge to harmonize productivity, sustainability, and environmental restoration. This study presents a bibliometric analysis of scientific production on the application of circular economy principles to greenhouse, nursery, and protected agriculture systems, based on 34 documents indexed in Scopus between 1994 and 2025, originating from the United States, Canada, Brazil, Argentina, and Colombia. The results show a steady increase over the last decade, driven by the expansion of the bioeconomy, the valorization of agricultural residues, and the pursuit of low-carbon food systems. The leading countries, the United States (47%) and Canada (26%), concentrate their studies on organic waste management, anaerobic digestion, and nutrient recovery, whereas in South America, emerging approaches focus on water reuse, substrate recycling, and energy efficiency in intensive greenhouse horticulture. The keyword co-occurrence analysis (VOSviewer) identifies three main conceptual axes: (i) waste management and soil fertility, (ii) bioeconomy and energy recycling, and (iii) sustainability in protected agriculture. Although the European model of Almería is widely regarded as a global technological reference, research across the Americas is shifting toward regional adaptation through appropriate technologies and ecological transition policies. Future research should prioritize life cycle assessment of materials and resources, the redesign of metabolic flows in greenhouses, the digitalization of circular systems, and multilevel governance that integrates science, policy, and producers. Strengthening inter-American research networks will be essential to consolidate a paradigm of circular protected agriculture that is resource-efficient, low-carbon, and climate-resilient, serving as a cornerstone for food security and environmental sustainability in the region.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-161569: Valorization of lignin for the development of sustainable amphiphilic modifiers with high surface activity for environmentally responsible cement systems

Marta Sybis¹, Emilia Konował^{2,*} and Anna Modrzejewska-Sikorska²

¹ Department of Construction and Geoengineering, Poznan University of Life Sciences, Piatkowska 94 E, 60-649 Poznan, Poland

² Institute of Chemistry and Technical Electrochemistry, Poznan University of Technology, Berdychowo 4, 60-965 Poznan, Poland

Developing construction materials with a reduced environmental footprint requires the use of biosurfactants or bioinspired modifiers that can partially replace conventional petrochemical additives. This study focuses on the surface activity of bioinspired amphiphilic compounds with aromatic structures, obtained from renewable resources. The aim was to evaluate their adsorption capacity and potential application in cement technology, particularly in influencing rheology and the porous structure of cement mixtures. Aqueous solutions of bioinspired compounds with different molecular weights and chemical modifications were prepared. For comparison, synthetic additives were analyzed, including sulfonated melamine–formaldehyde condensate (SMF), sulfonated naphthalene–formaldehyde condensate (SNF), and hydroxycarboxyl starch derivatives. Surface tension was measured using the Du Noüy ring method with a KSV Sigma 701 tensiometer. Adsorption parameters—surface excess (Γ), molecular area (A_{min}), and Gibbs free energy (ΔG_{ads})—were calculated using the Szyszkowski equation. The bioinspired compounds demonstrated high surface activity and formed stable, compact monolayers. Medium molecular weight samples showed the most effective packing, indicating favorable dispersing properties in cement systems. In comparison to synthetic superplasticizers and starch derivatives, these compounds exhibited competitive adsorption and surface activity, highlighting their practical potential. The findings confirm that renewable, aromatic amphiphilic compounds can serve as a foundation for designing next-generation biosurfactants. Their use in cement formulations supports sustainable construction practices and circular economy principles, reducing reliance on non-renewable resources and industrial waste while improving material performance.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-158234: Valorization of Strawberry (*Fragaria × ananassa* Duch) cv. ‘Malwina’ by-products: A Source of Phenolics and Antioxidants for Sustainable Applications

Greta Grikštaitė-Prapiestė *, Živilė Tarasevičienė and Indrė Čechovičienė

Department of Plant Biology and Food Sciences, University of Vytautas Magnus University, Agriculture Academy, Kaunas, Lithuania

The leaves, stems, and roots of strawberries (*Fragaria × ananassa* Duch.) are typically discarded, together with the pomace residues generated during industrial processing. This study evaluated the distribution of phenolic compounds, flavonoids, and anthocyanins in different plant parts and pomace to assess antioxidant activity and potential circular economy applications. Fully ripe strawberry (*Fragaria × ananassa* Duch.) cv. ‘Malwina’ fruits were harvested in August from Joniskis region, Lithuania. Calyces were separated and juice was pressed. The remaining agronomic waste (leaves, stems, crowns, rhizomes and roots) and pomace from juice extraction were freeze dried. Total phenolic content (TPC), total flavonoid content (TFC), and total anthocyanin content (TAC) were determined using spectrophotometric methods, while antioxidant activity was assessed using DPPH· and ABTS+· assays. Statistical analyses were performed using one-way analysis of variance (ANOVA). Fisher’s test was applied to assess significant differences (p0.05) between the samples. The relationship between parameters was assessed by Pearson’s linear correlation test at a p 0.05 significance level. The results revealed that the total phenolic content (TPC) was relatively high in all parts of the strawberry (*Fragaria × ananassa* Duch.) plant (41–51 mg GAE g⁻¹ D.W.), with the leaves exhibiting the highest flavonoid content (5.1–5.3 mg QE g⁻¹ D.W.) and the pomace showing moderate anthocyanin levels (0.32–0.36 mg Cy3G g⁻¹ D.W.). Strong positive correlations were notably observed between TPC and DPPH· radical scavenging activity across most plant parts, indicating that phenolic compounds largely contribute to the antioxidant potential. Although low in flavonoids and anthocyanins, roots, crowns and rhizomes still contributed to the overall phenolic content and antioxidant capacity, indicating a source of bioactive compounds. The findings indicate that strawberry by-products are rich in phenolics and antioxidants, highlighting their potential for valorization in food, nutraceutical, and cosmetic applications within a circular economy framework.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

sciforum-142556: Vermicomposting Technology as an Environmental Preservation Strategy in Sub-Saharan Africa

Vigilant Sebata ^{1,*}, Musaida Mercy Manyuchi ^{1,2,3}, Walter Stinner ⁴ and Charles Mbohwa ⁵

¹ Sustainable Tech Environmental Management Company, Harare, Zimbabwe

² Sustainability and Future Technologies Research Centre, University of South Africa, Pretoria, South Africa

³ Germany Biomass Research Centre, Leipzig, Germany

⁴ Bioenergy System Department, DBFZ German Biomass Research Center gGmbH, Torgauer Str. 116, 04347 Leipzig, Germany

⁵ College of Science, Engineering and Technology, University of South Africa, Florida Campus, Roodepoort 1709, South Africa

In the urban and peri-urban areas across Sub-Saharan Africa, rapid urbanization, population growth and changes in consumer behaviour have resulted in volumes of biodegradable waste, most of which is disposed of through open dumping and landfilling. These practices contribute to greenhouse gas emissions, contamination of water bodies and declining soil productivity. This research assesses the impact of vermicomposting technology for the production of biofertilisers in the environment in Sub-Saharan Africa, with a focus on its role in sustainable waste management, soil health restoration and environmental resilience. Vermicomposting is the biological conversion of organic waste into nutrient-rich vermicompost and vermivash using earthworms as catalysts. The process is low cost, decentralized and appropriate for rural and urban setup. This research embraces a mixed-methods approach, based on field observations, compost and soil analysis, structured interviews with farmers and waste managers and policy document reviews from case studies in South Africa, Kenya and Ghana. The results indicate that vermicomposting improves soil fertility by increasing organic matter, nitrogen, phosphorus and microbial activity, while improving water retention. It also reduces household organic waste by over 50%, contributing to lower methane emissions and cleaner urban environments. Regardless of ecological advantages, the implementation is still minimal, owing to policy gaps, limited technical skills and inadequate institutional backing. This study helps to understand how soil and waste interact, shows how waste can be turned into useful resources, supports efforts to restore damaged land and points out policy issues that slow down progress. It concludes that vermicomposting technology holds significant potential to improve environmental quality and promote sustainability in Sub-Saharan Africa. Scaling its impact will require integration into national policies, investment in education and community engagement and incentives for decentralized implementation. This approach is able to foster greener and more resilient communities across the region.



© 2026 by the author(s). Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

MDPI AG
Grosspeteranlage 5
4052 Basel
Switzerland
Tel.: +41 61 683 77 34

Environments Editorial Office
E-mail: environments@mdpi.com
www.mdpi.com/journal/environments



Disclaimer/Publishers' Note: The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of MDPI and/or the editor(s). MDPI and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.

