Celebrating 10 years

CIMEE'26

10TH Anniversary CIMEE conference celebration

8th International Symposium on

MATERIALS, ELECTROCHEMISTRY & ENVIRONMENT

Theme : Materials & Electrochemistry for Clean Energy & Environmental Sustainability

Program & ABSTRACT BOOK



Eight International Symposium on
Materials, Electrochemistry & Environment

cimee-science.org

PROGRAM & ABSTRACT BOOK, EIGTH INTERNATIONAL SYMPOSIUM, CIMEE26



BOOK OF ABSTRACTS & SCIENTIFIC PROGAM



C I M E E

INTERNATIONAL SYMPOSIUM ON MATERIALS, ELECTROCHEMISTRY & ENVIRONMENT



BOOK OF ABSTRACTS & SCIENTIFIC PROGAM

8th International Symposium on Materials Chemistry, Electrochemistry and Environment, CIMEE 26

8th International Symposium on Materials, Electrochemistry and Environment (CIMEE 2026)

September 24– 26, 2026 | Lebanon

The 8th International Virtual Conference on Materials Chemistry, Electrochemistry and Environmental Analytical Chemistry invites global participants to engage in a collaborative forum dedicated to novel research, advanced technologies, and practical applications. The event unites experts across these core fields and related disciplines, including agrogeochemistry, agroenvironment, biowaste/bioenergy, physical chemistry, biological chemistry, and green chemistry. Attendees will have the opportunity to connect, share insights, and exchange cutting-edge research findings and methodologies.

Organized by the Lebanese University in collaboration with five universities across the Middle East, Europe, and North Africa, this virtual event features a dynamic program of plenary and keynote sessions, oral presentations, and poster sessions. Participants can network with peers from international institutions, laboratories, and industries to foster discussions that propel scientific discovery. Ultimately, the conference serves as a premier platform for expanding international research collaborations, offering professionals a unique opportunity to enhance their expertise and explore innovative approaches in the field.



Chemistry plays an essential role in developing sustainable solutions, contributing significantly to the creation of eco-friendly materials, the deployment of green electrochemical processes, and the monitoring of air, water, and soil quality. Equipped with innovative techniques and technologies, researchers now have the vital tools needed to advance environmental protection. In the face of growing global challenges—such as climate change, pollution, and resource scarcity—continuous innovation is essential to building a climate-resilient future. **CIMEE 2026** aims to spark constructive dialogue, foster collaboration, and showcase groundbreaking technologies that advance resource security and environmental sustainability.



CIMEE'26 SEPTEMBER 24-26, 2026, LEBANON

MATERIALS & ELECTROCHEMISTRY FOR CLEAN ENERGY & ENVIRONMENTAL SUSTAINABILITY



THE WORLD EVENT IN INNOVATION CHEMISTRY & SUSTAINABLE ENVIRONMENTAL REMEDIATION

CIMEE26, THEME: MATERIALS & ELECTROCHEMISTRY FOR CLEAN ENERGY & ENVIRONMENTAL SUSTAINABILITY

SYMPOSIUM PARTNERS



Lab. of Electrochemistry, Molecular Engineering & Redox Catalysis, Faculty of Technology, University of F. Abbas Sétif-1, Algeria

Lab. of Environmental Engineering and EcoTechnology, National School of Engineering of Sfax, ENIS, University of Sfax, Tunisia

Center of Materials Technology and Photonics, Hellenic Mediterranean University, Heraklion, Crete, Greece

Lab. of Applied Chemistry & Environment, National School of Applied Sciences, ENSA, University of Ibn Zohr, Agadir, Morocco

Depart. of analytical Chemistry, Faculty of Pharmacy, Tandogan, Ankara University, Turkey

Conference Overview

Climate change and air pollution present interconnected threats to human health, resource availability, and global ecosystems, demanding immediate and coordinated action. Transitioning to a sustainable society requires a global commitment to combating climate change, minimizing waste, reducing energy consumption, and preserving clean environments.

Organized under the theme *"Advancing Sustainability through Materials, Electrochemistry, and Green Energy,"* the CIMEE26 conference focuses on developing innovative solutions to mitigate greenhouse gas (GHG) emissions and combat all forms of pollution. The event underscores the critical role of sustainable natural resource management in building a healthier, greener future.

Our partnering organizations have long served as premier platforms within the scientific community, each driving innovation and advancing knowledge in environmental problem-solving. This year, they have joined forces to create a unique forum for exchanging cutting-edge research, sharing emerging technologies, and exploring practical solutions to today's most pressing ecological challenges.

CIMEE26 will bring together world-renowned scientists in materials chemistry, electrochemistry, and environmental analytical chemistry to present their latest findings and perspectives. The conference will also highlight vital cross-disciplinary collaborations, bridging fields such as ecotoxicology, atmospheric and earth sciences, agrochemistry, geochemistry, and environmental technologies.

We warmly invite you to join us in this collaborative effort to catalyze meaningful change toward a sustainable future.

Welcome Message from Chairs

WELCOME MESSAGE FROM SCIENTIFIC COMMITTEE CHAIR

CIMEE26, EIGHT INTERNATIONAL SYMPOSIUM, CIMEE26

Scientific Committee Chair

THEME: MATERIALS & ELECTROCHEMISTRY FOR CLEAN ENERGY & ENVIRONMENTAL SUSTAINABILITY

Message from Scientific Committee Chair

Dear all,

We are proud to welcome you to this premier gathering dedicated to advancing the frontiers of environmental chemistry and sustainable science. Our planet faces unprecedented ecological challenges, from microplastic pollution to climate adaptation. Chemistry serves as a vital bridge between human innovation and the preservation of our biosphere.

During this conference, our technical program will explore transformative topics—including recent advancements in analytical chemistry, electrochemistry, advanced materials for a sustainable environment and energy, circular economy strategies, and data-driven ecological monitoring. We encourage every participant to actively share their research, challenge conventional paradigms, and forge powerful international collaborations.

Attendees will have the opportunity to engage with renowned speakers from around the world, gain valuable insights, and discover new pathways to advance their careers. May your time here stimulate creative ideas and lead to enduring partnerships that help safeguard our environment for future generations.

The sessions are centred around the following 8 themes, spanning all of chemistry and environmental chemistry. Under the theme *"Materials & electrochemistry for clean energy & environmental sustainability"*, the conference will explore Materials chemistry and electrochemistry as both a conceptual foundation and as a powerful practical tool that drives progress for chemical discovery and innovation. The theme program will showcase cutting-edge advances in Materials chemistry that pushes the boundaries of chemistry to find new solutions to global challenges in sustainability, energy, and the environment

We invite all environmental chemists, researchers (whether early- or late-career), and industry stakeholders to contribute to this edition—whether by presenting original research, participating in lively discussions, or exploring collaboration opportunities.

Scientific Committee Chairperson
El Moll Ahmad

Massage from Scientific Committee Chair

The choice of the theme of CIMEE'26 conference, "Materials and Electrochemistry for Clean Energy and Environmental Sustainability,"

Distinguished colleagues and friends,

In this message, we would like to share the vision behind choosing this year's conference theme: **"Materials and Electrochemistry for Clean Energy and Environmental Sustainability."**

The theme for **CIMEE'26** is both strategic and timely, as it lies at the very heart of the greatest scientific, economic, and societal challenges of our era. Below are the main reasons that drove the selection of this edition's theme:

1. A global emergency and political alignment:

• Energy transition: Faced with climate change, the transition to decarbonized energy is an absolute global priority.

• International objectives: This theme directly addresses the UN Sustainable Development Goals (SDGs), particularly access to clean energy (SDG 7) and combating climate change (SDG 13).

2. Materials science at the heart of innovation: The main current obstacle to the widespread deployment of these green technologies lies in the performance, cost, and durability of the materials used. This theme attracts researchers working on:

• The development of catalysts without critical metals (to eliminate the need for platinum or iridium).

• The discovery of new, safer, and more efficient electrode or electrolyte materials.

• The design of biodegradable or easily recyclable materials.

3. Electrochemistry as a main technology (Enabler): Electrochemistry is the essential scientific discipline for realizing the energy transition. It enables the linking of renewable (often intermittent) electricity production to its use and storage. Choosing this theme allows us to explore crucial technologies:

• Energy storage: Next-generation batteries (advanced lithium-ion, solid-state, sodium-ion) are essential for electric vehicles and the grid.

• Green hydrogen: Production through water electrolysis and conversion via fuel cells.

• Carbon capture: Electrochemical reduction of CO_2 to transform it into valuable fuels or chemicals.

4. A Strong Environmental Impact and Sustainability: Beyond clean energy, the term "environmental sustainability" encompasses essential aspects of the circular economy:

• Recycling: Electrochemical processes to recover precious metals from batteries or electronic waste.

• Water Treatment: Electro-purification and wastewater decontamination as well as the using of sensors to detect water pollutants

5. A Unifying and Attractive Theme: This topic has excellent appeal for a conference because it fosters:

• Interdisciplinarity: It brings together chemists, physicists, materials engineers, ecologists, and industry professionals.

• Funding and Partnerships: Governments and the private sector are investing heavily in these areas.

Dear colleagues, driven by a global climate emergency and unprecedented political alignment, the energy transition demands immediate, scalable solutions to decarbonize our most critical sectors. At the center of this transformation is the CIMEE'26 conference, unified under the compelling theme: "Electrochemistry and Advanced Materials: Powering a Sustainable and Decarbonized Future."

This year, materials science sits at the heart of our innovation agenda. We aim to attract leading researchers dedicated to developing cutting-edge catalysts and discovering next-generation, high-efficiency electrode and electrolyte materials. By positioning electrochemistry as the ultimate technological enabler, CIMEE'26 provides a vital platform to explore crucial, game-changing technologies, including:

- Advanced energy storage systems
- Green hydrogen production
- Carbon capture and utilization

With a profound commitment to environmental impact and sustainability, this unifying theme is designed to break down academic silos. CIMEE'26 actively fosters interdisciplinarity, bringing together chemists, physicists, materials engineers, and ecologists. By bridging the gap between fundamental science and ecological necessity, the conference serves as a premier catalyst for securing high-value funding, strategic partnerships, and cross-sector collaboration.

Scientific Committee Chairperson
El Moll Ahmad



WELCOME MESSAGE FROM THE PROGRAM COMMITTEE CHAIR

Message from the program committee chair

Welcome to the technical program for this edition and the rich program with Materials chemistry, environmental analytical chemistry sessions, where leading researchers gather to share cutting-edge breakthroughs in sustainability, remediation, and ecological safety.

Building on the success of previous meetings, the theme for 2026 is Materials & electrochemistry for clean energy & environmental sustainability, and I look forward to learning the latest results from top researchers and academic scientists on these topics and everything else that is presented. We are indeed in a time of great innovation in materials chemistry, electrochemistry and environmental analytical chemistry to enjoy the research, and report good results!

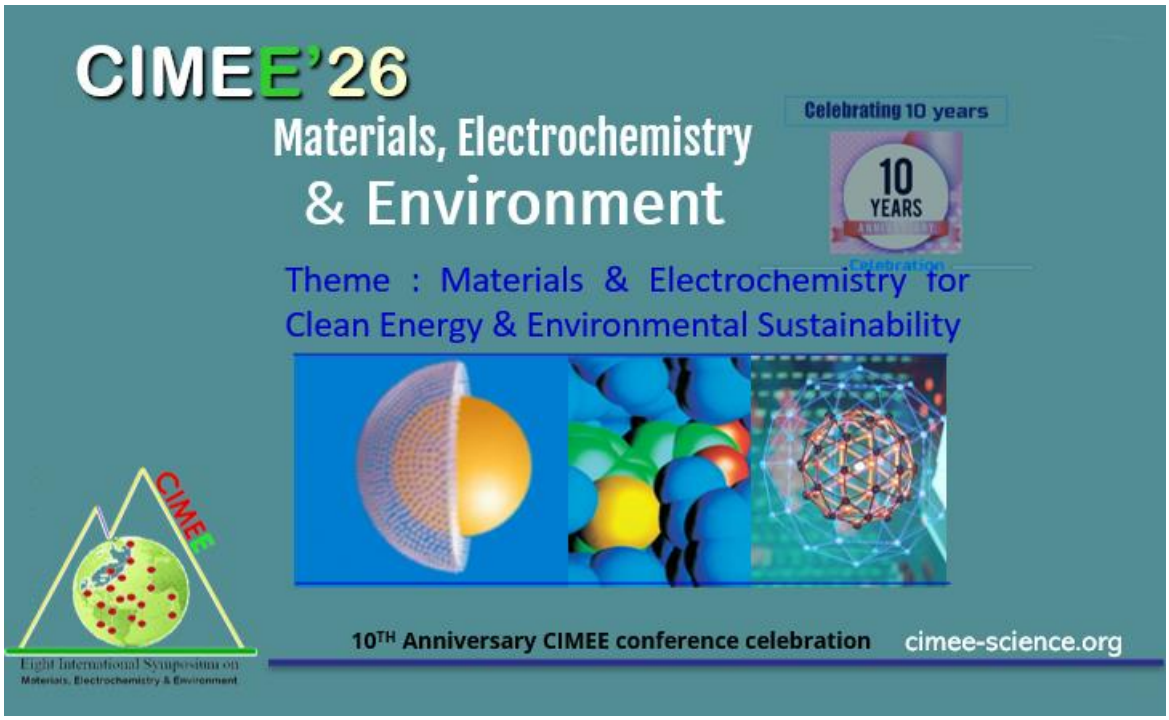
The program has already shaped up to be excellent, and the networking opportunities will be indeed outstanding. I add my best wishes for a successful and fruitful conference and my thanks to all organizers.

We're looking forward to an excellent meeting with great scientists from different countries around the world and sharing new and exciting results in Materials Chemistry, Electrochemistry and Environmental analytical chemistry which will be contributed in the sustainable future

I hope you enjoy the symposium as much as I have enjoyed being involved in its realization.

Yours Sincerely

Program Committee Chairperson
ElMoll Ahmad



WELCOME MESSAGE FROM THE ORGANISING COMMITTEE CHAIR

Distinguished Colleagues and Friends,

It is a great honor to welcome you to the Eight International Symposium, CIMEE26, during these three days a broad range of topics will be covered in scientific sessions in the form of oral presentations and poster sessions special sessions and workshops. And not to forget, there will also be invited lectures from renowned researchers from all over Middle East, each of them intricately connected to the conference topics.

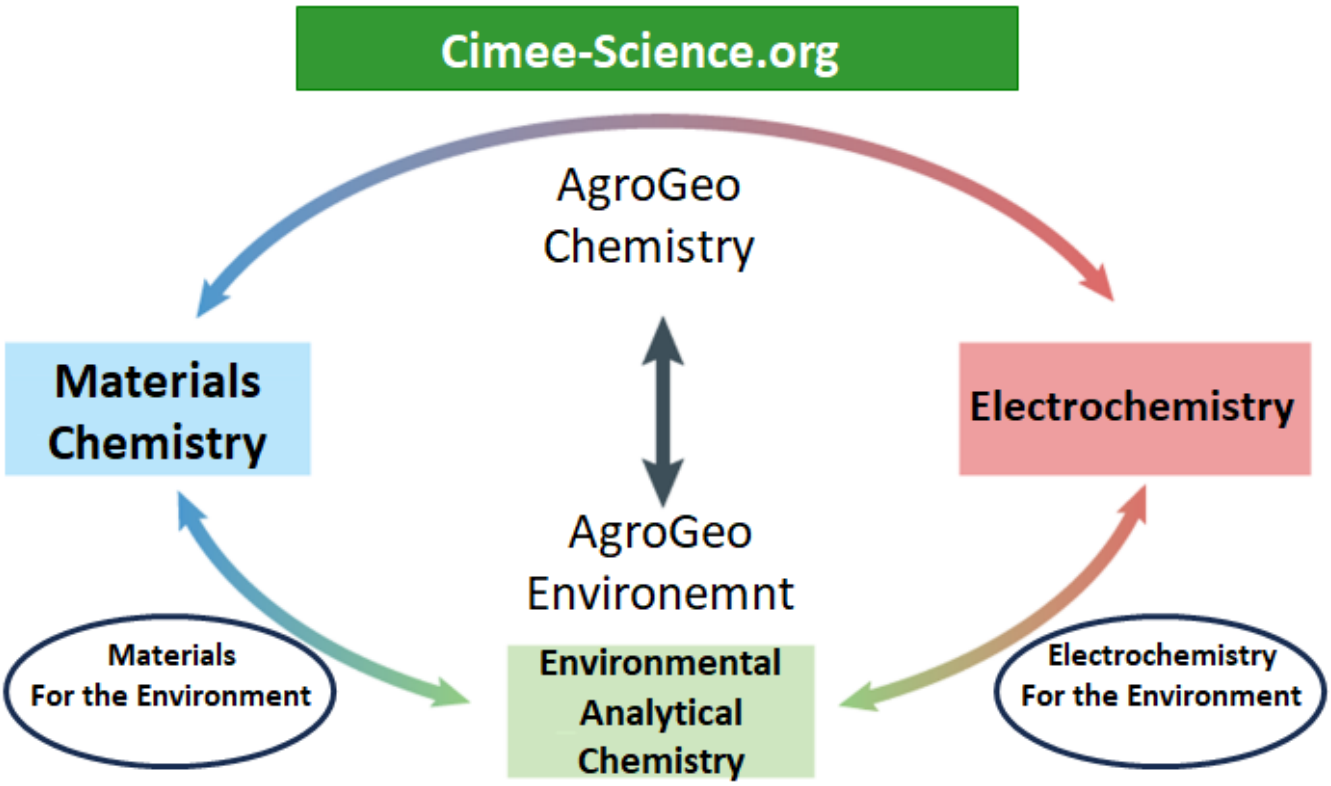
The main objectives of CIMEE26 are to bring together onsite the scientists and researchers, senior as well as early-stage, working in the field of environmental chemistry, sustainability, and resilience to report the latest advances in their fields also aimed to provide an opportunity to develop networks among researchers. We take this opportunity to thank all the members of the different committees for their outstanding efforts in preparing for this event.

It is a pleasure to work side by side with wonderful organizers from Algeria, Greece, Morocco, Tunisia, and Turkey. Together, we are preparing the sessions, managing the review process, and coordinating publications with partner journals alongside researchers from the Middle East, Europe, and North Africa

The organising team of CIMEE26 warmly welcomes you to join us at the CIMEE26 conference and celebrating the 10 years anniversary

Best Regards,
Program Committee and Conference Chair

ElMoll Ahmad



WELCOME MESSAGE FROM THE EXECUTIVE COMMITTEE CHAIR

Dear Colleagues and Friends,

On behalf of the CIMEE'26 Executive Committee, the Organizing Committee, and the symposium organizers, we extend a warm welcome to this eighth edition, which also marks our 10th anniversary. We look forward to your participation. From materials chemistry to environmental analytical chemistry—including electrochemistry and its vital environmental applications—all aspects of environmental chemistry will be represented at this gathering.
Based on this outline, the two key topics to be addressed during the conference—corresponding to the sessions listed in the scientific program—are: Materials Chemistry in Environmental Contexts and Environmental Electrochemistry & Applications.

Materials Chemistry in Environmental Contexts

focuses on designing, synthesizing, and applying specialized materials to monitor, capture, degrade, and prevent pollutants across air, water, and soil.

Porous Frameworks: Metal-organic frameworks (MOFs) and covalent organic frameworks capture greenhouse gases like carbon dioxide and remove persistent toxic substances from air and water.
Nanostructured Electrodes: Materials like carbon pastes, glassy carbon, and MXenes increase surface area, electron transfer rates, and adsorption capacity.
Catalytic Nanoparticles: Materials like CeO_2-Pt alloys and transition metal oxides catalyze the breakdown or conversion of toxic industrial byproducts into safer compounds.
Carbonaceous materials, such as activated carbon, carbon nanotubes, and biochar, have proven to be highly effective in environmental remediation due to their unique properties.

Environmental Electrochemistry & Applications

Environmental electrochemistry studies electron-transfer reactions at the interface of electrodes and environmental matrices (water, soil, air) to drive detection, treatment, and resource recovery.

Main Electrochemical Techniques

- **Electrochemical Sensors:** Employs techniques like voltammetry and potentiometry with ion-selective electrodes to detect trace levels of heavy metals, nitrates, and organic pollutants in real time
- **Electrocoagulation (EC):** Uses sacrificial metal anodes that dissolve into the water to neutralize charged colloidal particles and precipitate heavy metals or suspended solids.
- **Electro-oxidation (EO) & Electro-Fenton (EF):** Uses direct electron transfer or electrochemically generated oxidants to break down persistent organic pollutants, pesticides, and toxins into harmless carbon dioxide and water.
- **Electrodialysis (ED):** Uses ion-exchange membranes driven by an electric field to separate and recover dissolved salts, heavy metals, and ionic pollutants from wastewater streams.
- **Microbial Electrochemical Systems (MET / MFCs):** Combines electroactive bacteria with electrodes to break down organic waste in wastewater while simultaneously generating electrical energy or biofuels.

Vital Environmental Applications

Pollution Detection & Sensors: Real-time, low-limit-of-quantitation tracking of toxins, pesticides, and industrial effluents in natural waters and soil.

Water Treatment & Remediation: Degradation of recalcitrant organic contaminants via advanced oxidation processes and microbial electrochemical technologies (METs) that use bacteria as catalysts.

Resource Recovery & Energy: Harvesting energy from organic wastes (microbial fuel cells), recycling critical metals, and supporting the hydrogen economy

This event stands as the largest component of the CIMEE'26 conference in terms of the number of participants, oral presentations, and posters.
We welcome all chemists and invite you to foster exchanges across these diverse fields, forge new professional connections, and—above all—discover and cultivate new ideas.

Warm regards,
Executive committee Chair

WELCOME MESSAGE FROM THE ADVISORY COMMITTEE CHAIR

CIMEE Publication Opportunity

Dear Colleagues researchers and friends,

We have the honor of inviting you to submit your manuscripts to the CIMEE26 Conference Publications Committee. Publishing in our partner journals offers an excellent opportunity to collaborate with internationally renowned publishers, significantly increasing the global visibility and recognition of the CIMEE group's scientific research. These partner journals serve as a vital hub, connecting and strengthening the work of researchers across universities, research centers, and institutions.

Partner publications enable authors to achieve a wide range of academic goals, such as supporting CIMEE's young researchers, gaining an international reputation in specialized fields, or contributing to global initiatives.

Participants are invited to submit their manuscripts for either a special issue or a regular issue, following the specific guidelines provided in your invitation letter. Each submission will undergo a standard peer-review process according to the respective journal's guidelines. Please note that authors are required to update the conference committee on their submission status as outlined in the invitation letter.

To ensure a smooth evaluation, we kindly ask you to carefully observe the following requirements:

- Originality: Submit only original research manuscripts.
- Language: Write in clear, correct scientific English.
- Guidelines: Strictly follow the journal's specific instructions for authors.

We hope you enjoy the program and wish you a highly fruitful symposium. If you have any questions in the meantime, please do not hesitate to contact us at cimee16@ul.edu.lb.

We look forward to welcoming you soon and receive your papers!

Warm regards,

Advisory committees



WELCOME MESSAGE FROM THE CONFERENCE CHAIR

Welcome address





Dear Participants, and Attendees,

It is my great pleasure and honor to welcome you all to the 8th International Virtual Conference on Materials Chemistry, Electrochemistry and Environmental Analytical Chemistry, celebrating 10 years

The cimee'26 invites participants from around the globe to engage in a collaborative environment dedicated to novel research, technology, and applications in the field. This conference is designed to unite experts in Materials Chemistry, Electrochemistry and Environmental Analytical Chemistry, as well as related disciplines such as AgroGeochemistry, Agroenvironemnt, Biowaste/bioenergy, physical chemistry, biological chemistry and green chemistry. Attendees will have the opportunity to connect, share ideas, and exchange the latest research results and advanced methods in these areas.

Organized by Lebanese university and 5 universities in Middle East, Europe and North Africa, this virtual event will feature a range of engaging activities, including plenary/keynote sessions, oral presentations, and poster presentations. Participants will have the chance to network with researchers from various institutions, universities, laboratories, and industries, fostering discussions and insights that can propel scientific discoveries. The conference aims to provide a platform for sharing knowledge and expanding research collaborations, making it a unique opportunity for professionals in the field to enhance their understanding and explore new approaches in Materials Chemistry, Electrochemistry and Environmental Analytical Chemistry.

Climate change and intensifying environmental pressures are driving an urgent demand for innovative solutions rooted in materials science, electrochemistry, and environmental analytical chemistry. Materials chemistry has emerged as a dynamic, multidisciplinary field that powers key sectors such as nanotechnology, polymers, eco-friendly materials, clean energy, and alternative fuels like hydrogen. Furthermore, it leverages computational methods, advanced modeling, and simulation to bridge the gap between industrial applications and community needs. Complementing these advancements, environmental analytical chemistry and electrochemistry focus on critical sustainability challenges, including environmental protection, waste treatment, pollution control, and sustainable agriculture.

This edition of CIMEE'26 provides an excellent platform for researchers, scientists, engineers, industry professionals, policymakers, and other stakeholders to exchange knowledge, discuss emerging technologies, and explore innovative solutions to climate change and environmental sustainability.

Through our keynote and plenary presentations, special sessions, technical discussions, and collaborative forums, we aim to advance cleaner communities, environmental preservation, innovative remediation techniques, and more efficient industrial processes to improve the overall quality of life. I am confident that the sessions focusing on materials chemistry, electrochemistry, and related fields will provide all participants with valuable insights, meaningful networking opportunities, and practical strategies that can be adapted and deployed globally.

Together, let us champion green innovation, sustainable practices, and clean energy solutions to build a resilient and prosperous future.

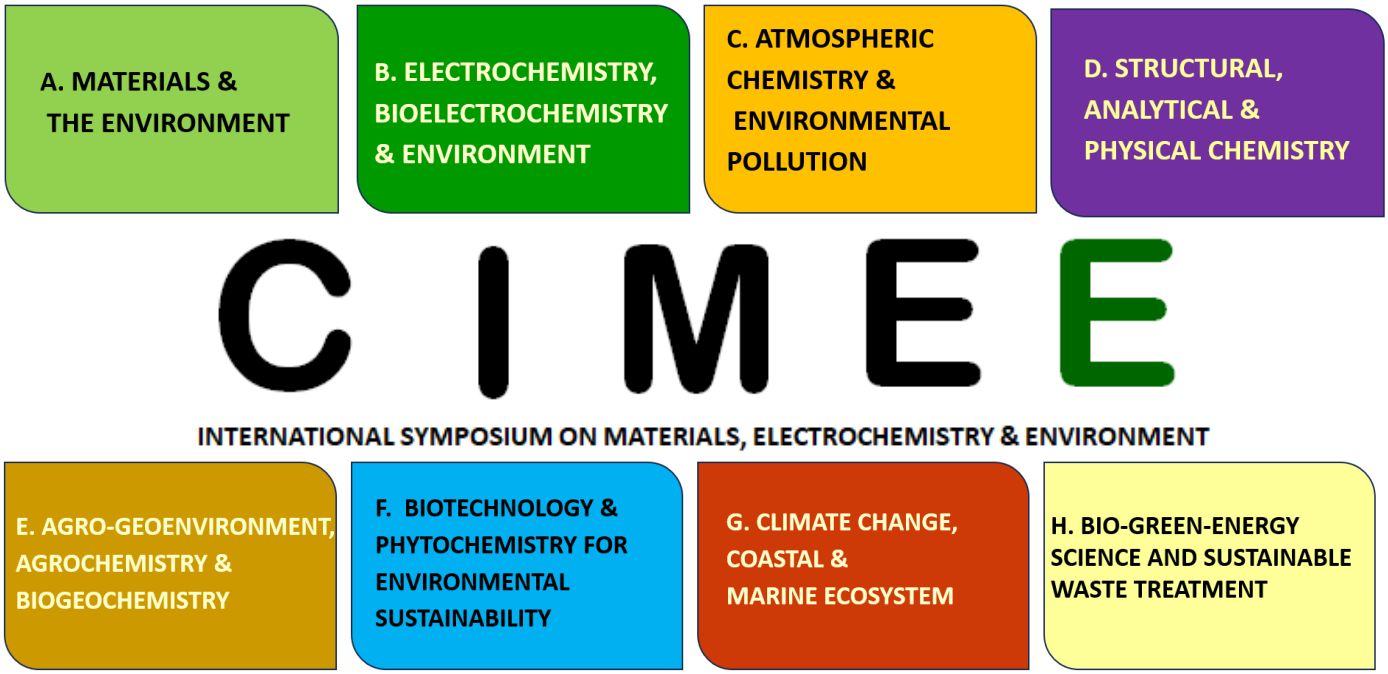
I warmly welcome you to CIMEE'26 to celebrate this milestone event together, and I wish you a productive, inspiring, and successful conference.

With warmest regards,

El Moll Ahmad

CONFERENCE SCOPE & TOPICS

The scientific scope will cover a wide range of fundamental and applied chemistry topics:



A. MATERIALS & THE ENVIRONMENT A.1. Nanomaterials, Nanostructures & Environment. A.2. Nanomaterial-based biosensors for pollutants detection A.3. Nanotechnology & Nanobiotechnology for Environmental Remediation A.4. Carbon Nanotubes-Based Nanomaterials & Their Applications A.5. Advanced Textile Materials for Composite Applications A.6. Energy, Developing new materials to clean energy cycles B. ELECTROCHEMISTRY, BIOELECTROCHEMISTRY & ENVIRONMENT B.1. Electrochemistry for the Environment B.2. Electrochemical and environmental sensors, Biosensors technology B.3. Organic electrochemistry & Bioelectrochemistry B.4. Electrochemical nanosensors and their application. C. ATMOSPHERIC CHEMISTRY & ENVIRONMENTAL POLLUTION C.1. Aerosols, Air Pollution and Meteorology C.2. Atmospheric aerosols and their role in climate change D. STRUCTURAL, ANALYTICAL & PHYSICAL CHEMISTRY D.1. Environmental chemistry, Analytical chemistry D.2. Air quality, Pesticides & environmental monitoring, D.3. Bioremediation & Phytoremediation of environmental Pollutants. D.4. Remediation Technologies Applied in the Environment	E. AGRO GEOENVIRONMENT, AGROCHEMISTRY & BIOGEOCHEMISTRY E.1. AgroGeoenvironment & Geomaterials E.2. Biomaterials, Waste & biomass valorization E.3. Atmospheric Chemistry, air pollution, Geochemistry & Earth Materials E.4. Agro-materials, & Environmental geochemistry E.5. Agroecology and soil biology, Geochemistry & Earth Materials. F. BIOTECHNOLOGY & PHYTOCHEMISTRY FOR ENVIRONEMNTAL SUSTAIABILITY F.1. Blue Carbon Ecosystems & Climate Change Mitigation F.2. Role of Blue Carbon in Climate Change Mitigation F.3. Biomonitoring using biosensors for detection of environmental contaminants F.4. Sustainability through the valorization of agricultural and food waste F.5. Biotechnological innovations. Nano-formulations, biopesticides, biofertilizers & soil health G. CLIMATE CHANGE, COASTAL & MARINE ECOSYSTEM G.1. Coastal ecosystems, wetlands & carbon sequestration G.2. Marine ecosystems, marine pollution & Marine species G.3. Sustainable management practices in fisheries & global warming H. BIO-GREEN-ENERGY SCIENCE, WASTE TREATMENT & TECHNOLOGYI H.1. Reducing global carbon emissions and transitioning to renewable energy H.2. Waste-to-energy conversion, biogas, biodiesel, bioalcohol, and bioelectricity H.3. Green technology, photoelectrochemical splitting for sustainable hydrogen production.



SEPTEMBER 24 - 26, 2026 | LEBANON





CIMEE'26 COMMITTEES

COMMITTEES

Scientific Committee

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Co-Chair

Rachid Salghi, Euro-Mediterranean University of Fes, UEMF, Fez, Morocco

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Marcello Locatelli, Depart. of Science, University "G. d'Annunzio" of Chieti-Pescara, Via dei Vestini 31, Chieti, Italy



CIMEE'26 Scientific Program

CIMEE26 Scientific Program	
Day 1 – Thursday 24 September 2026 **(Morning session)**	
Opening Session (Lebanon time (GMT+3))	
08h30 – 09h00	Registration
09h00 – 11h00	Official Opening Ceremony: Lebanese National Anthem and LU anthem Opening plenary session & welcome Speech from the Conference Chair: The Geopolitics of the Green Transition: From Resource Scarcity to Environmental Catastrophe. **Assoc. Prof. Ahmad El Moll,** Lebanese university, Lebanon Word of the Director of the Depart. of Environmental Sciences Director– ISSTE, University of Carthage, Tunisia, **Prof. Abdelkader Hamdouni,** Tunisia Opening Keynote session & welcome Speech from the Conference Co-Chair: Technological innovation: from Critical Raw Materials to Renewable Energy Transition **Prof. Rachid Salghi**, Euro-Mediterranean University of Fes, UEMF, Fez, Morocco
PLENARY SESSION I	
Plenary Session I: Atmospheric pollution, air quality & sustainability Chair/Co-chairs A. El Moll, Marcello Locatelli	
11h00 – 11h30	PL1: Sustainable strategies and advanced environmental solutions: the innovative role of materials chemistry, electrochemistry, and environmental analytical chemistry. **Prof. Ahmad El Moll,** Faculty of public health, faculty of science, Doctoral School for science & Technology, Lebanese university
Keynote Session I: Atmospheric pollution, air quality & sustainability Chair/Co-chairs A. El Moll, Marcello Locatelli	
11h30 – 12h30	KL 1: **Prof. Gilles Maignant**, GREDEG, CNRS, Université Côte d'Azur, RETINES, Université Côte d'Azur, France. Title presentation: Modelling air pollution at a fine scale: from classical dispersion to hybrid physics-AI models. KL 2: **Prof. Pasquale Avino**, Depart. of Agricultural, Environmental & Food Sciences, University of Molise, via F. De Sanctis, Campobasso, CB, Italy. Title presentation: Urban Ultrafine Particles: Size-Resolved Exposure and Respiratory Deposition in Traffic Environments. KL 3: **Prof. Ahmad El Moll,** Faculty of Public health, Faculty of Science, Doctoral School for Science & Technology, Lebanese univ., Lebanon Title presentation: Emerging technologies and innovative solutions to Monitor and Mitigate Air Pollution **OP 1 :** Deep Learning-Based Pixel Classification of Sentinel-1 SAR Imagery for Inundation Mapping Dr. Mariem Trifi, Georesources Lab., Water Research and Technology Center (CERTE), Borj-Cedria Technopole, Soliman, Tunisia
12h30 – 13h30	Break Networking, Roundtable Discussion, Photography
Afternoon Session	
Keynote Session II: STRUCTURAL, ANALYTICAL & PHYSICAL CHEMISTRY, Chair/Co-Chairs: A. El Moll, Najla Fourati	
13h30– 14h30	KL 4: The Fundamental Role of Modern Analytical Methods for Detection of Fraud or Falsification and Adulteration in Dietary Supplements at Global Level **Prof. Ilkay Erdogan Orhan,** Dean at Lokman Hekim University, Faculty of Pharmacy, Ankara, Turkey KL 5: Newly released metric tools for the analytical chemist to evaluate the adherence with the Green and White Analytical Chemistry principles. **Prof. Marcello Locatelli,** Depart. of Science, University "G. d'Annunzio" of Chieti-Pescara, Via dei Vestini 31, Chieti, Italy
PLENARY SESSION II	
14h30 – 15h00	PL2 : Environmental pollution and climate change in Mediterranean region. **Prof. El Moll Ahmad,** Faculty of Public Health, Faculty of Science, DSST, Lebanese University, Lebanon
Keynote Session III: MATERIALS & THE ENVIRONMENT, Chair/Co-Chairs: A. El Moll, Marcello Locatelli	
15h00 – 16h00	KL 6: From Microclusters to Conductive Networks: Rare-Earth-Doped ZnO/Graphene Nanocomposites **Prof. Mirela Suchea**, National Institute for Research and Development in Microtechnologies (IMT-Bucharest), Bucharest, Romania KL 7 : Synergistic g-C3N4-Transition-Metal Sulfide Heterostructures as Efficient Bifunctional Electrocatalysts for Water Splitting **Prof. Hilal Demir Kivrak**, Depart. of Chemical Engineering, Faculty of Engineering & Architectural Sciences, Eskisehir Osmangazi University, Turkey. **OP 2:** Eco-Friendly Low-Temperature Hydrothermal synthesis of LiFePO4/rGO nanocomposites: How Graphene Oxide Chemistry Shapes Structure and conductivity? **Chirstina Floraki,** PhD student**,** Depart. of Electrical and Computer Engineering, School of Engineering, Hellenic Mediterranean University, Heraklion, Greece, Depart. of Materials Science & Technology, University of Crete, Heraklion, Greece
16h00 – 16h30	Roundtable Discussion, Refreshment Break, Photography
Special session I	

Special Session I: Climate change mitigation, & Environmental Sustainability	
16h30 – 17h30	Special session, CIMEE'26: Climate change mitigation solutions in the Mediterranean region: towards a shared vision to address common challenges **Prof. El Moll Ahmad,** Faculty of Public Health, Faculty of Science, DSST, Lebanese University, Lebanon
WORKSHOP	
17h30 – 18h30	W1: Climate change: Aerosol chemical complexity, modeling & Monitoring combination W2: Climate Change mitigation: The potential role of Materials Electrochemistry **Prof. El Moll Ahmad,** Faculty of Public Health, Faculty of Science, DSST, Lebanese University, Lebanon
18h30 – 19h00	Chair's Closing Remarks & End of Conference Day One





Day 2: Friday 25 September (GMT + 3)

08h30 – 09h00	Registration
Morning Sessions	
PLENARY SESSION III	
Plenary Session III: Electrochemistry and the Environment, Chair/Co-Chairs: Najla Fourati, Ahmad El Moll	
09h00 – 09h30	PL 3 : Electrochemical sensing devices for sustainable agriculture: Emerging platforms and deployment challenges Pr. Najla Fourati, Conservatoire National des Arts et Métiers, CNAM, Paris, France PL 4 : Advanced Environmental Monitoring Systems and Sensor Technology toward achieving global sustainability Ahmad El Moll, Faculty of public Health, Faculty of science, Doctoral School for Science and Technology
Keynote Session IV: Materials for Water Remediation and Renewable Energy. Chair/Co-Chairs: El Moll, Najla Fourati	
09h30 - 12h00	KL 8: Photoelectrochemistry as an Innovative Approach to Sustainable Hydrogen Production **Pr. Youssef Naimi, Processing of Information Laboratory (LTI), Faculty of Sciences Ben M'Sick, Hassan II University of Casablanca, Morocco.** KL 9: Chemical Growth Routes to Advanced Materials for Efficient Energy Storage **Pr. Dimitra Vernadou, Dept. of Electrical & Computer Engineering, Hellenic Mediterranean University, Greece**.
12h00 – 12h20	Panel discussion - Break Networking, Photography
12h20 – 14h00	Light Lunch Break, Photography
Afternoon Sessions	
Keynote Session V : Water resources and Sustainable environment, Chair/Co-Chairs: A. El Moll, Najla Fourati	
14h00 – 15h30	KL 10: Next-generation Biocatalysts: Sustainable Removal of Emerging Contaminants for a Clean Water Future **Pr. Susana Rodriguez-Couto,** Dept. of Separation Science, Lappeenranta-Lahti University of Technology, LUT, Finland KL 11: From Knowledge to Cooperation: Advancing Nutrient Circularity in the Baltic Sea Region under CirCan platform **Pr. Marzena Smol,** Mineral & Energy Economy Research Institute of the Polish Academy of Sciences, Cracow, Poland KL 12: Advanced Environmental Monitoring Systems and Sensor Technology to achieving global sustainability. **Pr. El Moll Ahmad, Faculty of Public Health, Faculty of Science, DSST, Lebanese University, Lebanon**
Oral Session I: Water resources, Energy and Environmental Sustainability: Chair/Co-Chairs: A. El Moll, Najla Fourati	
15h30 – 16h30	**OP 3:** Biowaste to Energy Devices: Walnut Biochar-Based Electrodes for Aqueous Sodium-Ion Supercapacitors **Nikos Kavousanos**, Depart. of Electrical & Computer Engineering, Hellenic Mediterranean University (HMU), Heraklion, Crete, Greece **OP 4**: Towards a Sustainable Future: Integrating Food Safety, Technology, and Waste Valorization **Dr. Nada El Darra,** Depart. of Nutrition and Dietetics, Faculty of Health Sciences, Beirut Arab University, Beirut, Lebanon **OP 5**: Business models supporting Circular Economy implementation: a Danish digestate case study **Paulina Marcinek,** Mineral & Energy Economy Research Institute, Polish Academy of Sciences, Wybickiego, Kraków, Poland
16h30 – 17h00	Roundtable Discussion, Refreshment Break, Photography
Special session II	
Biogeochemistry Agrochemistry & Environmental Sustainability	
17h00 – 17h30	Special session CIMEE26: Agro-geochemistry, Agro-geoEnvironment & Sustainability: Challenges & Solutions **Pr. El Moll Ahmad,** Faculty of Public Health, Faculty of Science, DSST, Lebanese University, Lebanon
Poster Session I	
climate change mitigation & technological innovations : Chair/Co-Chairs: A. El Moll, Najla Fourati	
17h30 – 18h00	Achieving a circular economy and mitigating climate change: Key Aspects of Sustainable Catalysis and CO2 Conversion Combating climate change by using both technological innovations and nature-based solutions Clean Energy and Environmental Sustainability Strategies as a key solution to planetary boundaries Green Hydrogen Production: Role in the Ecological Transition and Emission Reduction Sustainable wastewater management: From AI innovations to technological treatment solutions **Pr. El Moll Ahmad,** Faculty of Public Health, Faculty of Science, DSST, Lebanese University, Lebanon
Poster Session II	
Sustainable wastewater management & Ecological Transition : Chair/Co-Chairs: A. El Moll, Najla Fourati	
18h00 – 18h30	Green Hydrogen Production: Role in the Ecological Transition and Emission Reduction Sustainable wastewater management: From AI innovations to technological treatment solutions **Pr. El Moll Ahmad,** Faculty of Public Health, Faculty of Science, DSST, Lebanese University, Lebanon
18h30– 18h50	Chair's Closing Remarks & End of Conference Day 2

Day 3: Saturday 26 October, Lebanon time (GMT+3)

08h30 – 09h00	Registration
Morning Sessions	
Plenary Session IV: Materials, Energy and sustainable Environment, Chair/Co-Chairs: A. El Moll, Najla Fourati	
09h00 – 09h30	PL 6 Towards a Greener Future: Eco-friendly Materials for Water Remediation and Renewable Energy Projects **Pr. Marta Pazos Currás, CINTECX, Depart. of Chemical Engineering. Universidade de Vigo, Spain**
Keynote Session VI: Wastewater treatment, valorization and the Environment, Chair/Co-Chairs: A. El Moll, Marta Pazos Currás	
09h30 - 11h40	KL 14: Evaluating Sebkhas as Brine Management Receptors in Algeria: Opportunities & Environmental Constraints of the El Mactaa Wetland Complex **Pr. Nadjib Drouiche,** Semiconductor Technology Research Center for Energy, CRTSE, Algiers, Algeria. KL 15: Engineering Microalgae–Alginate Biocomposites for High-Efficiency Heavy Metal Removal and Scalable Water Treatment **Dr. Jihen Elleuch,** Lab. of Enzymatic Engineering & Microbiology, Algae Biotechnology Team, National School of Engineers of Sfax, University of Sfax, Tunisia. KL 16: Wastewater Treatment: Resources Recovery & Coupling Technologies for Bioelectricity & Hydrogen Generation. **Dr. Gaurav Saxena,** Institute of Sciences SAGE University Indore, Madhya Pradesh India
Oral Session II: Bio-Green-Energy Science, Wastewater Treatment & Technology, Chair/Co-Chairs: A. El Moll, Marta Pazos Currás	
11h40 – 13h00	**OP 6:** Overview of Mining-Related Pollution at the Kherzet Youssef Lead–Zinc Mine, Algeria, and its Environmental Impacts **Dr. Issam Rouaiguia,** National Higher School of Technology and Engineering Annaba, Mining, Metallurgy and Materials Laboratory (L3M), Department of Mining Engineering, Metallurgy and Materials, Algeria **OP 7:** Digital support for water reuse – using Water Safe tool in a wastewater treatment plant **Dominika Szołdrowska,** PhD student, Mineral & Energy Economy Research Institute, Polish Academy of Sciences, Wybickiego, Kraków, Poland **OP 8 :** Preparation, Physicochemical Characterization and Lead Adsorption Mechanisms of H_3PO_4-Activated Carbons Derived from Date Pits, Olive Pits and Nigella sativa Seeds **Mohamad Baroudi**, PhD student, Lab. of Applied Biotechnology (LBA3B), AZM Center for Research in Biotechnology and Its Applications, Doctoral School for Sciences and Technology, Lebanese University, Lebanon
13h00 – 13h30	Panel Discussion
13h30 – 14h00	Lunch Break – Networking, Photography
Afternoon Sessions	
Keynote Session VII: Materials, Electrochemistry & energy transition A. El Moll, Marta Pazos Currás	
14h00 – 15h00	KL 16: The Golden Triangle for Climate Action: Water Positive, Carbon Negative and Zero Waste **Prof. Majeti Narasimha Vara Prasad,** Retired Professor, University of Hyderabad, (An Institution of eminence) Hyderabad, India KL 17: Integrating materials chemistry & electrochemistry: Sustainable synergy for a cleaner and more sustainable planet **Pr. Rachid Salghi,** Euro-Mediterranean University of Fes, UEMF, Fez, Morocco KL 18: Critical Raw Materials and the Clean Energy Transition: Supply Dynamics and Sustainability **Pr. El Moll Ahmad,** Faculty of Public Health, Faculty of Science, DSST, Lebanese University, Lebanon
Oral Session III: Artificial Intelligence & Machine learning in the Materials chemistry: Chair/Co-Chairs: A. El Moll, Marta Pazos Currás	
15h00 – 15h40	**OP9:** Physics-Informed Machine Learning for Rapid Thickness Estimation of Fe/Cu/Ag/Au Multilayer Structures Using Simulated HE-PIXE Spectra **Dr. Diana RAGHEB**, El hajjar, Lebanese University, Faculty of sciences, Department of Physics, Tripoli, Lebanon **OP10** : Physics-Informed Explainable Artificial Intelligence for Layer-Order Classification in High-Energy PIXE Spectroscopy **Dr. Mostafa Ragheb**, Department of Physics, Faculty of Sciences, Lebanese University, Tripoli, Leban
15h40 – 16h00	Panel Discussion
Workshop II	
Agriculture adaptation to the environmental crise Strengthening the resilience	
16h00 – 17h30	Workshop CIMEE26: Climate change is exerting a profound influence on water resources, especially in the agricultural sector, especially in the mediterranean region. In this workshop 5 presentation will be exposed: W1: Agriculture adaptation to the Environmental Crisis: A Strategy Combining Sustainable Resource Management, Agroecology, and Innovative Technologies W2: Agriculture adaptation to the Environmental Crises: Transition to Resilient, Sustainable, and Regenerative Systems. W3: Agriculture adaptation to the environmental crises: The integrated chemistry–soil–water–climate approach as sustainable solution

	W4: Integrated chemistry–soil–water–climate approach: Application in arid-region agriculture. Faculty of public Health, Faculty of science, Doctoral School for Science & Technology, Lebanese university, Lebanon. **Pr. El Moll Ahmad,** Faculty of Public Health, Faculty of Science, DSST, Lebanese University, Lebanon W5: Integrated chemistry–soil–water–climate approach to strengthen the resilience of Moroccan agro-ecosystems to drought **Mostafa Benramel,** Association for Development and Climate (Kenitra, Morocco); SabriJoude Consulting firm (Safi, Morocco)
Workshop III	
17h30 – 18h30	Future ambitions to combat global climate change: Nature and Adaptation Priorities **Prof. El Moll Ahmad,** Faculty of public Health, Faculty of science, Doctoral School for Science & Technology, Lebanese university, Lebanon
Closing session, recommendations and Perspectives and brainstorming, Publications in partner journals	



C I M E E

INTERNATIONAL SYMPOSIUM ON MATERIALS, ELECTROCHEMISTRY & ENVIRONMENT

Conference Program




CIMEE'26
Theme : Materials & electrochemistry for clean energy & environmental sustainability
10TH Anniversary CIMEE conference celebration
8th International Symposium on
MATERIALS, ELECTROCHEMISTRY & ENVIRONMENT
https://cimee-science.org/cimee26/
September 24-26, 2026
Website link : cimee-science.org/cimee26/
facebook.com/cimee.science/
instagram.com/cimee_science/
E-mail: cimee16@ul.edu.lb



CIMEE26 OFICIAL OPENING CEREMONY

Opening Ceremony

Opening Ceremony, - Thursday 24 September 2026



An opening ceremony was held on the first day of the conference. In this session, all participants of the Eight edition of the international symposium were welcomed and the 3-days program was officially opened.

The Session started with the national anthem of Lebanon and the Lebanese University

Opening Ceremony

Speech by Professor El Moll Ahmad, Lebanese University, Lebanon





The Geopolitics of the Green Transition: From Resource Scarcity to Environmental Catastrophe

Distinguished colleagues, and dear friends,

The global struggle for energy sources and rare minerals (such as lithium, cobalt, and nickel)—essential for the digital revolution and the green transition—has evolved beyond mere economic competition. It has become a driver of armed

conflicts spanning from Eastern Europe in 2022 to the Middle East in 2023, and reaching the Arabian Gulf by 2026. These wars have not only devastated infrastructure and economies but have also precipitated an environmental catastrophe with destructive consequences, including:

• Severe air pollution: massive fires at oil facilities, ammunition depots, and in forests have released vast quantities of greenhouse gases and toxic particulates (such as sulfur and lead), threatening public health and the climate.

• Contamination of water sources: Military chemicals and oil have leaked into groundwater and nearby bodies of water, polluting drinking water and destroying marine and riverine ecosystems.

• Destruction of soil and agricultural land: Shelling, heavy military machinery, and fires have caused the loss of vast tracts of fertile land, led to soil salinization, and rendered areas unfit for agriculture for decades.

The great irony here is that the race toward the "green transition" and clean energy is—through the instruments of war—causing widespread environmental destruction that threatens the future of the planet itself. To resolve this paradox, the fields of materials chemistry and electrochemistry must step forward to pioneer sustainable, alternative solutions that decouple clean energy from geopolitical conflict.

Indeed, materials chemistry, electrochemistry and Environmental analytical chemistry serve as the three fundamental pillars driving the innovation of practical, effective solutions for the green transition and the securing of sustainable clean energy sources. While materials chemistry focuses on designing new molecules and structures that meet sustainability requirements, electrochemistry enables us to control reactions for energy conversion and storage with maximum efficiency and minimal carbon emissions. Concurrently, environmental analytical chemistry tracks pollutants and utilizes advanced sensors to monitor and safeguard air, water, and soil quality.

Below is a comprehensive overview of how these sciences are integrated to achieve a sustainable future:

1. Energy Storage and Next-Generation Battery Development: Storing renewable energy (such as solar and wind power) requires advanced technologies to address the challenge of intermittent supply. Here, materials chemistry and electrochemistry play a crucial role in developing:

• Advanced Lithium-Ion Batteries: Improving electrode materials (cathode and anode) to increase energy density and extend battery lifespan.

• Solid-State Batteries: Replacing toxic, flammable liquid electrolytes with ion-conducting solid materials, thereby significantly enhancing safety and efficiency.

• Eco-Friendly Batteries: Seeking alternatives to rare and geopolitically sensitive metals by developing batteries based on sodium or zinc, which are abundant in nature.

2. Green Hydrogen Production and Fuel Cells: Green hydrogen represents the fuel of the future, and electrochemistry is directly central to its production:

• Water Electrolysis: Utilizing renewable energy to split water molecules into oxygen and hydrogen. Materials chemistry contributes here to the innovation of low-cost, high-efficiency electrocatalysts (alternatives to platinum and rare ceramics) to accelerate this reaction.

• Fuel cells: Converting stored hydrogen back into electrical energy when needed, with pure water being the only by-product of this process.

3. Carbon Capture and Utilization (CCU) technologies: Instead of allowing carbon dioxide (CO_2) emissions to pollute the atmosphere, they are chemically redirected: Electrochemical reduction of CO_2: Electrochemistry enables the direct conversion of carbon dioxide gas into biofuels or useful chemicals (such as methanol or ethylene) using electrodes and catalysts engineered at the molecular level.

4. Development of third-generation solar cells: Materials chemistry contributes to overcoming the limitations of traditional silicon cells through the innovation of nanomaterials and smart materials: Perovskite solar cells: Innovative crystalline materials characterized by flexibility, low manufacturing costs, and a very high capacity to absorb light and convert it into electricity compared to traditional silicon.

The CIMEE 2026 conference is a three-day program carefully designed to feature keynote lectures, oral presentations, plenary discussions, roundtables, hands-on workshops, thematic symposia, and student poster competitions (from more 20 countries). It encompasses all scientific disciplines and fields, aiming to identify advanced solutions and foster a sustainable future. The Editorial Committee of the CIMEE Group cordially invites researchers, professors, and young scholars to submit their manuscripts and research proposals. The Call for Papers is now open, and the submission deadline is December 31, 2026. https://cimee-science.org/cimee26-call-for-papers/ Author guidelines are available on our website: https://cimee-science.org/cimee26-guidelines/

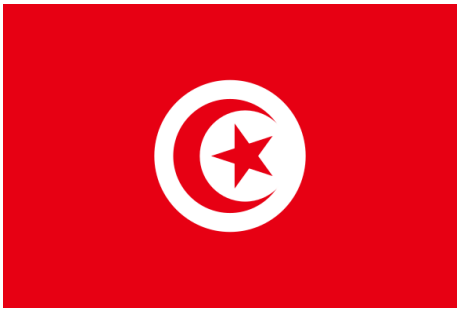
Thank you



Opening Ceremony

Speech by the Depart. of Environmental Sciences Director– ISSTE, University of Carthage, Tunisia, Professor, AbdelKader Hamdouni







isste
CEDRIA SMARTEK

جامعة قرطاج
Université de Carthage

OPENING REMARKS

CIMEE'26 – 8th International Symposium Materials, Electrochemistry & Environment

Ladies and Gentlemen,

Dear Colleagues, Dear Friends,

It is a great honor and a real pleasure for me to have the opportunity to address you, even remotely, on the occasion of the opening of the 8th International Symposium on Materials, Electrochemistry & Environment – CIMEE'26, which also celebrates the 10th anniversary of CIMEE.

First of all, allow me to warmly salute Lebanon, its universities, its researchers, its academics, and the entire Lebanese scientific community.

Tunisia and Lebanon share a common history, a rich cultural heritage, and deeply rooted values. But beyond this common history, I firmly believe that we also share a common future, particularly in the fields of science, innovation, and environmental protection.

Allow me to briefly introduce myself. I am Abdelkader Hamdouni, Director of the Department of Environmental Sciences at the Higher Institute of Environmental Sciences and Technology – ISSTE, within the University of Carthage. ISSTE is a pioneering institution dedicated to education and research in environmental sciences and technologies.

The University of Carthage is a major academic institution in Tunisia, bringing together education, research, innovation, and international cooperation.

Today, we are all facing the same major challenges: climate change, water scarcity and water quality, the energy transition, pollution, waste management, and, more broadly, the preservation of our planet.

Faced with these challenges, no country, institution, or researcher can act alone.

That is why, from Tunisia, we extend our hand to our Lebanese colleagues and to all researchers participating in this symposium, with the strong desire to build together a lasting scientific cooperation based on knowledge sharing, innovation, and mutual trust.

A cooperation between Tunisia and Lebanon, but also an open cooperation with all our international colleagues and partners, for the benefit of our two countries and, more broadly, for the benefit of our planet and future generations. Finally, I would like to warmly congratulate the Organizing Committee, the Scientific Committee, and everyone who has contributed to making CIMEE'26 possible.

I wish this 8th edition great success, fruitful scientific discussions, new collaborations, and, above all, promising perspectives for the future.

Long live the friendship between Tunisia and Lebanon,

long live scientific cooperation,

and long live science in the service of humanity and our planet.

Pr. Abdelkader Hamdouni

Director, Department of Environmental Sciences – ISSTE

University of Carthage, Tunisia.









Opening Ceremony

MOT D'OUVERTURE

CIMEE'26 – 8e Symposium International Materials, Electrochemistry & Environment

Mesdames et Messieurs,
Chers collègues, chers amis,

C'est pour moi un grand honneur et un réel plaisir de prendre la parole, même à distance, à l'occasion de l'ouverture de cette 8e édition du Symposium International CIMEE'26, qui célèbre également les 10 années de CIMEE.

Permettez-moi tout d'abord de saluer chaleureusement le Liban, son monde universitaire, ses chercheurs, ses enseignants et l'ensemble de la communauté scientifique libanaise.

La Tunisie et le Liban partagent une histoire, une culture et des valeurs profondément communes. Mais au-delà de cette histoire commune, je crois profondément que nous avons également un avenir commun, notamment dans le domaine de la science, de l'innovation et de la protection de notre environnement.

Je me présente brièvement : je suis Abdelkader Hamdouni, Directeur du Département des Sciences pour l'Environnement à l'Institut Supérieur des Sciences et Technologies de l'Environnement – ISSTE, relevant de l'Université de Carthage.

L'ISSTE est une institution pionnière, spécialisée dans la formation et la recherche dans le domaine de l'environnement.

L'Université de Carthage constitue aujourd'hui un espace majeur de formation, de recherche et de coopération internationale en Tunisie.

Aujourd'hui, nous sommes tous confrontés aux mêmes grands défis : les changements climatiques, la raréfaction et la qualité de l'eau, la transition énergétique, la pollution, la gestion des déchets et, plus largement, la préservation de notre planète.

Face à ces défis, aucun pays, aucune institution et aucun chercheur ne peut agir seul.

C'est pourquoi, depuis la Tunisie, nous vous tendons la main à nos collègues libanais et à tous les chercheurs présents à ce symposium, avec la volonté de construire ensemble une coopération scientifique durable, fondée sur le partage des connaissances, l'innovation et la confiance.

Une coopération entre la Tunisie et le Liban, mais aussi une coopération ouverte à tous nos collègues et partenaires internationaux, au service de nos deux pays et, plus largement, au service de notre planète et des générations futures. Je tiens enfin à féliciter très chaleureusement le comité d'organisation, le comité scientifique et tous ceux qui ont contribué à la réalisation de CIMEE'26.

Je souhaite à cette 8e édition un immense succès, des échanges scientifiques riches, de nouvelles collaborations et, surtout, de belles perspectives pour l'avenir.

Vive l'amitié entre la Tunisie et le Liban, vive la coopération scientifique, et vive la science au service de l'humanité et de notre planète.

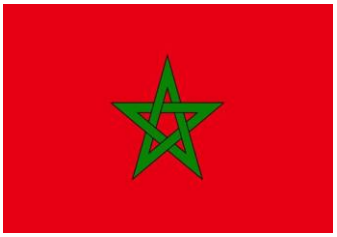
Abdelkader Hamdouni

Directeur du Département des Sciences pour l'Environnement – ISSTE

Université de Carthage

Opening Ceremony

3 - Speech by Rachid Salghi, Professor at the Euro-Mediterranean University of FES, Morocco





UEMF
الجامعة الأورومتوسطية بفاس
EURO-MEDITERRANEAN UNIVERSITY OF FES
UNIVERSITÉ EURO-MÉDITERRANÉENNE DE FÈS

Global renewable energy transition and Critical raw materials (CRMs): Role of Technological Innovation

Technological innovation is essential for securing the supply of critical raw materials (CRMs) and supporting the transition to renewable energy. Indeed, CRMs such as lithium, cobalt, nickel, copper, and rare earth elements form the indispensable physical foundation of this global transition, shifting our reliance from fossil fuels (based on flows) to stocks of concentrated minerals. Here, we address two aspects: the role of critical raw materials in clean energy and the role of technological innovation.

A - The role of critical raw materials in clean energy. Technologies such as wind turbines, solar panels, and electric vehicle (EV) batteries require significantly more metals than traditional fossil-fuel-based systems. While clean energy enables the decarbonization of electricity generation, it replaces a dependence on oil and gas flows with a dependence on stocks of extracted and processed minerals. Furthermore, supply chains are highly geographically concentrated. We have summarized the role of technological innovation in three points:

(i) Advanced extraction and recycling: artificial intelligence (AI) optimizes mining processes and enables the identification of new deposits. At the same time, advanced leaching techniques allow for the reprocessing of old mine tailings to extract valuable materials.

(ii) Material substitution: emerging chemical technologies, such as sodium-ion batteries, reduce reliance on lithium and copper. Additionally, alternative motor designs help lower overall rare earth consumption.

(iii) Circular economy: the development of recycling infrastructure aims to meet a larger share of domestic demand for critical materials using recovered resources.

B - The role of technological innovation: firstly, artificial intelligence (AI) optimizes mining processes and enables the identification of new deposits. At the same time, advanced leaching techniques allow for the reprocessing of old mine tailings to extract valuable materials. Secondly, emerging chemical technologies, such as sodium-ion batteries, reduce reliance on lithium and copper. Furthermore, alternative motor designs help lower overall rare-earth consumption. Finally, the large-scale deployment of recycling infrastructure aims to meet a greater share of domestic demand for critical materials.

C - Contribution to a sustainable transition through decarbonization and mitigation strategies: (i) Decarbonization: Despite supply-related challenges, these materials enable the massive deployment of zero-emission infrastructure required to meet global carbon neutrality targets by 2050. (ii) Mitigation strategies: To make the transition truly sustainable, policies aim to boost domestic extraction, improve material efficiency, identify substitutes, and develop large-scale recycling.

Critical raw materials play a pivotal role in driving sustainability and advancing efficient resource management. This impact is driven by four core pillars: Reducing Carbon Emissions, Preserving Natural Resources, Addressing Waste Pollution and Achieving Long-Term Goals

(i) Manufacturing clean-energy technologies like wind turbines and batteries requires critical minerals, but recycling secondary metal supplies cuts down the energy-intensive processing emissions tied to virgin manufacturing.

(ii) Adopting a circular model—keeping materials "in the loop" through repair, reuse, and advanced recycling—decreases total reliance on primary mining and virgin extraction.

(iii) Repurposing industrial solid wastes and municipal residues into secondary raw materials or construction inputs diverts material streams away from overflowing landfills.

(iv): Establishing robust material frameworks directly aligns global resource security with international climate targets and the United Nations Sustainable Development Goals (SDGs).

We hope the CIMEE'26 conference recommendations offer valuable new insights that contribute to reducing carbon emissions, preserving natural resources, mitigating waste pollution, and achieving long-term sustainability.

Best wishes for all participants

Rashid Salghi

Professor at the Euro-Mediterranean University of FES, Morocco





PLENARY SESSION I:

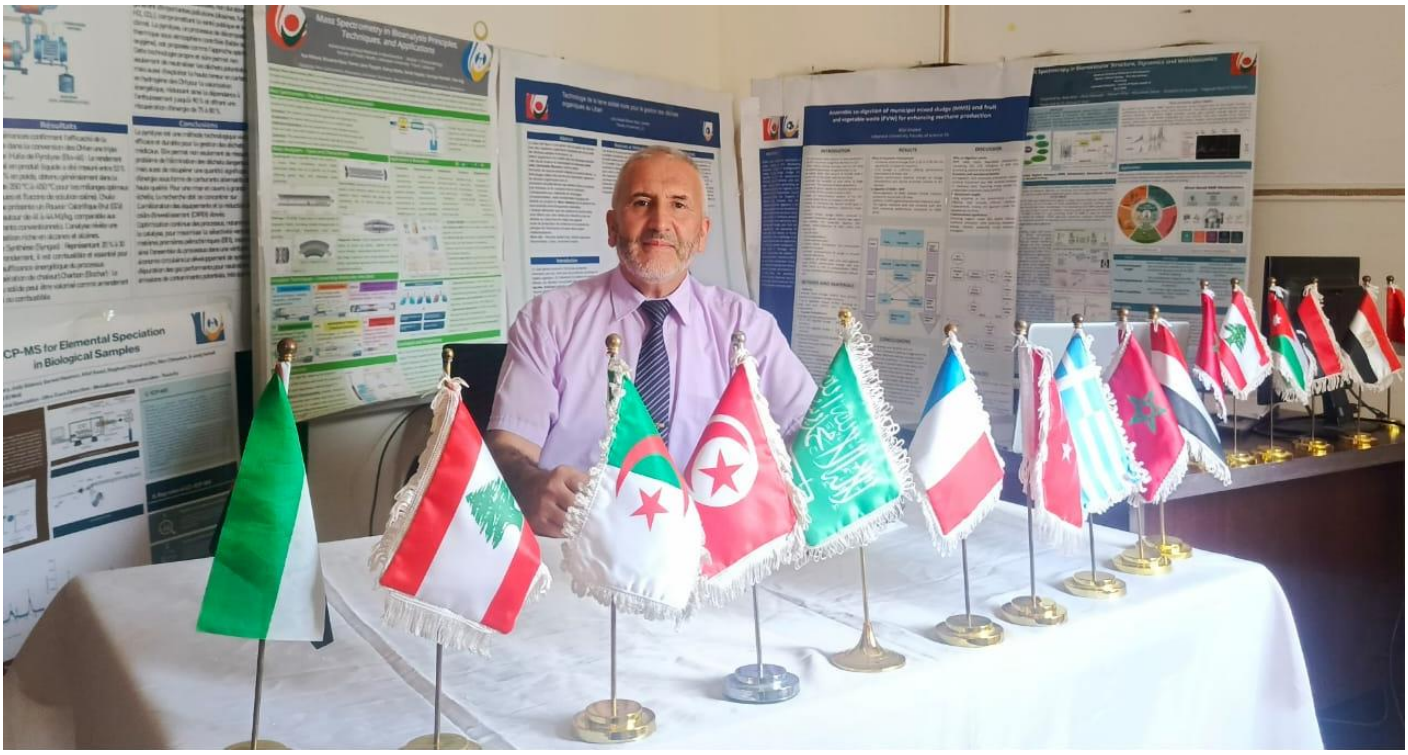
Plenary Lecture, Prof. Ahamad El Moll

Sustainable strategies and advanced environmental solutions: the innovative role of materials chemistry, electrochemistry, and environmental analytical chemistry.

Ahmad El Moll[1]

[1]*Faculty of public health, faculty of science, Doctoral School for science & Technology, Lebanese university*

* Corresponding author E-mail: aelmoll@ul.edu.lb



Dear attendees, esteemed researchers and friends,

Welcome to this wonderful day! Today, we are thrilled to celebrate a major milestone: the 10th anniversary of the CIMEE conference series at CIMEE26.

During the opening Plenary lecture, we will demonstrate how materials chemistry, electrochemistry, and environmental analytical chemistry collectively drive innovative strategies and outline sustainable solutions to protect planetary boundaries

The intersection of materials chemistry, electrochemistry, and environmental analytical chemistry provides a powerful framework for addressing global sustainability and safeguarding planetary boundaries. Together, these three branches move society away from linear "take-make-waste" models toward circular, low-carbon systems. Here is how each discipline contributes innovative strategies and sustainable solutions:

1. Materials Chemistry: Designing the Building Blocks of Sustainability

Materials chemistry focuses on synthesizing and structuring novel substances at the molecular level to optimize performance and reduce ecological footprints.

Green Catalysts: Developing earth-abundant, non-toxic catalysts (like iron- or copper-based frameworks) to replace scarce precious metals like platinum in industrial chemical reactions.

Sustainable Polymers: Designing bio-based, biodegradable, or infinitely recyclable plastics to mitigate the global plastic pollution crisis and protect marine ecosystems.

Advanced Energy Materials: Engineering highly efficient perovskite solar cells, solid-state battery components, and porous frameworks (like Metal-Organic Frameworks, or MOFs) capable of capturing and storing carbon dioxide directly from the atmosphere.

2. Electrochemistry: Powering the Clean Transition

Electrochemistry bridges the gap between chemical bonds and electricity, offering methods to decarbonize heavy industries and transition to renewable energy storage.

Green Hydrogen Production: Utilizing water electrolysis powered by wind or solar energy to produce green hydrogen, providing a clean fuel alternative for hard-to-abate sectors like steel and shipping.

Next-Generation Batteries: Advancing lithium-sulfur, sodium-ion, and redox flow batteries to stabilize electrical grids reliant on intermittent renewable energy sources.

Electrochemical Carbon Utilization: Converting captured CO2 directly into valuable chemicals, fuels, and industrial feedstocks using electricity, effectively turning a greenhouse gas into a resource.

3. Environmental Analytical Chemistry: Monitoring and Protecting Ecosystems

Environmental analytical chemistry provides the high-precision tools and data needed to monitor planetary health, enforce environmental regulations, and detect emerging threats.

Trace Pollutant Detection: Utilizing advanced mass spectrometry and chromatography to identify and quantify ultra-low levels of persistent organic pollutants, such as "forever chemicals" (PFAS), pharmaceuticals, and microplastics in water systems.

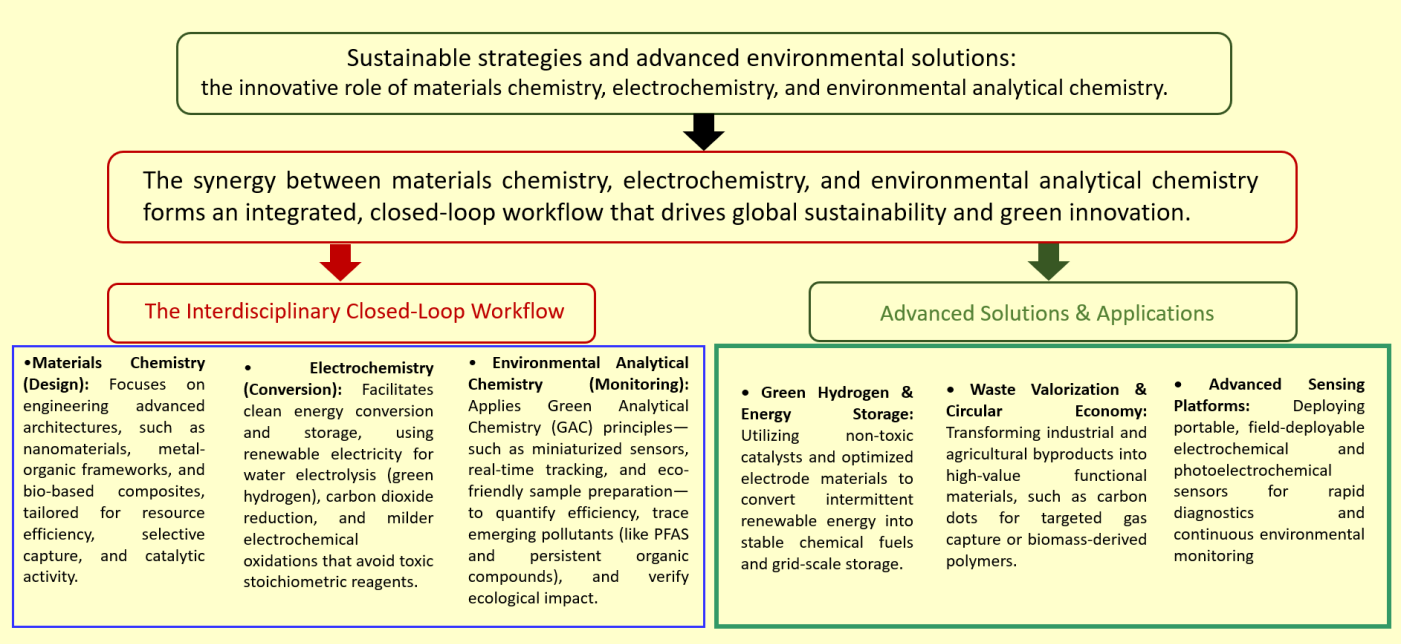
Real-Time Sensing: Deploying remote, electrochemical, or optical sensors for continuous, real-time tracking of air quality, greenhouse gas emissions, and ocean acidification.

Source Apportionment: Tracking chemical fingerprints to pinpoint the exact origins of industrial pollution, allowing for targeted remediation strategies and data-driven policymaking. Comparison of main Roles in Planetary Sustainability

Branch	Primary Strategy	Key Sustainable Output	Impact on Planetary Boundaries
Materials Chemistry	Molecular design & green synthesis	Eco-friendly polymers, high-efficiency solar cells, carbon-capture frameworks	Reduces resource depletion, minimizes chemical pollution, and lowers carbon footprints.
Electrochemistry	Electron-driven reactions & energy conversion	Green hydrogen, grid-scale batteries, CO2 recycling	Decarbonizes the energy sector and mitigates climate change.
Environmental Analytical Chemistry	High-precision measurement & trace analysis	Real-time pollution tracking, chemical fingerprinting, toxicological data	Prevents biosphere degradation, ensures clean water, and guides regulatory policy.

Good luck for all participants

El Moll Ahmad



Sustainable strategies and advanced environmental solutions: the innovative role of materials chemistry, electrochemistry, and environmental analytical chemistry.



PROGAM - DAY 1

Thursday, September 24, 2026

KEYNOTE SESSION I:

Atmospheric pollution, air quality & Environmental sustainability

Chair/Co-chairs A. El Moll, Najla Fourati

8th International Symposium on Materials, Electrochemistry & Environment
10th Anniversary CIMEE Conference Celebration
8th International Symposium on Materials, Electrochemistry and Environment – CIMEE26

Modelling air pollution at a fine scale: from classical dispersion to hybrid physics-AI models

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Thematic Area: *Atmospheric sciences & Environmental pollution*

Abstract

This presentation addresses fine-scale urban air pollution modelling. It establishes that urban pollutant concentration is a multi-scale, multi-source phenomenon strongly dependent on urban morphology and local meteorology. The talk traces the history of air quality modelling, from Gaussian plumes to urban digital twins, and offers a taxonomy of approaches: Gaussian models (fast but with strong assumptions), Lagrangian models (suited to transient transport), Eulerian/chemistry-transport models (relevant for secondary pollution), and urban CFD (fine-scale resolution around buildings). Significant attention is given to data sources: statistical/LUR approaches, geostatistics, low-cost sensors, and data fusion. A key message is that at high resolution, uncertainty from inputs (emissions, meteorology, morphology) often dominates over numerical solver uncertainty. The talk covers "fit-for-purpose" validation and provides a comparative grid of model families. The second half explores AI's contribution: model-order reduction, four roles for AI (predict, correct, assimilate, accelerate), and a hybrid physics-data-AI architecture identified as the most promising path forward. Risks of AI are also discussed: out-of-distribution extrapolation, data bias, lack of explainability, and the need to respect physical constraints. The conclusion delivers three takeaways: no model is universal, value comes from the multi-scale chain (regional→city→street), and AI is most promising when complementing physics rather than replacing it.

Keywords: Air pollution models –Eulerian models – Gaussian models – IA –Lagrangian models

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Urban Ultrafine Particles: Size-Resolved Exposure and Respiratory Deposition in Traffic Environments

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Thematic Area: Materials and The Environment

Abstract

Urban air pollution, and particularly particulate matter, represents an important environmental factor affecting respiratory and cardiovascular health. Among the different particle fractions, ultrafine particles (UFPs, <100 nm) deserve particular attention because of their small size, which allows them to penetrate deeply into the respiratory tract and may facilitate their transfer from the airways into the bloodstream. Moreover, particle size strongly influences the amount and location of aerosol deposited within the human respiratory system. To investigate these processes, time-resolved particle number size distributions were measured in a high-traffic area of downtown Rome. Measurements were performed using Fast Mobility Particle Sizer (FMPS) and Scanning Mobility Particle Sizer (SMPS) systems, covering particle size ranges of 5.6–560 nm and 3.5–117 nm, respectively. The high temporal resolution of the FMPS measurements provided insight into rapid variations in aerosol concentrations associated with vehicular emissions, including gasoline- and diesel-related sources. The measured particle size distributions were subsequently used to estimate the deposition of both total particles and ultrafine particles in the different regions of the human respiratory system, including the head, tracheobronchial and alveolar regions. Deposition was evaluated in terms of both instantaneous doses, expressed as the number of deposited particles per inhaled tidal volume, and cumulative dose during exposure. The results highlight the importance of combining high particle-size and time-resolution measurements to properly characterize exposure to traffic-related ultrafine particles and to assess their deposition within the lungs. The estimated doses also indicate a potentially greater particle burden in the right lung lobes, suggesting a possible increased susceptibility of these regions to the effects associated with prolonged exposure to urban traffic aerosols.

Keywords: aerosol concentrations, urban air pollution, ultrafine particles, deposition, traffic environment

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Emerging technologies and innovative solutions to Monitor and Mitigate Air Pollution

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Thematic Area: Atmospheric chemistry, Air Quality & sustainable environment

Abstract

Air pollution is a critical driver of environmental degradation, posing severe risks to global ecosystems and public health. As one of the most pervasive and harmful forms of contamination, it demands the development of sustainable, advanced technological solutions capable of both monitoring and treating airborne pollutants. This presentation reviews the current state of research in air pollution control and mitigation, focusing on innovative, state-of-the-art technological approaches designed to reduce and neutralize atmospheric contaminants. This study is divided into two primary sections:

Part A: Real-Time Air Quality Monitoring: Real-time air quality monitoring leverages cutting-edge technologies—such as low-cost sensor networks, satellite remote sensing, and mobile monitoring systems—to drastically improve data accuracy and spatial accessibility. Powered by miniaturized, high-sensitivity sensors, machine learning-driven data processing, and integrated Internet of Things (IoT) frameworks, these systems enable continuous, high-resolution data acquisition and proactive environmental management.

Part B: Advanced technologies mitigate air pollution by capturing industrial emissions, accelerating clean energy deployment, and mapping localized air quality. This section explores main technological pillars:

• Photocatalytic Materials: Building facades and specialized vertical curtains coated with titanium dioxide TiO2), or integrated with living microalgae, actively absorb carbon dioxide CO2 and decompose volatile organic compounds (VOCs) through sunlight-driven chemical reactions.

• Carbon Capture and Utilization (CCU): Industrial capture systems isolate CO2 directly from emission streams, converting it into economic commodities such as synthetic fuels, chemicals, and building materials.

• Carbon Capture and Storage (CCS): Large-scale engineering installations trap carbon emissions directly from industrial flues, compressing and injecting them into deep geological formations for permanent, secure storage.

• Integration of artificial intelligence (AI) agents and the Internet of Things (IoT) in mitigating Air pollution: Integration Integrating AI models with IoT sensor networks can deliver accurate, real-time air quality monitoring and forecasting in urban environments [3].

• Next-Generation Catalysts & Filters: Modern industrial facilities utilize advanced materials, such as ultrafine titanium dioxide TiO2, acting as high-efficiency "DeNOx" catalysts to neutralize harmful nitrogen oxides.

Finally, the study evaluates greenhouse gas emission monitoring technologies and their prospective role in pollution abatement. Ultimately, these technologies enable governments, industries, and scientific communities to identify super-emitters, enforce regulatory frameworks, and expedite mitigation strategies.

Keywords: Air pollution control, mitigation, artificial intelligence, Internet of Things, Carbon Capture and utilization, Carbon Capture and Storage, greenhouse gas emission monitoring technologies

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Deep Learning-Based Pixel Classification of Sentinel-1 SAR Imagery for Inundation Mapping

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Not Presented

Thematic Area: Climate Change, Coastal & Marine Ecosystem

Abstract

Floods represent one of the most frequent and destructive natural hazards globally, resulting in significant loss of life, widespread community disruption, and severe economic damage each year. Consequently, rapid and accurate monitoring of these events is essential to assessing their impacts and minimizing associated losses. Flood inundation mapping has traditionally relied on aerial observations and ground-based surveys; however, these methods can be costly, time-consuming, and difficult to implement over large or inaccessible areas. Furthermore, adverse weather conditions may hinder aerial surveys, while persistent cloud cover can severely restrict the use of optical satellite imagery during flood events. In this context, Synthetic Aperture Radar (SAR) satellite imagery offers a robust alternative, owing to its ability to acquire data regardless of cloud cover or daylight conditions, thereby enabling timely and continuous flood monitoring and inundation mapping. This study evaluates a deep learning-based approach to pixel classification for rapid flood-extent mapping using Sentinel-1 observations. The approach was applied to the flash flood event that affected Cap Bon, northern Tunisia, in September 2018, causing extensive damage to buildings and critical infrastructure. To ensure high precision in flood delineation, dual-polarization (VV/VH) Sentinel-1 SAR imagery underwent a standardized preprocessing workflow, including radiometric calibration, speckle noise reduction, and terrain correction. Moreover, three-channel composite images were generated by replicating the VH-polarization band across the red, green, and blue channels and subsequently classified at the pixel level using the pretrained 'Water Body Extraction (SAR)' deep-learning model based on the DeepLab architecture. In addition, bi-temporal change detection analysis was conducted on pre- and post-flood SAR datasets to systematically isolate and delineate backscatter variations associated with the inundation event. The spatial analysis demonstrates that the most pronounced impacts in the Cap Bon region were concentrated in Takelsa, Béni Khalled, Bou Argoub, Menzel Bouzelfa, Korba, Soliman, Nabeul, and Dar Chaabane. Moreover, flood distribution exhibited a strong association with topography and land cover, as digital elevation model (DEM) data consistently revealed that low-lying, flat areas were particularly prone to extensive inundation. Overall, the results highlight the effectiveness of the integrated SAR–deep learning framework for accurate and timely flood mapping under challenging environmental conditions, offering a scalable solution to support disaster management, risk reduction, and resilience in flood-prone regions.

Keywords: Sentinel-1, SAR Imagery, Deep Learning, Classify Pixels, Inundation Mapping.

Acknowledgements: The authors would like to express their sincere gratitude to all individuals and institutions who contributed to the completion of this work. The authors also acknowledge the European Space Agency (ESA) for providing access to Sentinel-1 satellite data used in this study.

KEYNOTE SESSION II

STRUCTURAL, ANALYTICAL & PHYSICAL CHEMISTRY

Chair/Co-chairs Ahmad . El Moll, Najla Fourati

8th International Symposium on Materials, Electrochemistry and Environment – CIMEE26

The Fundamental Role of Modern Analytical Methods for Detection of Fraud or Falsification and Adulteration in Dietary Supplements at Global Level

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Not presented

Thematic Area: Structural, Analytical & Physical Chemistry

Abstract

The global dietary supplement market is increasingly plagued by significant challenges surrounding product authenticity, safety, and quality. A primary concern is the widespread adulteration of these products, which often feature hidden ingredients, inaccurate dosages, or entirely falsified compositions. Adulteration with synthetic pharmaceuticals or structural analogues is disproportionately prevalent in specific high-demand categories, most notably supplements marketed for weight loss, body building, and sexual enhancement. To guarantee consumer safety and restore trust, the deployment of robust, highly precise detection methodologies is critical. Standard analytical techniques, including high-performance liquid chromatography (HPLC), gas chromatography-mass spectrometry (GC-MS), and liquid chromatography-mass spectrometry (LC-MS), serve as indispensable tools for scrutinizing chemical profiles and identifying fraudulent formulations. Beyond these foundational methods, a diverse toolkit of specialized approaches is utilized to target specific types of adulteration or provide complementary verification. These include nuclear magnetic resonance (NMR) spectroscopy, optical spectroscopy (UV-Vis, FTIR, Raman/SERS), capillary electrophoresis (CE), enzyme-linked immunosorbent assays (ELISA), and X-ray powder diffraction (XRPD). Furthermore, DNA barcoding has emerged as a powerful mechanism to authenticate herbal and botanical supplements, ensuring that the labelled plant species accurately matches the contents. Techniques such as DNA barcoding reveal unlisted plant species or synthetic contaminants, it exposes clear instances of substitution, filler usage, or cross-contamination. In conclusion, our analysis of the nutritional supplement market in Türkiye is consistent with global reports, revealing alarmingly high rates of mislabelled and fraudulent products across the industry.

Keywords: Adulteration, analytical methods, chromatographic techniques, quality control, supplements

Acknowledgements: This work was partially supported by the Turkish Academy of Sciences (TÜBA).

8th International Symposium on Materials, Electrochemistry and Environment – CIMEE26

Newly released metric tools for the analytical chemist to evaluate the adherence with the Green and White Analytical Chemistry principles

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Thematic Area: STRUCTURAL, ANALYTICAL & PHYSICAL CHEMISTRY

Abstract

The growing focus on sustainability and safety in analytical laboratories, particularly in light of the principles of Green Analytical Chemistry (GAC), Green Sample Preparation (GSP), and Circular Analytical Chemistry (CAC), has led to the development and adoption of new tools and approaches aligned with these principles throughout the analytical process (from sample to sampling, from sample preparation to instrumental analysis) in order to standardize and harmonize the evaluation of new methods and protocols being developed.
This presentation aims to provide a critical overview of the main tools, accepted by the International Scientific Community, used in analytical chemistry to reduce environmental impact, improve efficiency, and simultaneously ensure high analytical performance and protect operator health. Continuous training and ongoing research have allowed us to increase the number of instruments available, especially in the last two years, focusing not only on green and white analytical chemistry but also on performance and practicality. The latest instruments, however, not only address the principles of green and/or white chemistry but are also beginning to evaluate other parameters of analytical importance such as reliability, carbon footprint, stability, and procedural innovation, demonstrating how the multidisciplinary nature of Analytical Chemistry can support many other fields of application and/or production.
This presentation focuses on the latest instruments, analyzing their advantages and disadvantages, approaches, innovations, and ease of use.

Keywords: Green Profile Tools; Analytical Method Evaluation; White Analytical Chemistry; Sustainability; Practicality

PLENERAY SESSION II:

Environmental pollution and climate change in Mediterranean region

Environmental pollution and climate change in Mediterranean region, paving the Way for a Sustainable Environment

The Mediterranean Sea—a semi-enclosed basin connecting Europe, Africa, and Asia—is a global hotspot for both climate change and biodiversity. It is warming at a rate approximately 20% faster than the global average. Over the course of the 21st century, the Mediterranean basin is projected to experience climate impacts more severe than those in most other regions of the world. It is important to remember here that one-third of the Mediterranean population lives near the sea and depends on the infrastructure and economic activities of the immediate coastal area. The combination of rising temperatures, rainfall deficits, and an increase in the frequency and intensity of extreme events creates a negative synergistic effect. These climatic drivers compound chronic human-induced pressures, exacerbating the ecosystem's vulnerability. This multidimensional environmental crisis is defined by six major dynamics:

1. Accelerated warming: Mediterranean Sea surface temperatures rose by 1.3°C between 1982 and 2019 (compared to 0.6°C globally), leading to frequent marine heatwaves and increased water acidification.

2. Declining precipitation and aridification: The region lies at the transition zone between temperate and arid climates. Summers are lengthening, droughts are becoming more frequent, and freshwater resources are dwindling.

3. Extreme weather events: Rising air and water temperatures fuel more violent storms and intense Mediterranean weather episodes, causing destructive flooding.

4. Anthropogenic pressures: Intense coastal urbanization, intensive agriculture, mass tourism, and overfishing are undermining the unique biodiversity of this semi-enclosed sea.

5. Massive plastic pollution: It is estimated that approximately 730 tonnes of plastic waste are discharged into the sea daily. Plastics account for 95% to 100% of floating debris, with microplastic concentrations sometimes exceeding 64 million particles per km^2.

6. Air pollution and health impacts: Concentrations of fine particulate matter (PM2.5) frequently exceed WHO standards in several urban and industrial areas, contributing to tens of thousands of premature deaths.

In light of these findings, immediate and coordinated action is required. Universities, research institutes, and international governing bodies must urgently join forces to mitigate these cumulative threats and safeguard the socio-ecological future of the Mediterranean region. Achieving this necessitates the development of a sustainable vision and strategy. Concrete solutions must be based on the convergence of three key scientific pillars: materials science, electrochemistry, and environmental analytical chemistry. Through these three scientific disciplines, we can address massive plastic pollution, as well as air pollution and climate change.

Dear colleagues, this framework outlines the scheme "Paving the Way for a Sustainable Environment in the Mediterranean Basin."

(a) Materials Science focuses on designing, developing, and altering matter at the molecular level to create sustainable alternatives and advanced capture systems.
(b) Electrochemistry utilizes electrical energy to drive chemical transformations, offering an efficient pathway to store renewable energy and convert pollutants into valuable resources.
(c) Environmental Analytical Chemistry provides the precise detection, quantification, and monitoring required to map pollution dynamics and validate interventions.
The Convergence Framework: When these three fields work in tandem, they create a highly efficient, closed-loop system for environmental remediation: (i) Capture and Replace: Materials science traps existing pollutants or replaces harmful materials entirely. (ii) Transform and Recycle: Electrochemistry converts or recycles those captured pollutants

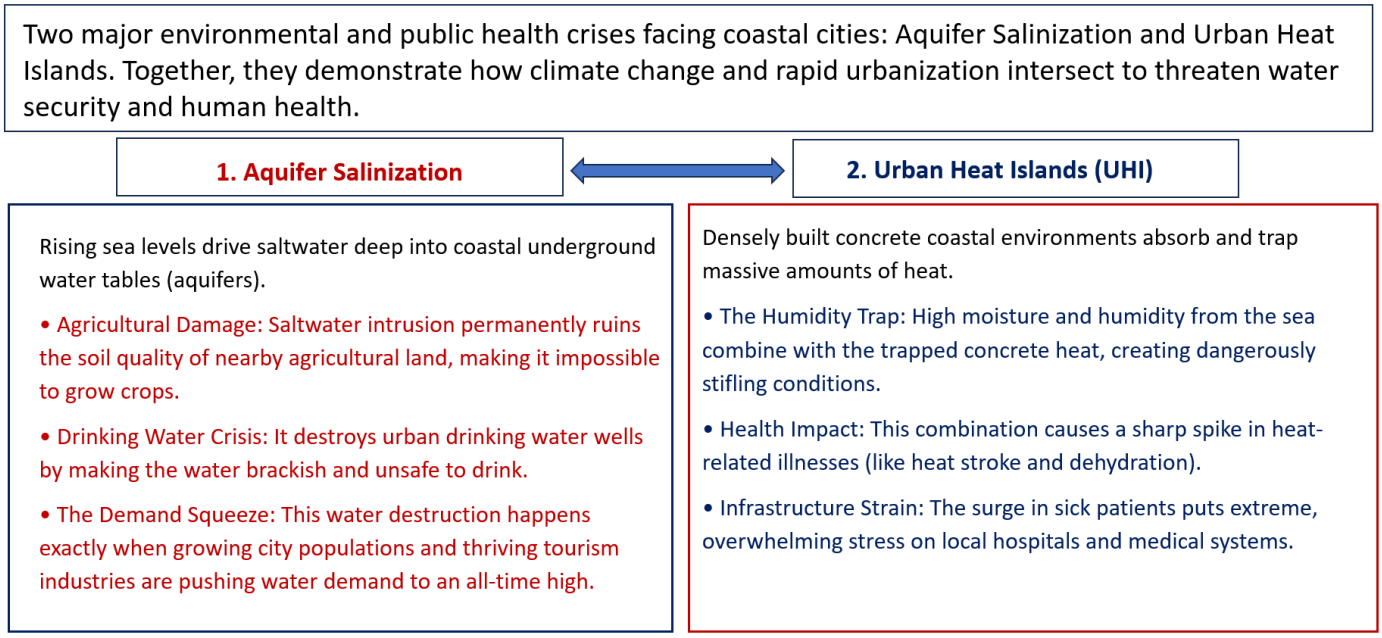
using renewable energy. (iii) Monitor and Optimize: Environmental analytical chemistry tracks the entire process to maximize safety, verify efficiency, and ensure long-term sustainability.

This three-day conference aims to bring together researchers, academics, doctoral students, and educators working in the fields of materials chemistry, electrochemistry, and environmental analytical chemistry. The event will provide an opportunity to present current research, discuss career prospects, and share new ideas. Through round-table discussions and networking sessions, the conference seeks to foster the development of sustainable solutions and enrich the experience of every participant.

Dear colleagues, we're looking forward to an excellent meeting with great scientists from different countries around the world and sharing new and exciting results in Materials Chemistry, Electrochemistry and Environmental analytical chemistry.

Visual Abstract

Demonstration how climate change and rapid urbanization intersect to threaten water security and human health



Adaptation Strategy

To mitigate the combined threats of climate change and rapid urbanization, modern cities are moving away from traditional concrete engineering toward **integrated, nature-based, and decentralized water management strategies**. These adaptation strategies simultaneously restore the natural water cycle, secure clean water supplies, and protect public health.

Strategy	Primary Water Security Benefit	Primary Human Health Benefit
Blue-Green Infrastructure	Reduces urban flood volumes	Lowers ambient temperatures and heatstroke rates
Sponge City Design	Recharges local groundwater aquifers	Eliminates stagnant water pools that breed mosquitoes
Wastewater Recycling	Creates a drought-proof water supply	Prevents the use of contaminated water for urban agriculture
Resilient Sanitation	Protects water networks from pollution	Drastically reduces outbreaks of waterborne cholera and typhoid

KEYNOTE SESSION III:

MATERIALS & THE ENVIRONMENT,

Chair/Co-chairs Ahmad El Moll, Marcello Locatelli

8th International Symposium on Materials, Electrochemistry and Environment – CIMEE26

From Microclusters to Conductive Networks: Rare-Earth-Doped ZnO/Graphene Nanocomposites

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Thematic Area: Materials & The Environment

Abstract

The development of lightweight, multifunctional materials with tunable electrical and dielectric properties is of increasing interest for electromagnetic interference (EMI) shielding and emerging electronic applications. In this work, a new family of hierarchical nanocomposites based on rare-earth-doped ZnO (RE:ZnO; RE = La, Er, Sm) and graphene nanoplatelets (GNPs) is investigated. The material concept combines the tunable defect chemistry and dielectric response of RE-doped ZnO with the conductive network provided by graphene, targeting controlled charge transport and enhanced interfacial polarization. RE:ZnO/GNP composites were prepared through an electrospinning–calcination route that enables the transformation of precursor fibrous structures into self-organized three-dimensional microclusters. The nature and concentration of the rare-earth dopant strongly influence the resulting morphology, generating distinct architectures ranging from compact clusters and short needles to dense nanobrushes and highly porous structures. The incorporation of graphene produces a further morphological transformation, with graphene becoming integrated within the oxide architecture rather than acting simply as a surface additive. This synergistic interaction leads to complex hierarchical structures and extended conductive pathways. Rare-earth doping and graphene incorporation modify the ZnO electronic structure and significantly affect charge-transport mechanisms. The results demonstrate that electrospinning–calcination can serve not only as a synthesis method but also as an effective morphology-engineering strategy for constructing three-dimensional oxide/carbon networks. The combination of dopant-controlled defect chemistry, hierarchical architecture, interfacial polarization, and enhanced electrical transport makes RE:ZnO/GNP microcluster composites promising candidates for tunable EMI shielding as well as sensing, photocatalytic, electronic, and other multifunctional applications.

Keywords: RE-doped ZnO; graphene nanoplatelets; nanocomposites; electrospinning; microclusters; dielectric properties; electrical conductivity; electromagnetic shielding.

Acknowledgements: IMT's contribution was partially supported by Romanian Ministry of Research, Innovation and Digitalization through the μNanoEl, Cod: 23 07 core Programme.

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Synergistic g-C_3N_4-Transition-Metal Sulfide Heterostructures as Efficient Bifunctional Electrocatalysts for Water Splitting

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Nor Presented

Thematic Area: Electrochemistry and Energy Materials

Abstract

Hydrogen production through alkaline water electrolysis is considered one of the most promising approaches for sustainable and clean energy generation, making the development of efficient and cost-effective bifunctional electrocatalysts a critical research priority**.** Hydrothermally synthesized g-C_3N_4-MS_2 (M = Co, Fe, Ni) composites with mass ratios of 2:1, 1:1, and 1:2 were evaluated as bifunctional electrocatalysts for alkaline water splitting in 1.0 M KOH using linear sweep voltammetry (LSV) and Tafel analysis. The electrocatalytic performance was strongly influenced by both the metal sulfide and the composition ratio. For OER, g-C_3N_4-NiS_2 (1:1) delivered the highest current density of 59.34 mA/cm^2, whereas g-C_3N_4-FeS_2 (1:2) achieved 54.63 mA/cm^2 with the lowest Tafel slope of 45.41 mV/dec. For HER, g-C_3N_4-FeS_2 (1:2) exhibited the highest current density of 43.68 mA/cm^2, followed by g-C_3N_4-NiS_2 (1:1). The improved activity was attributed to synergistic interfacial interactions, enhanced charge transfer, and optimized heterojunction formation. These findings highlight g-C_3N_4-MS_2 heterostructures as promising bifunctional electrocatalysts for efficient alkaline water splitting. In addition, comprehensive structural, morphological, and physicochemical characterization of the synthesized catalysts will be presented to establish the relationship between their properties and electrocatalytic performance.

Keywords: Alkaline water splitting, Bifunctional electrocatalysis, g-C_3N_4 composites, Hydrogen evolution, Oxygen evolution, Transition-metal sulfides.

Acknowledgements: This work was supported by the Scientific Research Projects Coordination Unit of Eskişehir Osmangazi University (Project No. FOA-2024-3276).

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Eco-Friendly Low-Temperature Hydrothermal synthesis of $LiFePO_4$/rGO nanocomposites: How Graphene Oxide Chemistry Shapes Structure and conductivity?

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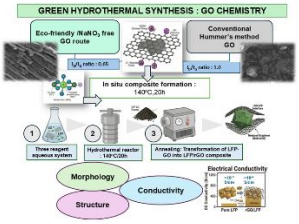
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Thematic Area: Materials and The Environment

Abstract

$LiFePO_4$ (LFP) is a promising cathode material for lithium-ion batteries due to its environmental benignity, low cost, safe operating voltage of ~3.45 V vs. Li^+/Li, and thermal stability. However, its low electronic conductivity and limited lithium-ion diffusion restrict its electrochemical performance. In this work, an eco-friendly and low-temperature hydrothermal route was developed for the synthesis of $LiFePO_4$/reduced graphene oxide (LFP/rGO) nanocomposites at 140 °C for 20 h using an aqueous system of three reagents. In contrast to many reported LFP/rGO studies, where graphene derivatives are incorporated after LFP formation, the present method allows in situ interaction between graphene oxide (GO) and the precursor system during composite formation. To evaluate the role of GO chemistry, composites prepared using the conventional Hummer's method were directly compared with those obtained from an eco-friendly, $NaNO_3$ free GO oxidation route. The materials were characterized by Rietveld-refined X-ray diffraction, Raman spectroscopy, X-ray photoelectron spectroscopy, Scanning electron microscopy, and electrical measurements. Raman analysis revealed a significantly lower I_D/I_G ratio of 0.65 for the eco-friendly route compared to the conventional one (1.03), indicating a higher degree of graphitization and fewer structural defects. Also, XRD analysis confirmed the formation of the single-phase olivine structure, while, the eco-friendly LFP/rGO composite exhibited enhanced crystallinity compared to the conventional one, without compromising the LFP crystal structure. These findings highlight the importance of GO precursor chemistry in LFP/rGO composites and support the development of greener hydrothermal synthesis strategies for energy storage materials [1-6].



Keywords: Electrical Conductivity, Hydrothermal synthesis, Lithium-ion phosphate, Nanocomposites, Reduced Graphene oxide.

Acknowledgements: Many thanks to Litharaki Labs/Lithium Cells of Sunlight Group Energy Storage Systems for funding this work.

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SPECIAL SESSION I:

Climate change mitigation, & Environmental Sustainability

Climate change mitigation and environmental sustainability overlap heavily. Reducing greenhouse gases often improves air quality, protects local habitats, and saves precious water resources

8th International Symposium on Materials, Electrochemistry and Environment – CIMEE26

Climate change mitigation solutions in the Mediterranean region: towards a shared vision to address common challenges

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Thematic Area: Materials & the Environment

Abstract

The Mediterranean region is one of the most severe climate change hotspots on Earth. Indeed, everywhere in the world, the climate crisis is accelerating, but in the Mediterranean region it is worse. Indeed, the Mediterranean region is now considered a climate change hotspot, undergoing transformations twice as fast as the global average. Massive urbanization and the concentration of human activities (agriculture, transportation, urban areas) around the Mediterranean basin are creating a major ecological crisis. During various sessions spread over three days (September 24-26, 2026) of the CIMEE conference, https://cimee-science.org/program-sessions-list/) the most critical challenges facing the Mediterranean region—climate change, water resources, and waste treatment—will be addressed by renowned experts from around the world. Here we present a brief overview of the pressures exerted on the region and the main sectors emitting greenhouse gases (GHGs): **I - Major environmental pressures:** Pressure on water resources: Overexploitation of groundwater for agriculture and tourism, combined with decreased rainfall, exacerbates drought. Soil sealing: Urban sprawl destroys local ecosystems, reduces biodiversity, and increases the risk of flooding by rendering soils impermeable. Marine and coastal pollution: The discharge of plastic waste, untreated wastewater, and industrial pollutants by coastal countries is suffocating the Mediterranean Sea. **II - Main GHG emitting sectors:** Transportation: Heavy international maritime traffic, coupled with congested road transport in metropolitan areas, generates a massive amount of CO_2 and fine particulate matter. Urban areas: High population density leads to enormous energy consumption (air conditioning, heating, lighting) and complex waste management, which emits methane. Agriculture: The intensive use of nitrogen fertilizers and livestock farming emit nitrous oxide and methane, while depleting the soil. Significant efforts are needed to combat climate change and conserve biodiversity in the Mediterranean. Therefore, region-specific scientific knowledge and solutions based on decarbonizing various sectors are essential for stakeholders and governments to make informed climate and environmental decisions. **Scientific Solutions for Mediterranean Climate Mitigation:** (i) Materials Chemistry: Focuses on developing advanced materials to capture and store carbon. It is also used to design highly efficient solar cells and sustainable building materials that reduce the urban heat island effect in Mediterranean cities. (ii) Electrochemistry: Drives the clean energy transition through efficient energy storage systems (like next-generation batteries) and green hydrogen production via water splitting, reducing reliance on fossil fuels. (iii) Environmental Analytical Chemistry: Provides the tools to precisely monitor pollutants, track greenhouse gas emission sources, and analyze soil and water degradation to guide local conservation policies. **Main Impact Areas in the Mediterranean** (i) Water Scarcity: Electro-dialysis and advanced membrane materials improve desalination processes, providing fresh water with lower energy consumption. (ii) Renewable Energy Integration: Electrochemical storage bridges the gap for intermittent solar and wind energy, which are abundant in the Mediterranean basin. (iii) Ecosystem Preservation: Analytical tracking allows scientists to monitor the acidification of the Mediterranean Sea and implement targeted marine protection.

Keywords: climate crisis, Massive urbanization, conserve biodiversity, agriculture, transportation, urban areas, Mediterranean basin, GHG emitting sectors, major ecological crisis, water resources, waste treatment.

Scientific Solutions for Mediterranean Climate Mitigation

- Materials Chemistry: Focuses on developing advanced materials to capture and store carbon. It is also used to design highly efficient solar cells and sustainable building materials that reduce the urban heat island effect in Mediterranean cities.
- Environmental Analytical Chemistry: Provides the tools to precisely monitor pollutants, track greenhouse gas emission sources, and analyze soil and water degradation to guide local conservation policies.
- Electrochemistry: Drives the clean energy transition through efficient energy storage systems (like next-generation batteries) and green hydrogen production via water splitting, reducing reliance on fossil fuels.

Key Impact Areas in the Mediterranean

- Water Scarcity: Electro-dialysis and advanced membrane materials improve desalination processes, providing fresh water with lower energy consumption.
- Renewable Energy Integration: Electrochemical storage bridges the gap for intermittent solar and wind energy, which are abundant in the Mediterranean basin.
- Ecosystem Preservation: Analytical tracking allows scientists to monitor the acidification of the Mediterranean Sea and implement targeted marine protection.

Workshop

WORKSHOP I

Waste management & sustainable Energy,

Chair/Co-Chairs: A. El Moll



Extreme heat is shattering records in July 2026, especially in the Mediterranean region, are not a new phenomenon, but climate change is prolonging them, making them more frequent and intense. This critical reality represents a threat to the future and demands an immediate transformation of our societal models. Faced with crises of historic proportions, mitigation (reducing emissions) and adaptation (adjusting our infrastructure) must be based on radically innovative solutions.

WORKSHOP 1: Climate change mitigation: the potential role of materials electrochemistry
WORKSHOP 2 : Climate change, Aerosol chemical complexity, modeling and Monitoring combination

8th International Symposium on Materials, Electrochemistry and Environment – CIMEE26

Climate change: Aerosol chemical complexity, modeling & Monitoring combination

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Thematic Area: Materials & the Environment

Abstract

Understanding the chemical complexity of aerosols represents one of the greatest current challenges for atmospheric science. Aerosols are suspended particles whose composition varies continuously under the influence of chemical reactions and environmental factors. To anticipate their impacts on public health, air quality, and climate change, scientific research now relies on a synergistic combination of numerical modeling and instrumental monitoring. Bridging the gap between empirical observation (monitoring) and predictive simulation (modeling) is crucial to quantifying how aerosols influence air quality, human health, and global climate feedback loops. **1. The Chemical Complexity of Aerosols: A Major Challenge**. Aerosols are not static entities, but a dynamic mixture of compounds from diverse origins: (i) Multiple origins: Direct emissions (primary aerosols such as desert dust, sea salt, or combustion soot) and chemical transformations of precursor gases (secondary aerosols such as sulfates, nitrates, and organics). (ii) Secondary Organic Aerosols (SOAs): Resulting from the oxidation of semi-volatile organic compounds (SVOCs), they constantly evolve as they age in the atmosphere, changing their toxicity and properties. (iii) Physical interactions: The mechanisms include condensation, evaporation, hydrophilicity (water absorption), and multiphase processes (reactions within clouds). **2. Monitoring: Measuring Reality at High Resolution.** To address this complexity, environmental monitoring networks deploy cutting-edge technologies capable of characterizing particles in real time: (i) Online Monitoring: Instruments like Aerosol Mass Spectrometers (AMS) and time-of-flight systems allow scientists to measure rapid changes in chemical composition and molecular oxygen-to-carbon ratios at sub-minute intervals. (ii) Offline Monitoring: Traditional filter-based networks (e.g., IMPROVE Network or CSN) gather 24-hour samples for meticulous analysis via ion chromatography and thermal-optical tools. (iii) Remote Sensing and Satellites: Space-based sensors provide global coverage by measuring the optical thickness of aerosols, validated by ground-based networks such as AERONET. (iv) Health Indicators: Monitoring of Oxidative Potential (OP), an emerging measurement assessing the capacity of aerosols to generate oxidative stress in the lungs. **3. Modeling: Simulating and Predicting Atmospheric Evolution.** Chemical Transport Models (CTMs), such as CHIMERE or EMEP, translate the laws of physics and chemistry into numerical equations to map pollution: (i) Advection-Diffusion-Reaction Equation: The models calculate the transport by wind (advection), turbulent mixing (diffusion), and chemical transformations (reactions) of pollutants. (ii) Complex Aerosol Modules: Integration of thermodynamic schemes to simulate the partitioning of compounds between the gaseous and particulate phases. (iii) Numerical Representations: Modal approaches (grouping by size modes) or sectoral/binary approaches (fine discretization by size classes) to track particle size evolution. **4. The Synergy of Modeling and Monitoring: The Winning Approach.** Neither approach is sufficient on its own: monitoring lacks continuous spatiotemporal coverage, while models suffer from uncertainties regarding emission inventories or chemical mechanisms. Combining them offers significantly increased power (Fig). (i) Data assimilation: Real-time injection of observations (satellites, ground stations) into numerical models to correct air quality forecast trajectories (similar to meteorological practices). (ii) Mechanism validation: High-resolution monitoring data (e.g., campaigns from the European ACTRIS infrastructure) serve as a testbed for adjusting the chemical parameters of the models, particularly for the complex formation of atmospheric pollution (AOS). (iii) Source attribution: Statistical modeling based on chemical measurements (such as the PMF - Positive Matrix Factorization model) makes it possible to identify the exact origin of particles, thus guiding public policies for emission reductions.

Keywords: Climate change, Aerosol chemical complexity, modeling, Monitoring, secondary Organic Aerosols, Synergy of Modeling and Monitoring, data assimilation, Mechanism validation

1. The Main Problem: Aerosol Chemical Complexity

Aerosols are not uniform spheres; they are dynamically changing, chemically intricate structures. They are either emitted directly as primary particles (e.g., mineral dust, sea spray, black carbon) or formed in the atmosphere as secondary aerosols via gas-to-particle conversion (e.g., sulfates, nitrates, secondary organic aerosols). Their climate impact hinges entirely on this chemical complexity through two primary mechani:

Aerosol-Radiation Interactions (Direct Effect):
The chemical makeup dictates whether an aerosol reflects or absorbs light. (i) Sulfates and Nitrates: Scatter incoming solar radiation back into space, providing a net cooling effect.
(ii) Black Carbon (Soot): Heavily absorbs solar energy, warming the surrounding atmosphere.

Aerosol-Cloud Interactions (Indirect Effect):
Aerosols serve as cloud condensation nuclei (CCN). The particle's chemical composition governs its hygroscopicity

2. The Bridge: Advanced Modeling

Because aerosols evolve via complex multiphase chemistry—where gases, liquids, and solids continuously interact—climate simulations require specialized chemical transport models (CTMs) and coupled Earth System Models (ESMs).

Interactive Aerosol Modules: Modern climate models, such as the Community Atmosphere Model incorporate dynamic representations of microphysics and secondary organic aerosol formation.
Feedback Loops: Climate change itself alters meteorology (temperature, humidity, and wind), which in turn alters natural aerosol emissions (like dust storms or marine sea spray) and accelerates chemical reaction rates.

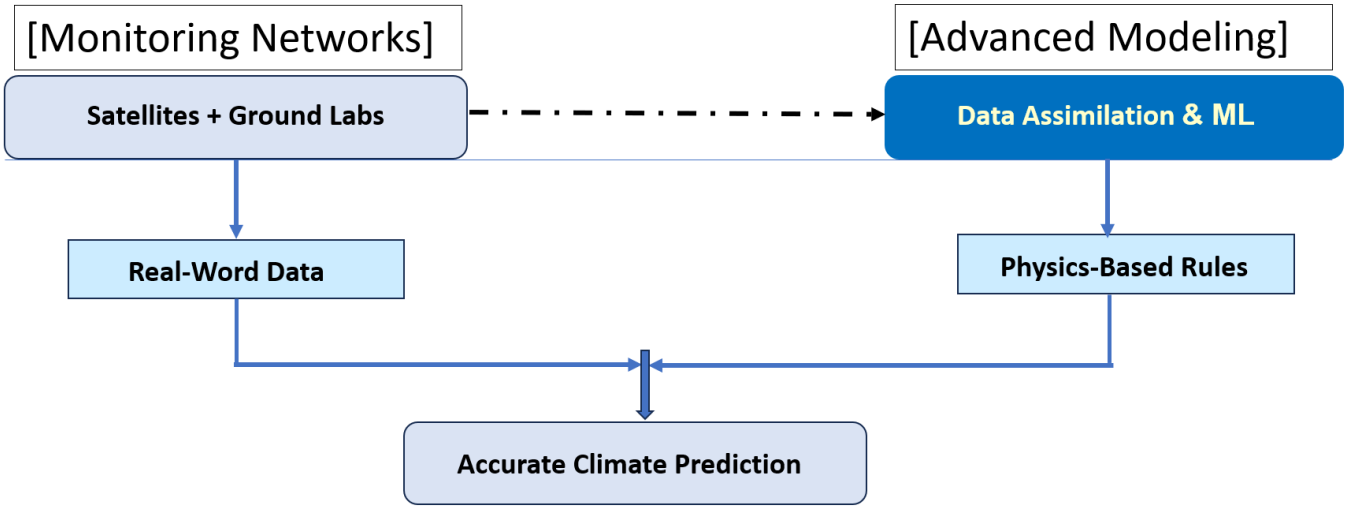
3. The Ground Truth: Integrated Monitoring

Models are only as good as the data that constrains them. Characterizing global aerosol burdens requires a coordinated, multi-angle monitoring system.

Monitoring Platform	Core Contribution to Climate Science
Ground-Based Remote Sensing	Networks like NASA's AERONET provide high-accuracy, long-term datasets of aerosol optical depth (AOD)
Satellite Missions	Instruments like the ESA/JAXA EarthCARE satellite deliver a global 3D view of vertical aerosol profiling and real-time cloud-aerosol radiative forcing.
In-Situ Surface Stations	Global networks monitor PM2.5 and PM10 chemical speciation, tracking how real-world aerosol mixtures shift over decades due to pollution policies.

4. The Synergy: Forging the Combination

The true breakthrough in reducing climate uncertainty lies in combining all three pillars. Data assimilation injects real-time satellite and ground observations directly into chemical transport models. Simultaneously, advanced laboratory tracking of aerosol chemical complexity provides the fundamental equations that dictate how these modules behave inside vast global simulations. Without this integrated approach, our understanding of the Earth's energy imbalance and future warming trajectories remains incomplete



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Climate Change mitigation: The potential role of Materials Electrochemistry

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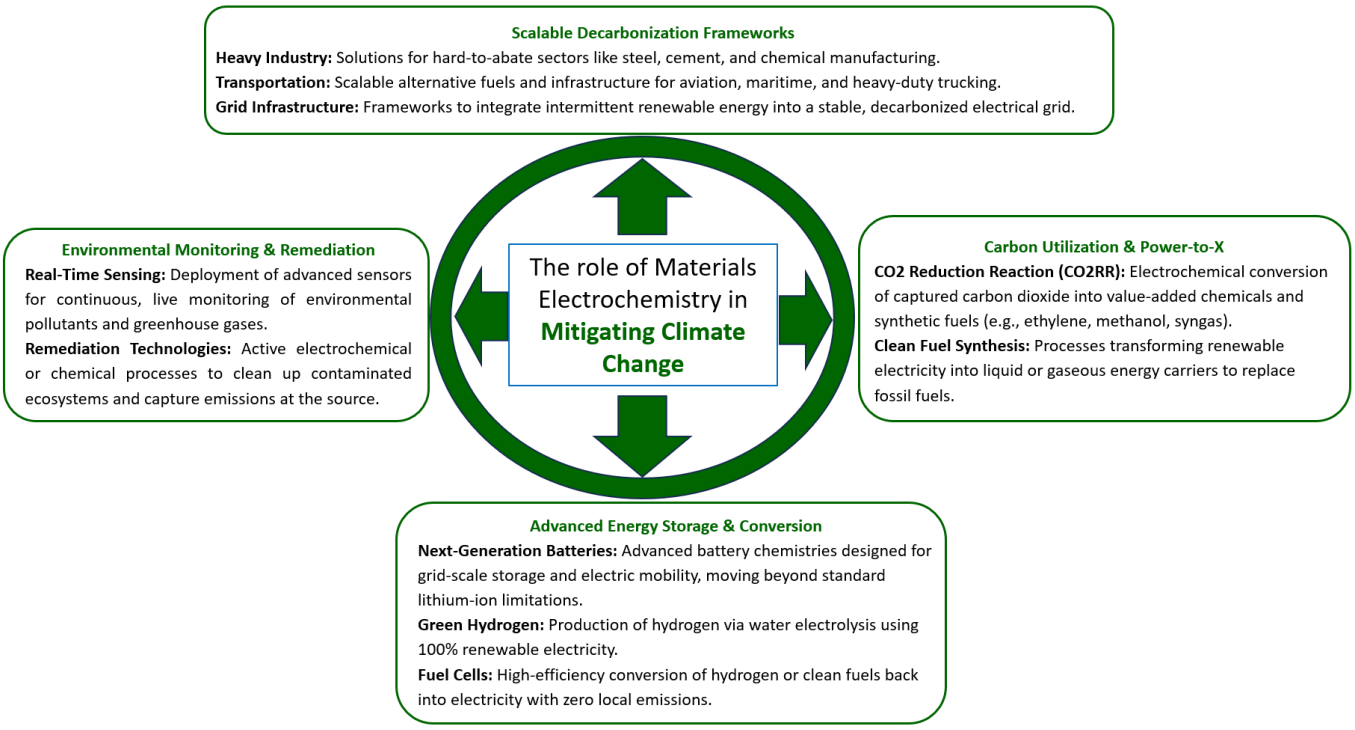
Thematic Area: T3. Atmospheric Chemistry & Environmental Pollution

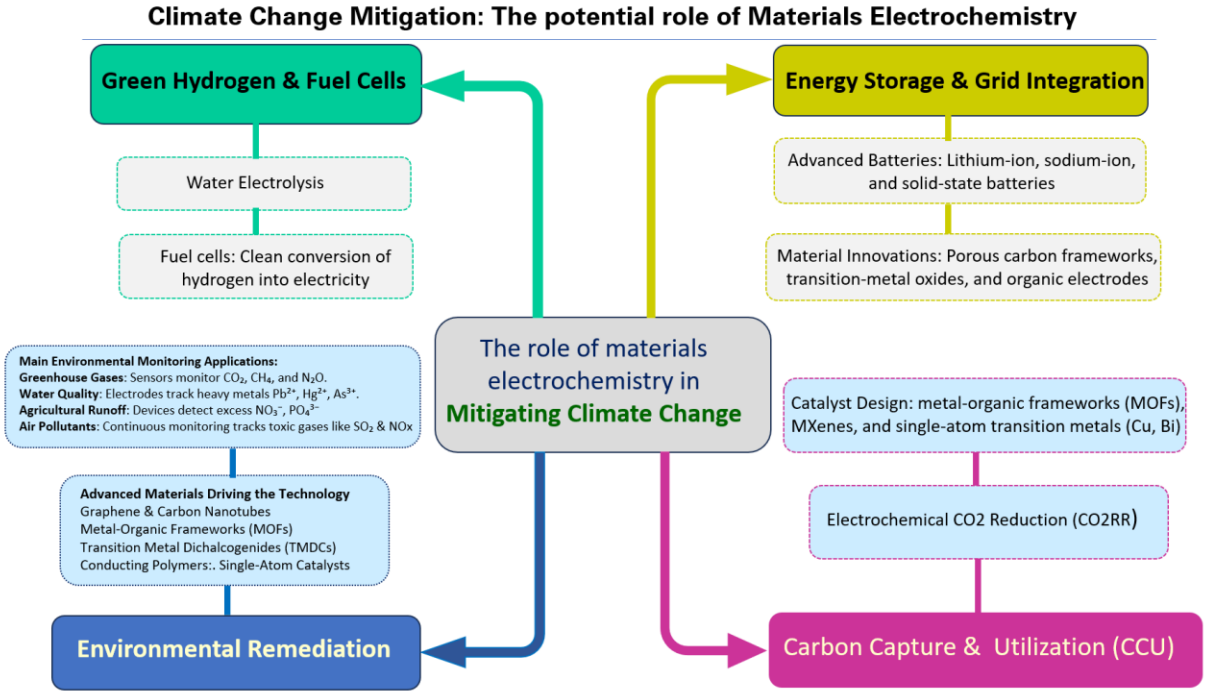
Abstract

Materials electrochemistry is a major technological pillar for decarbonizing our society and combating climate change. It enables the storage of renewable energies, the transformation of the chemical industry, and the capture of greenhouse gases. It allows also to monitor pollutants and address environmental pollution while sustainably transforming our energy systems. Materials electrochemistry drives climate change mitigation by enabling green energy storage, carbon dioxide conversion clean fuel production, and value-added chemicals. These electrified processes convert renewable electricity into vital chemical energy carriers to decarbonize heavy industry and transport. In addition, Materials electrochemistry serves as the backbone for climate change mitigation by enabling highly precise, real-time environmental sensing and remediation. By designing advanced electrode materials, scientists can detect pollutants, monitor greenhouse gases, and actively clean ecosystems**. I - Energy Storage and Grid Integration:** A- Advanced Batteries: Lithium-ion, sodium-ion, and solid-state batteries balance unstable renewable grid loads and electrify transport. (ii) Material Innovations: Porous carbon frameworks, transition-metal oxides, and organic electrodes boost charge capacity and cycle life. (iii) Quantified Impact: Grid storage deployment reduces peak fossil-fuel peaker plant reliance, cutting sector emissions by up to 30–40% during high-wind/solar intervals. B - Carbon Capture and Utilization (CCU). Electrochemical CO2 Reduction (CO2RR): Transforms captured CO_2 from industrial point sources or air into feedstocks like carbon monoxide, formate, and methanol using renewable electrons. Catalyst Design: Utilizes metal-organic frameworks (MOFs), MXenes, and single-atom transition metals (Cu, Bi) for precise reaction selectivity. **II - Green Hydrogen and Fuel Cells:** (i) Water Electrolysis: Cleaves water molecules using advanced earth-abundant catalysts (phosphides/oxides) to generate zero-emission hydrogen fuel. (ii) Energy Vectors: Serves as a heavy-industry and long-duration storage medium to abate hard-to-electrify sectors like steel and shipping. On the other hand, materials electrochemistry serves as the backbone for climate change mitigation by enabling highly precise, real-time environmental sensing and remediation. I- Key Environmental Monitoring Applications: Advanced materials allow for the continuous tracking of critical climate and pollution vectors. (i) Greenhouse Gases: Sensors monitor carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). (ii) Water Quality: Electrodes track heavy metals like lead (Pb^{2+}), mercury (Hg^{2+}), and arsenic (As^{3+}). (iii) Agricultural Runoff: Devices detect excess nitrates (NO_3^-) and phosphates (PO_4^{3-}) to prevent water suffocation. (iv) Air Pollutants: Continuous monitoring tracks toxic gases like sulfur dioxide (SO_2) and nitrogen oxides NOx. II - Advanced Materials Driving the Technology: The performance of an environmental sensor depends directly on the nanoscale architecture of its electrodes. (i) Graphene & Carbon Nanotubes: Provide ultra-high surface area and rapid electron transfer. (ii) Metal-Organic Frameworks (MOFs): Offer highly porous, customizable structures to trap specific gas molecules. (iii) Transition Metal Dichalcogenides (TMDCs): Exhibit high catalytic activity for sensitive redox reactions. (iv) Conducting Polymers: Deliver flexible, biocompatible matrices for organic pollutant detection. (v) Single-Atom Catalysts: Maximize atom efficiency, ensuring extreme sensitivity to trace toxins. **III - The Sensing-to-Remediation Loop.** Monitoring directly informs and automates active climate mitigation and cleanup strategies. (i) Smart Grids: Real-time CO_2 tracking optimizes the deployment of carbon-capture systems. (ii) Automated Water Treatment: Sensor feedback triggers electrochemical oxidation to destroy organic toxins. (iii) Precision Agriculture: Nitrate sensors prevent

fertilizer overuse, curbing soil-driven greenhouse emissions. (iv) Early Warning Systems: Flash sensors detect industrial chemical leaks before widespread ecological damage occurs.

Keywords: Materials electrochemistry, climate change, decarbonizing, renewable energies, Carbone capture and utilization, Graphene & Carbon Nanotubes, Metal-Organic Frameworks, green energy storage, monitor pollutants, environmental sensing and remediation, clean fuel production, value-added chemicals.





DAY 2

PROGAM - DAY 2

Friday, September 25, 2026



PLENARY SESSION III:

Electrochemistry and the Environment,

Chair/Co-Chairs: A. ElMoll, Najla Fourati

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Electrochemical sensing devices for sustainable agriculture: Emerging platforms and deployment challenges

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Thematic Area: Electrochemistry, Bioelectrochemistry & Environment

Abstract

Sustainable agriculture increasingly depends on analytical tools capable of converting local information on soils, plants, water, and agrochemical residues into timely management decisions. Electrochemical sensing is particularly well suited to this transition because it combines high analytical sensitivity with miniaturization, low power requirements, portability, and compatibility with low-cost manufacturing. Rather than serving only as stand-alone detectors, current devices are evolving toward distributed sensing platforms for precision agriculture. They can support nutrient and soil-quality assessment, early identification of plant stress, rational use of water and fertilizers, and on-site surveillance of contaminants such as pesticides and heavy metals [1]. Recent developments are reshaping both sensor architecture and data use. Nanostructured electrodes and functional materials improve interfacial charge transfer, recognition, and detection limits, while disposable formats facilitate decentralized measurements and reduce the infrastructure required for field analysis [2]. Connectivity is becoming equally important: coupling sensors to wireless networks, smartphones, and Internet-of-Things platforms enables automated acquisition, georeferenced monitoring, and rapid transmission of measurements. The resulting data streams can be combined with artificial intelligence and machine-learning methods to extract patterns, compensate for complex matrices, and support decision-making. At the plant scale, wearable and implantable electrochemical (bio)sensors are extending monitoring from the surrounding environment to physiological and biochemical markers directly in living tissues, opening new opportunities for minimally invasive assessment of stress, nutrients, signaling molecules, and agrochemical exposure [3]. The principal challenge is translating laboratory demonstrations into reliable agricultural deployment. Long-term stability, calibration drift, biofouling, matrix effects, sensor-to-sensor reproducibility, sustainable materials, interoperability, and validation under realistic field conditions remain critical issues [4-5]. Progress therefore requires a systems-level approach that considers analytical performance alongside manufacturability, connectivity, data quality, user requirements, and environmental impact. Addressing these constraints should allow electrochemical sensors to move from isolated measurements toward robust decision-support networks that reduce unnecessary chemical inputs, improve resource-use efficiency, and strengthen the environmental sustainability of crop production.

Keywords: Chemical sensors, Emerging pollutants' detection, Molecularly imprinted polymers, Remediation.

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Advanced Environmental Monitoring Systems and Sensor Technology toward achieving global sustainability

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Thematic Area: Environmental & Agricultural Chemistry

Abstract

Biodiversity is fundamental to sustaining life on Earth, making the precise tracking of ecosystems and species increasingly critical. While near-real-time monitoring enables decision-makers to respond swiftly to environmental shifts, practical adoption remains low. Automated workflows are technically feasible, yet a unified implementation framework is still lacking. To bridge this gap, this study proposes integrating Advanced Environmental Monitoring Systems (AEMS) and Smart Environmental Monitoring Systems (SEMS) into a powerful hybrid infrastructure. By merging the rugged, high-precision capabilities of traditional advanced stations with the agile, dense, and AI-driven nature of smart IoT technologies, this approach establishes a continuous, high-resolution network for live ecological tracking. Furthermore, this study examines the primary obstacles to deploying near-real-time monitoring across diverse geographical areas and ecological disciplines, providing a comprehensive overview of the core architecture and underlying technologies.

• IoT Sensor Networks: Deploy ground-level hardware to stream live data on air parameters PM2.5, PM10, NO2, CO2, SO2, water health (pH, turbidity, dissolved oxygen, nitrates), and soil/temperature conditions.

• Remote Sensing & Drones (UAVs): Use satellite imagery and aerial drones to scan large terrain tracts, track land-use changes, and monitor wide-area habitat shifts.

• AI and Machine Learning: Apply predictive models, deep reinforcement learning, and Principal Component Analysis (PCA) to fuse multi-source data streams, forecast pollution spikes, and detect anomalies automatically.

• Cloud & Edge Computing: Process data locally at the sensor edge or via cloud platforms to maintain low-latency reporting (often under two seconds) and high reliability.

• Blockchain Integration: Secure audit trails and regulatory compliance data to ensure tamper-proof environmental reporting. Main Applications for Global Sustainability: (i) Air and Water Quality Management: Real-time environmental tracking empowers cities and industrial operators to pinpoint pollution sources, manage harmful algal blooms, and protect public health. (ii) Smart Agriculture & Resource Conservation: Advanced soil and micro-climate sensors optimize irrigation networks, minimize chemical runoff, and reduce crop-yield waste. (iii) Smart Cities & Waste Management: Ultrasonic and infrared sensors paired with LoRaWAN (Long Range Wide Area Network) optimize municipal waste collection routes and track urban traffic emissions. (iv) Climate Resilience & Disaster Prevention: Continuous environmental monitoring enables utilities and governments to mitigate the impacts of severe weather, grid outages, and severe flooding events. Primary Implementation Challenges: Despite the broad utility of these integrated technologies, several critical implementation challenges remain: (i) Sensor Reliability and Calibration: Environmental wear, signal drift, and ambient interference degrade sensor accuracy over time, necessitating frequent and labor-intensive maintenance. (ii) Interoperability and Data Standardization: Fragmented hardware specifications and proprietary communication protocols hinder the seamless integration of multi-vendor data streams. (iii) Cost and Infrastructure Constraints: Substantial upfront capital expenditure, limited rural connectivity, and rigorous cybersecurity demands often restrict large-scale deployment in resource-constrained regions.

Keywords: artificial intelligence, biosensors, environment monitoring, nanotechnology, sensors, sustainable materials.

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KEYNOTE SESSION IV:

Nanomaterials for Environmental Sensing and Remediation

Chair/Co-Chairs: N. Fourati, A. El Moll,

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Photoelectrochemistry as an Innovative Approach to Sustainable Hydrogen Production

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Thematic Area: Electrochemistry, Bioelectrochemistry & Environment

Abstract

Hydrogen is widely regarded as a fundamental energy carrier for decarbonizing hard-to-decarbonize sectors, but its climate benefit depends entirely on its production method. Photoelectrochemical (PEC) electrolysis of water offers a pathway that couples light capture and electrocatalysis in a single device, converting sunlight and water directly into hydrogen and oxygen without going through the intermediate step of electricity generation as in the case of photovoltaic-electrolytic (PV-EC) systems. This article reviews the operating principles of photoelectrochemical cells (PECs), the semiconductor materials used as photoanodes and photocathodes, the record solar-hydrogen conversion (STH) efficiencies obtained with single-absorber and tandem architectures. In addition, we outline the main obstacles to the deployment of this technology: charge carrier recombination, photocorrosion, the trade-off between light absorption and carrier transport length (film thickness), and the difficulty of scaling up laboratory devices to industrial-scale photoreactors. The role of computer modeling and techno-economic and life-cycle analysis in resolving this problem is examined, as well as the specific opportunity that photoelectrochemistry represents for a country with high levels of sunshine like Morocco, where a roadmap for adopting a green hydrogen sector has been established. Indeed, Morocco has abundant solar resources, creating favorable conditions for both applied research and potential industrial integration with desalination and electrolysis powered by renewable energy. The article concludes that, although PEC technology is not yet cost-competitive with large-scale PV-EC hydrogen, it remains a scientifically important and strategically relevant pathway, especially for decentralized low-carbon hydrogen production.

Keywords: photoelectrochemistry; solar water splitting; green hydrogen; photoanode; photocathode; solar-to-hydrogen efficiency.

Acknowledgements: We thank all those who, directly or indirectly, contributed to the completion of this work.

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Chemical Growth Routes to Advanced Materials for Efficient Energy Storage

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Thematic Area: Materials & The Environment

Abstract

The transition toward sustainable electrified transportation requires the development of energy storage technologies that simultaneously satisfy the demands for safety, cost-effectiveness, scalability, and high electrochemical performance. This work presents sustainable manufacturing strategies for advanced lithium-based cathode materials using scalable chemical deposition techniques, with emphasis on spray deposition and chemical vapor deposition (CVD). Lithium iron phosphate ($LiFePO_4$) was synthesized directly onto graphite substrates through a water-based spray process under ambient conditions, eliminating the need for binders, toxic organic solvents, and energy-intensive slurry processing. The influence of aqueous LiOH electrolyte concentration on electrochemical performance demonstrated that 1 M LiOH provides the optimal balance between cycling stability and specific capacity, whereas 2 M LiOH enhances conductivity but compromises long-term electrode integrity. In parallel, Ag-doped V_2O_5 thin films prepared by CVD exhibited improved conductivity, enhanced Li^+ intercalation/deintercalation reversibility, and remarkable cycling stability, with the 15% Ag composition delivering superior electrochemical activity. The proposed manufacturing approaches significantly reduce processing complexity, energy consumption, and environmental impact while maintaining competitive battery performance. These findings highlight the potential of low-temperature, scalable thin-film deposition technologies to replace conventional powder/slurry fabrication routes, providing a viable pathway toward safe, sustainable, and industrially competitive next-generation lithium-ion and solid-state batteries for transportation and large-scale energy storage applications.

Keywords: Chemical vapor deposition, Electrochemical energy storage, Lithium iron phosphate, Lithium-ion batteries, Spray deposition, Sustainable manufacturing.

Acknowledgements: D. Vernardou would sincerely like to thank C. Floraki, M. Apostolopoulou, N. Kavousanos, D. Aivaliotis and T. Tsoukas for their enthusiasm and valuable support.

Graphical abstract



KEYNOTE SESSION V:

Water resources and Sustainable environment

Chair/Co-Chairs: A. El Moll, Najla Fourati

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Next-generation Biocatalysts: Sustainable Removal of Emerging Contaminants for a Clean Water Future

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Thematic Area: Biotechnology & Phytochemistry for Environmental Sustainability

Abstract

The ubiquitous presence of emerging contaminants (ECs) in the environment is a cause for alarm due to their detrimental effects on both ecosystems and human health. These pollutants are recalcitrant to degradation by native microorganisms, causing their persistence and accumulation in the environment. Examples of ECs are pharmaceuticals, personal care products, endocrine disrupting compounds, pesticides and microplastics. The primary source of ECs entering the water bodies is through wastewater treatment plants (WWTPs), since they are not designed to remove this kind of pollutants. Additionally, the use of traditional and advanced physical and chemical methods to remove them is energy demanding, operationally expensive and generates toxic byproducts [1]. This together with the application of more rigorous environmental rules demand the development of cost-effective and environmentally friendly methods to remove ECs from wastewater before being discharged into the environment. Based-enzyme approaches appear as a sustainable solution, among which laccase enzymes are outstanding because they have a broad substrate specificity and only use molecular oxygen for their catalytic activity [2]. However, the cost of laccase production, its instability, poor reusability and inactivation under the harsh conditions usually existing in wastewater restrain its scalability. Therefore, strategies to overcome these limitations must be solved before laccase-based treatments can be applied in real scenarios.

Keywords: biocatalysis, clean water, emerging contaminants, laccase, sustainability, wastewater

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From Knowledge to Cooperation: Advancing Nutrient Circularity in the Baltic Sea Region under CirCan platform

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Thematic Area: Sustainable marine resource management and ecological restoration

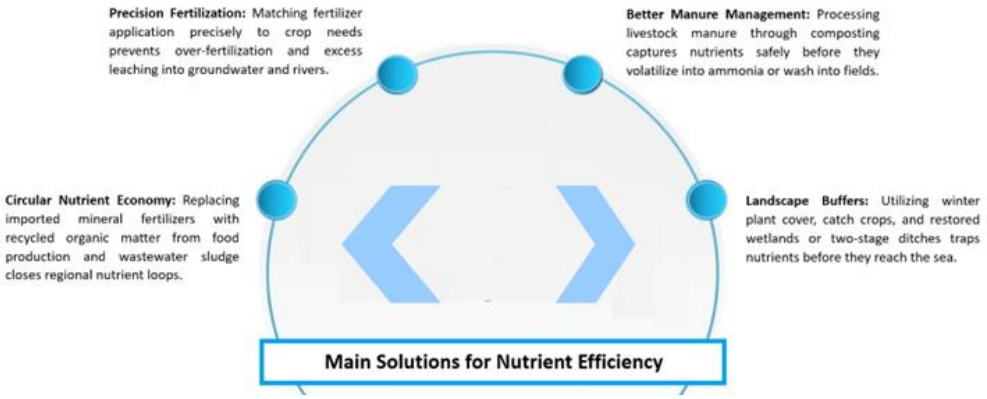
Abstract

Nutrient recovery and recycling are essential for reducing nutrient losses, improving resource efficiency and restoring the ecological status of the Baltic Sea. Despite growing knowledge and a shared policy framework provided by the Baltic Sea Regional Nutrient Recycling Strategy, implementation remains challenging. Available solutions and evidence are often dispersed across projects and sectors, while limited institutional capacity and resources constrain their uptake in national and regional policymaking.

Therefore, a dedicated platform "CirCan" was established as a part of the international project "Capacities for Nutrient Circularity in the Baltic Sea Region" finances by Interreg Baltic Sea. CirCan platform aims to bridge this implementation gap by consolidating and transferring knowledge generated by recent Interreg, Horizon Europe and national initiatives. The platform brings together evidence on recycled nutrient markets, enabling policy and economic instruments, and the environmental and social benefits and trade-offs associated with nutrient circularity. Rather than generating knowledge in isolation, it focuses on making existing results more accessible, comparable and actionable for public authorities. The platform is expected to strengthen institutional capacity and improve the use of existing knowledge across the Baltic Sea region. By supporting more coherent and evidence-based approaches to nutrient circularity, it contributes to closing nutrient cycles, reducing nutrient losses to the environment, improving the health of the Baltic Sea and supporting more sustainable and resilient agricultural systems.

Keywords: circular economy, nutrients, water, Baltic Sea region, resilient agricultural systems, sustainability

Acknowledgements: This paper was prepared as a part of the project "Capacities for Nutrient Circularity in the Baltic Sea Region" (CirCan), financed by Interreg Baltic Sea under the European Regional Development Fund (ERDF), project no. #P012 (2026-2028).



Graphical Abstract

ORAL SESSION I:

Water resources, Energy and Environmental Sustainability

Chair/Co-Chairs: N. Fourati, A. El Moll,

8th International Symposium on Materials Electrochemistry & Environment
10th Anniversary CIMEE Conference Celebration
8th International Symposium on Materials, Electrochemistry and Environment – CIMEE26

Biowaste to Energy Devices: Walnut Biochar-Based Electrodes for Aqueous Sodium-Ion Supercapacitors

Nikos Kavousanos [1*], Eleftheria Tsikritsaki [1], Dimitrios Kalderis[2], Dimitra Vernardou [1]

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Not presented

Thematic Area: MATERIALS & THE ENVIRONMENT

Abstract

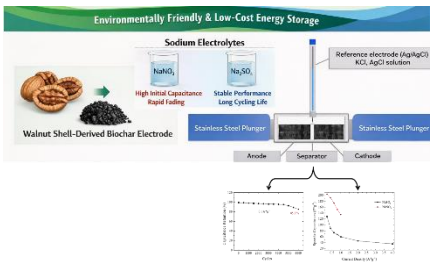
The development of sustainable electrode materials for aqueous sodium-ion supercapacitors is essential for achieving cost-effective and environmentally friendly energy storage solutions. In this study, we report the use of walnut shell–derived biochar as an electrode material in neutral sodium-based aqueous electrolytes[1]. Electrochemical characterization, conducted in both three-electrode and symmetric two-electrode configurations, demonstrates typical electrical double-layer capacitive behavior, low internal resistance, and efficient ion transport within the porous carbon framework [2]. Although the $NaNO_3$ electrolyte delivers higher initial capacitance (up to 204 F g^{-1} at 0.2 A g^{-1}), its limited electrochemical stability results in rapid capacitance degradation. In contrast, Na_2SO_4 exhibits highest stability comparison to $NaNO_3$, retaining approximately 85.3% of its capacitance after 6000 cycles and enabling better performance at higher specific currents. Electrochemical impedance spectroscopy further confirms favorable interfacial kinetics and near-ideal capacitive behavior. These findings highlight the critical role of electrolyte selection in optimizing the performance of walnut shell–derived biochar, offering a low-cost and sustainable pathway for supercapacitor applications.

Keywords: Walnut shell biochar; Aqueous sodium-ion supercapacitor; Sustainable carbon electrode; Neutral electrolyte; Energy storage; Electrochemical performance

Acknowledgements: Nikos Kavousanos and Dimitra Vernardou sincerely thank Professor Dimitrios Kalderis for opening a new research direction in their work through the introduction of locally sourced biomass.

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Graphical Abstract

8th International Symposium on Materials Electrochemistry & Environment
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Towards a Sustainable Future: Integrating Food Safety, Technology, and Waste Valorization

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Not presented

Thematic Area: Environmental & Agricultural Chemistry

Abstract

Ensuring food safety while promoting sustainable resource utilization has become a global priority for developing resilient food systems. This work presents an integrated perspective on food safety and food waste valorization by highlighting innovative technologies and sustainable approaches that improve food quality, reduce environmental impacts, and support circular economy principles. Food safety strategies include contaminant screening, risk assessment, and the application of emerging technologies such as hurdle technology, artificial intelligence, and biosensors to strengthen food monitoring and quality assurance. In parallel, sustainable extraction techniques are explored to recover high-value bioactive compounds from food by-products for value-added applications. Particular emphasis is placed on the development of natural preservatives and anti-sprouting agents derived from food waste, demonstrating how agricultural and food processing residues can be transformed into functional ingredients with industrial relevance. The integration of these technologies contributes to safer food production while reducing waste generation and creating new economic opportunities. International collaborative research and successful case studies further demonstrate the feasibility of translating these innovations into practical applications. Overall, this work highlights the importance of combining technological innovation with sustainable waste management to support food security, environmental protection, and the transition toward more sustainable food systems.

Keywords: Artificial intelligence, Food contaminants, Food safety, Food waste valorization, Hurdle technology, Risk assessment

Acknowledgements: The author acknowledges the support of Beirut Arab University and collaborating research institutions.

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Business models supporting Circular Economy implementation: a Danish digestate case study

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Thematic Area: Materials & The Environment

Abstract

The transition towards a Circular Economy (CE) requires business models (BM) that enable recovered resources to become economically viable and socially accepted products. Although anaerobic digestion contributes to renewable energy production and nutrient recovery, the successful digestate utilisation depends on stakeholder cooperation, regulatory compliance, efficient logistics and market acceptance. This study builds on the ongoing DeliSoil work on value chain selection, value chain analysis and BM development, including the initial Business Model Canvas (BMC), currently being refined for the Danish case within the DeliSoil project. A preliminary BM analysis of the Danish digestate value chain is presented using a structured approach that combines value chain analysis with the BMC. The model identifies key stakeholders, value propositions, business activities, customer segments, required resources, cost structure and revenue streams while considering operational and environmental challenges. The analysis suggests that transport logistics, storage capacity, product quality assurance and regulatory requirements are important factors influencing the economic feasibility of digestate utilisation. Collaboration between biogas operators, farmers, transport providers, advisory services and public authorities may create opportunities to improve nutrient recycling, reduce dependence on mineral fertilisers and strengthen circular resource management. The proposed framework illustrates how BMs can support CE implementation by integrating environmental, economic and organisational perspectives into a single decision support approach. Although based on the Danish case study, the framework may be adapted to other recovered resource value chains, supporting the further development of BMs.

Keywords: circular economy, business model, digestate, value chain, nutrient recovery.

Acknowledgements: Funded by the European Union under the Horizon Europe Programme, Grant Agreement No. 101112855 (DeliSoil). Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or Research Executive Agency (REA). Neither the European Union nor the granting authority can be held responsible for them. Swiss partners (FiBL) have received funding from the Swiss State Secretariat for Education, Research and Innovation (SERI).

SPECIAL SESSION II:

Agro-geochemistry, Agro-geoEnvironment & Sustainability: Challenges & Solutions

8th International Symposium on Materials Electrochemistry & Environment
10th Anniversary CIMEE Conference Celebration

Agro-geochemistry, Agro-geoEnvironment & Sustainability: Challenges & Solutions

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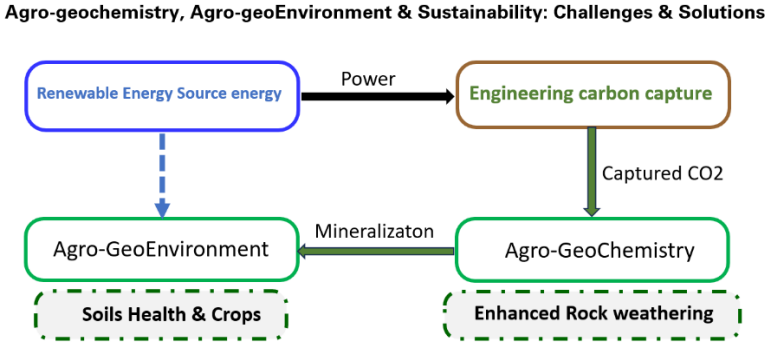
* Corresponding author E-mail: aelmoll@ul.edu.lb

Thematic Agro-geochemistry, Agro-geoEnvironment, *&* Sustainability

Abstract

Agro-geochemistry, Agro-geoEnvironment, and Sustainability focus on the intersection of soil chemistry, geological materials, and agricultural management to address food security while minimizing environmental impact. The main challenge involves mitigating the impact of human activity (such as intensive farming, pollution, and climate change) on Earth's surface resources, including water and soil health. Sustainable development requires integrating geochemical monitoring with agricultural policy to manage soil and water resources effectively. Solutions are shifting towards circular economy approaches, such as converting agricultural waste to biofuel. More specifically, sustainable development, through agro-chemistry and agro-environmental science, primarily aims to manage the chemical, physical, and biological processes within agricultural systems to maintain soil health, water quality, and ecosystem stability. It involves using geological and geochemical principles to understand soil nutrient dynamics, prevent contamination from agrochemicals, and restore degraded lands. To promote a sustainable planet for future generations, objectives can be achieved by addressing several points: fostering biodiversity, restoring habitats and natural landscapes, and strengthening ecosystem resilience, particularly by improving soil health and carbon sequestration. This can help mitigate the effects of climate change and facilitate adaptation, thus protecting against severe droughts, floods, and soil erosion. In this presentation we will discuss the following points: 1. Study the challenges and barriers to adopting sustainable agricultural practices in eastern Mediterranean region, such as limited resources, water shortages, and climate change. 2. Evaluate the potential benefits of transitioning to environmentally sustainable agriculture, including improved soil health, water conservation, biodiversity conservation, and resilience to climate change. 3. Discuss the importance of interdisciplinary collaboration and stakeholder engagement in achieving environmental sustainability goals in agriculture. 4. Apply knowledge of environmental sustainability principles to real-world agricultural scenarios in the eastern Mediterranean region, proposing sustainable solutions and strategies. 5. Synthesize the key concepts related to environmental sustainability in agriculture effectively through written and oral presentations, discussions, and case studies.

Keywords: Agro-geochemistry, Agro-geoEnvironment, Sustainability, chemical, physical, and biological processes, carbon sequestration, sustainable agriculture, climate mitigation



Agro-geochemistry, Agro-geoEnvironment & Sustainability: Challenges & Solutions

Agro-geochemistry, Agro-geoEnvironment, and Sustainability are critical, interconnected fields addressing the challenges of feeding a growing global population while managing environmental impacts on soil, water, and ecosystems. Key challenges involve heavy metal contamination, water scarcity, and climate-induced land degradation, while solutions focus on precision agriculture, nanotechnology, and circular economy approaches.

Challenges in Agro-geochemistry and Agro-geoEnvironment

Soil and Groundwater Contamination: Agricultural, industrial, and mining activities contribute to the contamination of soil and groundwater with toxic heavy metals such as As, Cd, Co, Cr, Cu, Pb, and Zn.

Water Scarcity and Salinity: Increased water demand for agriculture leads to depletion of freshwater resources and increasing salinity in soil and groundwater, particularly in arid regions.

Contaminant Transfer to Food: Hazardous heavy metals and metalloids accumulate in crops (bioaccumulation) from contaminated soil and water, posing risks to human health.

Emerging Contaminants: The widespread use of agricultural plastic films has increased microplastic pollution in farmland by 5%–8% annually.

Climate Change Impacts: Droughts, land degradation, and extreme events affect food quality and soil health, while increasing methane emissions, which can be mitigated to avoid significant warming.

Solutions & Sustainable Approaches

Solutions and Sustainable Approaches

Precision Agriculture and IoT: Using IoT-based smart irrigation systems and precision fertilization can enhance water-use efficiency by over 40% and improve nitrogen use efficiency from 30% to 60%.

Green Chemistry & Remediation: The application of natural minerals, nanomaterials, and carbonaceous materials can help treat contaminated soils and waters.

Circular Economy Solutions: Transforming agricultural and mining waste, such as fly ash, into useful, productive agricultural resources reduces environmental impact and improves sustainability.

Sustainable Farming Practices: Adopting agroecology and organic farming to improve biodiversity, enhance soil carbon sequestration (0.5–2.0 tons per hectare annually), and reduce synthetic chemical use.

Geochemical Mapping and Monitoring: Utilizing GIS and remote sensing to monitor soil geochemistry allows for better tracking of contaminant spread and better management of land use.

Sustainability and Future Outlook: Integrating geochemical insights into agricultural policy is crucial to ensure safety, such as monitoring soil-to-plant transfer of elements. Emerging research focuses on "One Health" approaches that link environmental geochemistry with animal and human health, ensuring that sustainable food systems do not jeopardize long-term environmental health.

POSTER SESSION I:

Climate change mitigation & technological innovations

Chair/Co-Chairs: N. Fourati, A. El Moll

Achieving a circular economy and mitigating climate change: Key Aspects of Sustainable Catalysis and CO2 Conversion

Combating climate change by using both technological innovations and nature-based solutions

Clean Energy and Environmental Sustainability Strategies as a key solution to planetary boundaries

8th International Symposium on Materials, Electrochemistry and Environment – CIMEE26

Achieving a circular economy and mitigating climate change: Key Aspects of Sustainable Catalysis and CO2 Conversion

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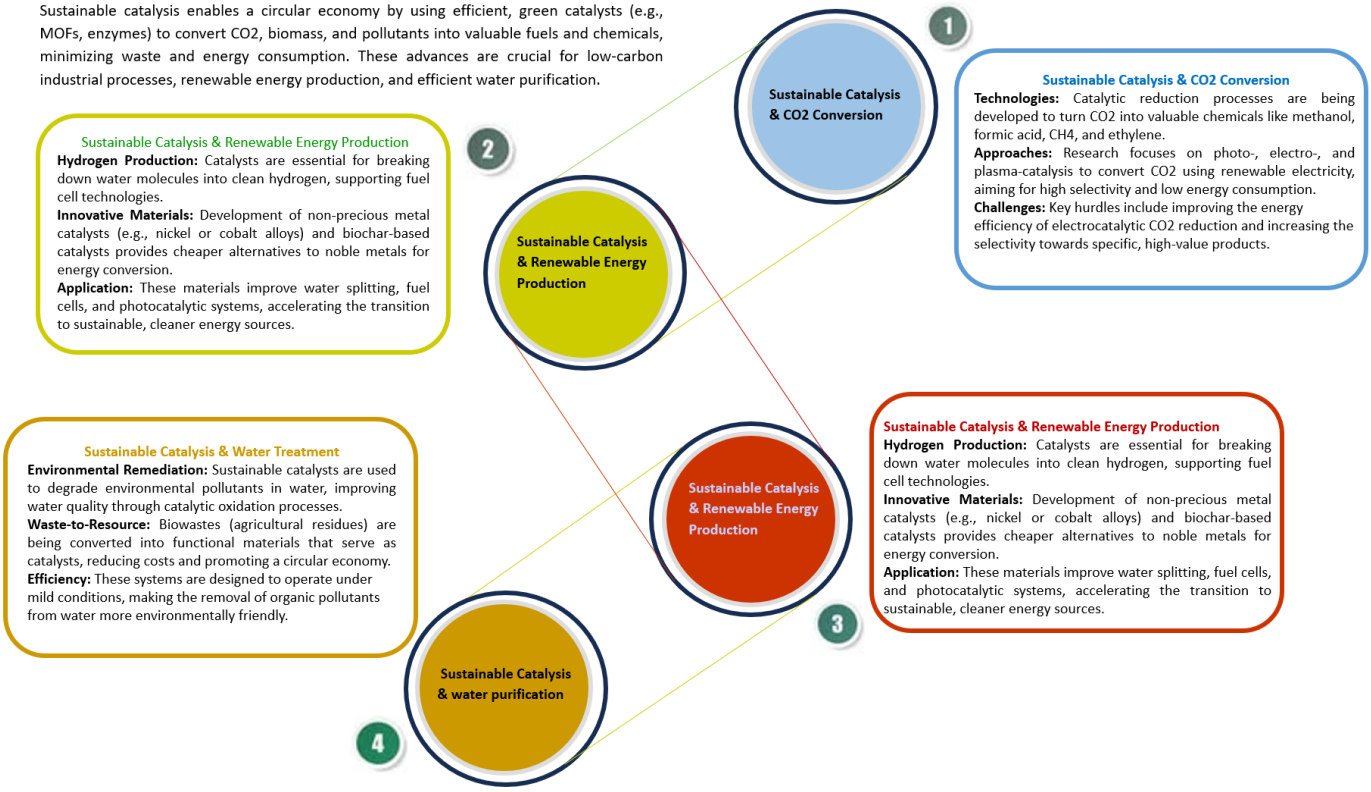
Thematic Area: BioGreenEnergy & sustainable Environment

Abstract

Faced with the problem of climate change and the accumulation of CO2 in the atmosphere, the urgent need for sustainable solutions has placed the conversion of carbon dioxide (CO2) into value-added products at the forefront and has even become a major research focus. Since CO2 is the most abundant greenhouse gas, primarily resulting from the combustion of fossil fuels, innovative approaches are needed to reduce its atmospheric concentration. Catalysis offers promising pathways for transforming CO2 into fuels, chemicals, and other high-value products, thus constituting a viable alternative to conventional carbon capture and storage techniques. Sustainable catalysis for CO2 conversion transforms captured carbon dioxide into valuable products like methanol, methane, and ethylene using renewable energy, creating a circular carbon economy. Key methods include thermal catalytic hydrogenation, electrochemical reduction, and photocatalysis. These processes utilize specialized catalysts (e.g., Cu, Ag, Fe) to break stable CO2 bonds, aiming for high selectivity and low-temperature operation. **Key Aspects of Sustainable Catalysis and CO2 Conversion.** (i) Development of Earth-Abundant Catalysts: To ensure sustainability, research is moving away from scarce, costly noble metals (e.g., Pt, Ru) toward cost-effective catalysts, including metal-free materials, nanomaterials, and transition metals like copper and nickel. These new catalysts are designed to improve selectivity, efficiency, and longevity in industrial environments. (ii) Renewable Energy Integration: Catalytic reactions, particularly electrochemical and photochemical methods, must be powered by renewable energy sources (solar, wind) to make the conversion process sustainable, often utilizing green hydrogen H2 as a co-reactant. (iii) CO2 Utilization and Valorization: Technologies such as thermocatalysis, electrocatalysis, and photocatalysis convert captured CO2 into valuable chemicals and products like urea, carbonates, and synthetic polymers, essentially creating a circular carbon economy. (iv) Hybrid Technologies: Combining technologies, such as non-thermal plasma (NTP) with traditional catalysts, can overcome thermodynamic barriers to CO2 conversion, promising higher efficiency in converting CO2 to syngas or liquid fuels. (v) Biocatalysis: Enzyme engineering and protein engineering, including directed evolution, are used to create highly selective biocatalysts that can operate under mild conditions for CO2 fixation. **Role in Mitigating Climate Change**: Sustainable catalysis acts as a critical link between reducing carbon emissions and providing necessary industrial feedstocks. (i) Carbon Capture and Utilization (CCU): By treating CO2 as a feedstock rather than a waste product, CCU mitigates emissions while creating value, offering economic benefits over simple storage. (ii) Production of E-Fuels: Catalytic processes enable the production of synthetic fuels (e-fuels), allowing for a circular carbon loop where CO2 is captured, converted, used, and emitted again, preventing the release of new fossil carbon. (iii) Waste-to-Resource Conversion: Catalytic chemical recycling of plastics and organic waste minimizes fossil resource use and associated CO2 emissions

Keywords: Climate change, CO2 conversion Sustainable calatlysis, Earth-Abundant Catalysts, thermal catalytic hydrogenation, electrochemical reduction, photocatalysis, thermocatalysis, electrocatalysis

Sustainable catalysis enables a circular economy by using efficient, green catalysts (e.g., MOFs, enzymes) to convert CO2, biomass, and pollutants into valuable fuels and chemicals, minimizing waste and energy consumption. These advances are crucial for low-carbon industrial processes, renewable energy production, and efficient water purification.



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Combating climate change by using both technological innovations and nature-based solutions

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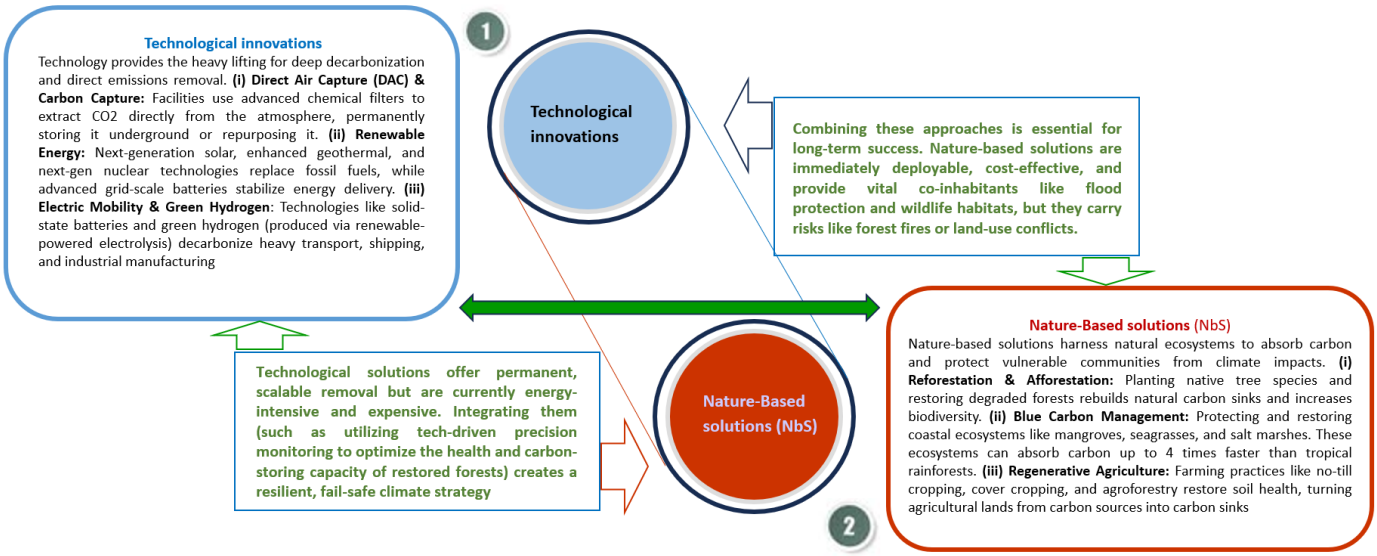
Thematic Area: BioGreenEnergy & sustainable Environment

Abstract

Climate, Carbon Neutrality, and Energy are deeply linked: climate change is driven by greenhouse gases (GHGs) from energy use, and carbon neutrality (net-zero emissions) is the goal to stop it, requiring a massive shift to clean energy (renewables, efficiency, innovation) and balancing remaining emissions via removal methods like reforestation or capture, transforming industry, transport, and lifestyles to achieve a sustainable planet. **Climate Change & Energy:** (i) The Problem: Burning fossil fuels for energy releases GHGs (like CO_2, methane) that trap heat, causing global warming, extreme weather, and ecosystem disruption. (ii) The Goal: Limit warming (e.g., to 1.5°C) by achieving global net-zero emissions, primarily by decarbonizing energy systems. **Carbon/Climate Neutrality: The Solution:** (i) Net Zero: Achieving a balance where GHGs emitted equal GHGs removed from the atmosphere. (ii) Key Actions: (a) Reduce Emissions: Drastically cut fossil fuel use in power, industry, buildings, and transport. (b) Boost Clean Energy: Scale up renewables (solar, wind, bioenergy) and improve energy efficiency. (c) Remove Carbon: Use natural sinks (forests) or technology (Carbon capture) for hard-to-abate emissions. **Energy Transition Strategies.** (i) Renewable Energy: Solar, wind, hydro, and bioenergy (biomass, biogas) are crucial. (ii) Energy Efficiency: Using less energy for the same output (better insulation, efficient machines, process optimization). (iii) Innovation: Developing low-carbon gases, carbon management, and sustainable infrastructure. (iv) Battery Storage: Lithium-ion and emerging solid-state battery grids store excess renewable energy, overcoming the intermittent nature of wind and sun. **Carbon Capture & Circular Economy:** (i) Direct Air Capture (DAC): by using massive filters to extract CO2 directly from the atmosphere, which can then be safely stored underground or repurposed into sustainable fuels. (ii) Green Materials: Low-carbon alternatives to traditional materials, such as cement-free concrete that traps CO2 inside the blocks, are fundamentally greening the construction industry. **Precision Agriculture & AI:** (i) AI Climate Models: Advanced AI and satellite Earth observation systems provide real-time data to help communities and governments predict extreme weather and adapt to droughts or floods. (ii) AgTech Innovations: Drones, Internet of Things (IoT) soil sensors, and AI-driven precision irrigation allow farmers to reduce water usage, minimize fertilizer runoff, and maintain crop yields amid extreme heat. Achieving carbon neutrality and ensuring a stable climate for the future can be achieved through a systemic renovation of energy and economic systems, with a transition from fossil fuels to clean sources and the removal of excess carbon. Indeed, the global transition to net-zero greenhouse gas emissions, by balancing emissions and carbon absorption capacity, effectively contributes to achieving carbon neutrality. This session will focus on three points: • Recent techniques for the transition to renewable energies, • Improving energy efficiency, • and the large-scale deployment of carbon capture technologies.

Keywords: carbon neutrality, climate change, Energy Transition, Remove Carbon, reduce emissions, Green Materials, Direct Air Capture, transition to renewable energies, Circular Economy, Clean Energy, Precision Agriculture.

Combating climate change effectively requires a dual approach: technological innovations rapidly reduce greenhouse gas emissions and decarbonize energy grids, while nature-based solutions (NbS) safely capture existing carbon, restore ecosystems, and build long-term climate resilience. Here is how the two strategies work together to create a comprehensive climate strategy:



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Clean Energy and Environmental Sustainability Strategies as a key solution to planetary boundaries

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Thematic Area: BioGreenEnergy & sustainable Environment

Abstract

The urgency to limit global warming is critical, particularly with fossil fuels still accounting for over 75% of global GHG emissions and over 80% of energy consumption. Combating climate change by reducing greenhouse gas emissions requires clean energy strategies and environmental sustainability, which are essential for preserving the Earth. Main Strategies to Address Planetary Boundaries: Strategies must be integrated across sectors to address the interdependent nature of these boundaries. (i) Rapid Decarbonization and Renewable Energy Transition: Replacing fossil-fuel-based power, industry, and transportation with solar, wind, and other renewables eliminates greenhouse gas emissions and reduces air pollution. (ii) Adopting a Circular Economy: Shifting from "take-make-waste" models to circularity minimizes the extraction of resources and reduces waste, easing pressure on biodiversity and chemical pollution boundaries. (iii) Nature-Based Solutions and Ecosystem Restoration: Protecting and regenerating ecosystems (e.g., reforestation, coastal wetland restoration) helps mitigate climate change by absorbing carbon and preserving biodiversity. (iv) Sustainable Agriculture and Land Use: Transforming food systems to reduce land use, lower water usage, and decrease the use of nitrogen and phosphorus fertilizers is critical to stay within land and biogeochemical boundaries. (v) Electrification and Efficiency: Enhancing electrification of road transport and industrial processes, combined with massive energy efficiency improvements, can enable a sustainable and profitable energy transition.
The Role of Clean Energy: Clean energy is not merely an emission-reduction tool; it is a fundamental pillar of Earth system stability. (i) Reducing Environmental Footprint: Renewable energy technologies generally have lower demands on water and land compared to fossil fuels, although careful planning is needed to manage their specific land-use impacts. (ii) Meeting Sustainability Thresholds: Powering development with renewables helps keep atmospheric CO2 concentrations within safe limits. (iii) Energy Security and Stability: Diversifying energy sources with local renewables reduces reliance on imported fuels, strengthening economic and social resilience. Implementing Sustainability Solutions: Key actions to ensure these strategies are effective include: (i) Setting Science-Based Targets: Organizations must align their goals with planetary boundaries, such as setting specific carbon reduction targets. (ii) Investing in Innovative Infrastructure: Developing technology for energy storage and smart grids is essential to handle the intermittency of renewable energy sources. (iii) Interdisciplinary Governance: Transitioning requires holistic, systemic approaches that address climate, biodiversity, and resource depletion simultaneously. To achieve Net Zero by 2050, the global community must shift investments from fossil fuels to clean energy solutions rapidly and implement a sustainable solution. By implementing these sustainable strategies, humanity can move from crossing boundaries to operating within a safe and just Boundaries

Keywords: Materials chemistry, Electrochemistry, Environmental analytical chemistry, Sustainability, Clean Energy, Nature-Based Solutions, Circular Economy, planetary boundaries

Clean energy and environmental sustainability Strategies as a key solution to planetary boundaries

With seven of nine boundaries already transgressed—including climate change, biodiversity loss, and nutrient cycles—shifting toward renewable energy and sustainable resource management is essential to prevent system collapse

Clean Energy as a Key Solution

Clean energy technologies, such as wind, solar, and hydropower, are foundational to reducing pressure on the climate boundary and accelerating the transition to a sustainable economy.

Climate Change Mitigation: Switching to clean energy eliminates the majority of greenhouse gas emissions from the power sector, which is critical for reducing global temperature rise.

Reducing Air Pollution and Land Pressure: Clean energy sources have lower water and land demands compared to fossil fuels, which mitigates impacts on biodiversity and habitat loss.

Decoupling Economic Activity: Transitioning from fossil fuels allows for economic growth that is not dependent on finite resources, thereby reducing the strain on Earth's systems.

Environmental Sustainability Strategies

Sustainability requires a, holistic, "safe operating space" approach, which entails operating within all nine boundaries simultaneously, rather than tackling climate change alone.

Circular Economy: Moving away from a linear "take-make-waste" model to a circular model (reduce, reuse, recycle) helps lower greenhouse gas emissions and eliminates the leakage of toxins into the ecosystem.

Regenerative Agriculture: Adopting farming practices that restore soil health and biodiversity directly addresses the nitrogen and land-system change boundaries.

Nature-Based Solutions: Protecting and restoring natural habitats—forests, wetlands, and oceans—crucially helps regulate the biosphere and manage climate change.

Sustainable Food Systems: Reducing food waste and shifting to more sustainable diets alleviates pressures on freshwater use and land-system change.

Interdependence of Solutions

Planetary boundaries are interconnected, meaning actions to fix one (like climate change) may exacerbate another (like land-system change if biomass is used excessively). Therefore, integrated strategies are necessary to avoid burden-shifting between sustainability dimensions.

Key Impacts on Planetary Boundaries

Climate Change: Reduced through renewable energy and improved energy efficiency.

Biosphere Integrity: Protected by minimizing habitat disruption and land usage.

Biogeochemical Flows (Nitrogen/Phosphorus): Controlled by optimizing fertilizer usage in agriculture.

Freshwater Change: Managed by improving water-use efficiency in industrial and agricultural processes.

Novel Entities (Pollution/Plastics): Addressed by sustainable production and circular economy principles.

Conclusion: Transitioning to a sustainable future involves a profound transformation of energy and food systems. While immediate, massive investment in clean technology is necessary, it must be paired with circular economies and biodiversity protection to ensure the planet remains a safe operating space for humanity

POSTER SESSION II:

Sustainable wastewater management & Ecological Transition

Chair/Co-Chairs: N. Fourati, A. El Moll

Green Hydrogen Production: Role in the Ecological Transition and Emission Reduction

Sustainable wastewater management: From AI innovations to technological treatment solutions

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Green Hydrogen Production: Role in the Ecological Transition and Emission Reduction

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Thematic Area: BioGreenEnergy & sustainable Environment

Abstract

A robust hydrogen economy has the potential to revolutionize energy systems, drastically reduce greenhouse gas emissions, and accelerate the green transition. The hydrogen strategy, launched for the 2024–2025 period, has played a pivotal role in the adoption of hydrogen and fuel cell technologies, demonstrating the CIMEE Group's commitment to low-carbon development and clean energy. This initiative also leverages collaborations with partners in India to strengthen innovation capabilities, master key technologies, and improve manufacturing processes. These efforts are essential for replacing fossil fuels in maritime and air transport in the near future, as well as for producing low-carbon fertilizers, thereby contributing to the overarching goal of decarbonization. Additional factors include:

A. The use of hydrogen fuel cells in vehicles, which not only reduces emissions but also promotes energy efficiency and sustainability across the entire transport sector.

B. Replacing natural gas and other fossil fuels with hydrogen in heating systems, significantly lowering emissions in line with the objectives of a hydrogen economy.

C. The development of e-fuels (or synthetic fuels) for sustainable agriculture: (i) Integration of green fertilizers: the green hydrogen component used in e-fuel systems directly overlaps with green ammonia production for zero-emission agricultural fertilizers. (ii) Energy storage: e-fuels serve as chemical storage carriers for surplus solar and wind energy, whether seasonal or generated off-grid near agricultural regions. The main current challenges relate, on the one hand, to production costs—as green hydrogen remains more expensive to produce than fossil-based hydrogen—and, on the other, to energy yield, due to significant losses throughout the value chain that limit the system's overall efficiency.

Against this backdrop, we acknowledge the established ambitions:

By 2030: producing renewable hydrogen from biowaste to significantly reduce the country's carbon emissions.

By 2035: fully integrating hydrogen into the energy mix, thereby increasing the share of renewable energy in total consumption. These initiatives will be crucial for accelerating the energy transition, achieving carbon neutrality, and meeting Nationally Determined Contributions (NDCs). The initial encouraging signs observed must now be sustained and scaled up.

Keywords: Green transition, green hydrogen, Reduction GHG, energy mix, low-carbon fertilizers, biowaste.

References: Special issue, Bioenergy, Bioresource technology & Environmental Sustainability, 2023, Guest Editors: Vijayanand Suryakant Moholkar, Kaustubha Mohanty, Ravikrishnan Vinu, Ahmad Elmoll, Sankar Chakma, energy Nexus, water food, power, https://www.sciencedirect.com/special-issue/104XS15FMPG

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Sustainable wastewater management: From AI innovations to technological treatment solutions

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Thematic Area: Pesticides, sustainable agriculture & environmental monitoring

Abstract

Due to increasing pressure from population growth, urbanization, and climate change, sustainable access to water has become a crucial issue. Consequently, the need for innovative solutions in integrated water resource management necessitates innovative approaches to ensure effective planning, monitoring, and optimization of water supply systems. Artificial intelligence and deep learning are revolutionizing sustainable wastewater management by enabling real-time monitoring, predictive maintenance, and autonomous control. These technologies optimize energy use, improve effluent water quality, and maximize resource recovery, paving the way for climate-resilient water systems. **Main Applications in Wastewater Treatment:** (i) Predictive Maintenance: AI transforms plant maintenance from reactive to proactive by forecasting equipment failures. This prevents costly, unplanned downtimes and extends the lifespan of critical infrastructure like pumps and blowers. (ii) Biological Process Control: Advanced algorithms identify and monitor microorganisms and bacteria in incoming water, allowing for precise control of biological nutrient removal (BNR) processes. (iii) Real-Time Process Optimization: Deep learning models, such as Long Short-Term Memory (LSTM) networks, analyze dynamic influent data and historical weather patterns to autonomously adjust treatment parameters (e.g., aeration rates and chemical dosing). This prevents over-treatment, reducing energy consumption by 15% to 30%. (iv) Water Quality Forecasting: By leveraging Internet of Things (IoT) sensors, deep learning models can predict chemical oxygen demand (COD), total suspended solids (TSS), and nutrient concentrations. (v) Circular Economy Integration: By optimizing water reuse, reducing greenhouse gas emissions, and enhancing energy recovery processes to achieve net-zero wastewater treatment facilities. This presentation explores the crucial role of artificial intelligence (AI) in modern wastewater management and highlights the importance of integrating these technologies to achieve sustainable and efficient wastewater treatment practices. It focuses on modern technologies and various advanced techniques, such as IoT sensors and other methods, that effectively improve real-time monitoring, predictive maintenance, and optimal coagulant dosing, thereby significantly improving water quality. The presentation will delve into machine learning algorithms and IoT technologies to address global water resource challenges and promote environmental sustainability.

Keywords: Wastewater treatment, Resource Recovery, Circular Economy, Electrochemical Oxidation, Membrane Bioreactors, Advanced Oxidation Processes, Nature-Based Systems, Predictive Maintenance, Machine Learning, Digital Twins, Advanced Monitoring

A sustainable wastewater management scheme bridges the gap between AI-driven intelligence and advanced physical-chemical-biological treatment solutions to achieve carbon neutrality, resource recovery, and regulatory compliance.

Phase 1: Inflow & Characterization (Smart Sensing Layer)

•**Real-time Monitoring:** Continuous deployment of IoT-enabled sensors measuring pH, turbidity, temperature, and UV-Vis spectrometry for Chemical Oxygen Demand (COD).

•**AI-Powered "Soft Sensors":** Machine learning models (e.g., LSTMs, Neural Networks) predict delayed or hard-to-measure parameters (BOD, NH_4-N, heavy metals) in real time.

•**Anomaly & Fault Detection:** Automated data validation pipelines (such as the alpha method) filter out sensor drift, noise, and data corruption.

Phase 2: AI & Digital Twin Control Layer

•**Digital Twins:** Virtual replicas of adsorption units and treatment tanks enable continuous performance monitoring and scenario testing.

•**Aeration & Energy Optimization:** AI dynamically controls the most energy-intensive process—aeration—slashing energy consumption by 30% to 50%.

•**Predictive Chemical Dosing:** Machine learning algorithms forecast load variations and adjust coagulants, flocculants, and disinfectants precisely, cutting chemical waste.

•**Predictive Maintenance:** Vibration and motor current analysis forecast equipment failures in pumps and blowers before breakdowns occur.

Phase 3: Technological Treatment Solutions

•**Advanced Biological & Hybrid**
□ **Systems:Microalgae and Anaerobic Digestion:** Nutrient and heavy metal removal paired with biological energy loops.
□ **Adsorption & Advanced Oxidation Processes (AOPs):** Targeted removal of persistent micropollutants and greywater contaminants.

•**Circular Resource Recovery:**
□ **Biogas Generation:** Converting sludge and food waste into renewable energy via integrated anaerobic digesters and combined heat-and-power hubs.
□ **Water Reuse:** Producing high-purity effluent that complies with strict environmental standards (e.g., Central Pollution Control Board/SDG 6 targets) for agricultural or industrial recycling.

Phase 4: Decision Support & Compliance

•**Multi-Criteria Decision Analysis (MCDA):** AI-supported evaluation frameworks analyze trade-offs across financial, environmental, and social key performance indicators.

•**Regulatory Reporting:** Explainable AI models generate audit-ready compliance logs and continuous sustainability tracking.

Sustainable wastewater management is shifting from static infrastructure to adaptive, data-driven systems. By integrating Artificial Intelligence (AI) and cutting-edge technologies, utilities are proactively optimizing treatment processes, reducing energy consumption, recovering resources, and minimizing the discharge of pollutants into delicate ecosystems

AI Innovations in Wastewater Management
AI and the Internet of Things (IoT) transform treatment plants from reactive, manual facilities into intelligent, interconnected ecosystems.

Predictive Maintenance: Machine Learning (ML) models analyze vibration and thermal data from motors and pumps to detect anomalies before equipment fails, lowering repair costs and eliminating downtime.
Digital Twins: Utilities utilize accurate virtual replicas of physical plants to experiment with new processes safely, which has been shown to reduce operational expenses by up to 15%.
Advanced Monitoring: Algorithms (such as ANN and LSTM) process raw chemical and biological inputs in real-time, accurately predicting Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) to dynamically adjust aeration and chemical dosing.
Blockage Forecasting: AI models (e.g., SIWA) evaluate rainfall, network usage, and chemistry to provide early warnings for potential sewer blockages and flood risks.

Technological Treatment Solutions
Innovative physical, chemical, and biological technologies work in tandem with AI to extract contaminants and ensure water can be safely repurposed for agriculture or potable use.

Electrochemical Oxidation: Uses electricity to degrade stubborn, emerging contaminants (like pharmaceuticals and synthetic dyes) where traditional biological methods fall short.
Membrane Bioreactors (MBR): Combines biological waste degradation with membrane filtration to produce exceptionally high-quality effluent, perfect for water reuse and recycling.
Advanced Oxidation Processes (AOPs): Technologies utilizing UV irradiation and ozonation to neutralize harmful pathogens and toxic micro-pollutants.
Nature-Based Systems: Engineered or constructed wetlands integrate bio-electrochemical systems to decompose organic materials, providing a highly cost-effective, low-energy tertiary treatment.

Resource Recovery & Circular Economy
Modern wastewater treatment facilities are no longer just disposal hubs; they are emerging as vital nodes in the circular economy.

Nutrient Mining: Technologies selectively extract phosphorus and nitrogen from sewage, converting these pollutants into valuable agricultural fertilizers.
Energy Co-generation: Sludge digestion captures biogas (methane) to power the treatment plant itself, offsetting operational energy demands and lowering carbon emissions.
Decentralized Systems: Small-scale, modular AI-powered treatment systems allow for localized sewage recycling, reducing the need for massive, centralized pipeline infrastructure

DAY 3

PROGAM - DAY 3

Saturday, September 26, 2026

PLENARY SESSION IV

Materials, Energy and sustainable Environment

Chair: A. El Moll, N. Fourati



8th International Symposium on Materials Electrochemistry & Environment
10th Anniversary CIMEE Conference Celebration

Towards a Greener Future: Eco-friendly Materials for Water Remediation and Renewable Energy Projects

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Thematic Area: T1 Materials and the environment

Abstract

The increasing occurrence of emerging contaminants in aquatic environments, together with the urgent need for decarbonization, calls for sustainable strategies in material design. This communication presents an eco-design approach for the development of advanced catalysts and electrocatalysts based on the valorization of agro-industrial and industrial residues. Through green synthesis methods, including hydrothermal carbonization, slow pyrolysis, and deep eutectic solvents utilization, carbonaceous materials such as biochar and hydrochar were obtained. These materials were further optimized through heteroatom doping and the incorporation of advanced structures, including metal–organic frameworks, graphitic carbon nitride, and high-entropy spinel oxides. The resulting catalysts exhibited outstanding performance in two major application areas: water remediation in advanced oxidation processes (AOP) and hydrogen production through water splitting. In water treatment, pollutant removal efficiencies above 90% were achieved, together with effective microbial disinfection in real wastewater matrices. In parallel, the materials acted as efficient noble-metal-free electrocatalysts for the oxygen and hydrogen evolution reactions, displaying low overpotentials and long-term stability during water splitting using treated wastewater as the electrolyte. Another approach is the development of sustained-release materials for AOP. These controlled-oxidant-release systems reduce the burst effect associated with direct oxidant addition, ensuring prolonged activity, minimizing reagent losses, and preventing secondary contamination. Sustained-release materials exhibited a stable release profile, maintaining effective oxidant concentrations over extended treatment periods and enhancing overall process efficiency compared with conventional dosing strategies. Overall, this research demonstrates how eco-design can support circular economy and zero-waste principles while delivering scalable solutions for environmental remediation and sustainable energy production.

Keywords: AOP, Biochar, Circular economy, Controlled oxidant release, Electrocatalysis, water splitting, Metal Organic Frameworks, Water remediation.

Acknowledgements: This work has been funded by MICIU/AEI /10.13039/501100011033 and ERDF/EU projects PID2023-146133NB-I00, CPP2024-011260 and PDC2025-165347-I00.

KEYNOTE SESSION VI

Wastewater treatment, valorization and the Environment,

Chair/Co-Chairs: A. El Moll, Marta Pazos Curras

8th International Symposium on Materials Electrochemistry & Environment
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Evaluating Sebkhas as Brine Management Receptors in Algeria: Opportunities and Environmental Constraints of the El Mactaa Wetland Complex

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Not Presented

Topic: T6. Biotechnology & Phytochemistry for Environmental Sustainability

Abstract

The rapid expansion of seawater desalination in Algeria has significantly strengthened national water security, particularly in water-stressed coastal regions. However, the increasing production of hypersaline brine represents a major environmental challenge due to its potential impacts on marine ecosystems, including salinity stratification, benthic habitat degradation, and biodiversity loss. The Mactaa desalination plant, one of the largest reverse osmosis facilities in Africa with a production capacity of 500,000 m^3/day, generates an equivalent volume of concentrated brine with salinity levels reaching approximately 65 g/L. This study evaluates the feasibility of integrating brine management within a circular economy framework by examining the potential use of the Sebkha of Arzew (i.e., coastal saline depression) and the Mactaa wetland complex as a platform for resource recovery. The analysis combines environmental, hydrogeological, geotechnical, and economic considerations to assess the opportunities and constraints associated with natural evaporation and mineral recovery processes. The high natural salinity and semi-arid climatic conditions of the region suggest favorable conditions for solar evaporation and the extraction of valuable mineral resources, including sodium chloride, magnesium compounds, and sulfates. Nevertheless, the investigation highlights significant limitations. The Mactaa wetland complex is a Ramsar-protected ecosystem characterized by high ecological value, rich avian biodiversity, and sensitive hydrochemical balances. Direct discharge or storage of brines in natural sebkhas may increase the risk of groundwater salinization, chemical accumulation, ecosystem disturbance, and long-term environmental degradation. Comparative assessment of alternative management scenarios indicates that engineered evaporation ponds and closed-loop Zero Liquid Discharge (ZLD) systems offer substantially lower environmental risks while maximizing resource recovery potential. Based on these findings, a strategic roadmap is proposed, including detailed hydrogeological investigations, pilot-scale evaporation facilities, and the progressive development of a national brine valorization industry. The study demonstrates that while natural sebkhas cannot be considered sustainable receptors for industrial brines, they provide valuable insights for designing integrated resource recovery systems that support environmental protection, industrial development, and circular economy objectives in Algeria.

Keywords: Desalination brine; Circular economy; Resource recovery; Zero Liquid Discharge (ZLD); Wetlands; Environmental sustainability.

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Engineering Microalgae–Alginate Biocomposites for High-Efficiency Heavy Metal Removal and Scalable Water Treatment

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Thematic Area: Biotechnology & Phytochemistry for Environmental Sustainability

Abstract

Pb(II) and Cu(II) contamination in aquatic environments is widely associated with wastewater discharges from mining, electroplating, battery production, metal finishing, and smelting industries, where persistent heavy metal effluents pose major ecological and public health concerns. Addressing this challenge requires the development of efficient, low-cost, and scalable treatment technologies. This keynote presents engineered microalgae–alginate biocomposites as advanced biosorbents combining biological affinity with material robustness. Biomass of *Dunaliella* sp. AL-1 [1] and *Chlorococcum dorsiventrale* [2] was immobilized in Ca^{2+}-cross-linked alginate to enhance stability, handling, and reusability. Spectroscopic and morphological analyses (FTIR, SEM, EDX, XRD) identified key functional groups involved in metal binding. The composites exhibited high adsorption performance, with capacities up to 167.06 mg g^{-1} for Pb(II) in continuous systems. Adsorption followed Langmuir behavior for Pb(II) and Freundlich/Temkin models for Cu(II), with spontaneous and endothermic thermodynamics. Metal uptake is governed by synergistic mechanisms including electrostatic interactions, ion exchange, and surface complexation. Fixed-bed column experiments confirmed process scalability, while regeneration tests demonstrated sustained performance over multiple cycles. These results position microalgae–alginate biocomposites as robust, reusable, and sustainable materials for next-generation wastewater treatment, supporting the transition toward circular and bio-based environmental technologies.

Keywords: Microalgae; alginate; biocomposites; biosorption; heavy metals; scalable water treatment.

Acknowledgements: This work has been supported by the Tunisian Ministry of Higher Education and Scientific Research.

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Wastewater Treatment: Resources Recovery & Coupling Technologies for Bioelectricity & Hydrogen Generation

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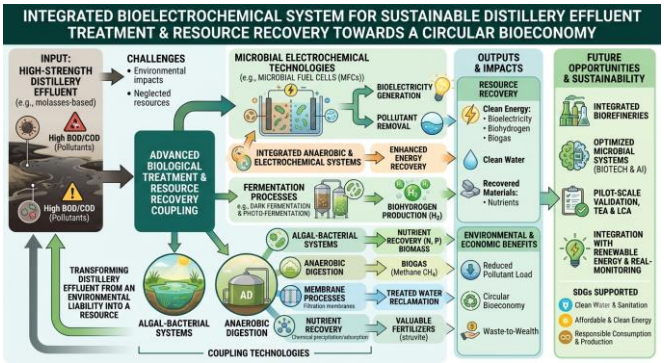
Thematic Area: Bio-Green-Energy Science, Waste Treatment & Technology

Abstract

Treating and detoxifying high-strength effluents remains a challenge and requires sustainable wastewater management strategies to minimize environmental impacts and promote long-term environmental sustainability. Traditional treatments primarily focus on pollutant removal, often neglecting the potential for resource recovery and energy generation. This study examines the combination of advanced biological wastewater treatment and resource recovery and coupling technologies for the simultaneous removal of pollutants and the production of bioenergy, particularly bioelectricity and biohydrogen from distillery effluent as a potential feedstock. Microbial electrochemical technologies such as microbial fuel cells (MFCs) can produce electricity and reduce the organic load by using the biodegradable organic matter of distillery wastewater. Similarly, dark fermentation and photo-fermentation can convert residual organic substrates to hydrogen-rich biogas while integrated anaerobic and electrochemical systems can enhance overall energy recovery. The combination of these technologies with algal-bacterial systems, anaerobic digestion, membrane processes and nutrient recovery can further enhance treatment efficiency and foster circular bioeconomy. Such integrated platforms offer the possibility of transforming distillery effluent from an environmental liability into a resource for clean energy, recovered nutrients, and treated water. Future opportunities include developing integrated biorefineries for resource recovery, optimizing microbial systems using biotechnology and AI, and advancing low-cost technologies for bioelectricity and hydrogen production. Integration with renewable energy, real-time monitoring, and automation could improve scalability and efficiency. Future research should emphasize pilot-scale validation, techno-economic and life-cycle assessments, and recovery of value-added products, transforming distillery effluent into a resource for clean energy, recovered materials, and treated water while supporting sustainable industrial development and relevant SDGs.

Keywords: Biotechnology, Wastewater Treatment, Bioelectricity Generation, Biohydrogen, Resource Recovery, Environmental Sustainability

Acknowledgements: Thanks are due to my co-authors, Dr. Himani Chandel, Shoolini University, Solan, Himachal Pradesh, India and Prof. Diane Purchase, Middlesex University, London, United Kingdom, for kind support in the study.



Graphical Abstract

ORAL SESSION II

Bio-Green-Energy Science, Wastewater Treatment & Technology,

Chair/Co-Chairs: A. El Moll, Marta Pazos Curras

8th International Symposium on Materials, Electrochemistry and Environment – CIMEE26

Overview of Mining-Related Pollution at the Kherzet Youssef Lead–Zinc Mine, Algeria, and its Environmental Impacts

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Thematic Area: Atmospheric Chemistry & Environmental Pollution

Abstract

Lead and zinc mining is an important activity in Algeria; however, mining and ore-processing operations generate large quantities of waste that may constitute a long-term source of environmental pollution. This study provides an overview of the pollution associated with the Kherzet Youcef lead-zinc mining complex, located near Aïn Azel, in Sétif Province, and evaluates its main environmental impacts and possible waste-treatment strategies. On June 2, 1990, an exceptional groundwater inflow, estimated at approximately 22,000 m³/h, flooded the mine, causing the death of 19 miners and resulting in its permanent closure [2]. Since then, abandoned infrastructure and tailings have represented a persistent environmental liability. The weathering and oxidation of sulfide minerals may release potentially toxic elements into surrounding soils, sediments, and water resources. Studies at other Algerian Pb-Zn mining sites confirm this potential risk. Around the abandoned Ichmoul mine-plant, significant contamination by Zn, Pb, and Cd was reported, while Cu contamination was less pronounced [3]. Magnetic susceptibility (K) can also help investigate the vertical distribution of metalliferous particles [1]. According to [4], most studied elements, except Cu, exceeded the geochemical background of the Earth's crust, while the association of Pb, Zn, and As suggested a common anthropogenic origin. For Kherzet Youcef, detailed mineralogical, granulometric, chemical, and geochemical characterization of the tailings is essential to assess metal mobility and pollution potential. Treatment techniques such as screening, gravity separation, and flotation could help separate contaminated fractions and recover valuable metals. An integrated approach combining waste characterization, hydrogeological studies, treatment, metal recovery, and environmental monitoring is therefore essential for reducing pollution risks and promoting the sustainable rehabilitation of the Kherzet Youcef site.

Keywords: Algeria, atmospheric pollution, environment, Kherzet Youssef mine, impacts, mining industry, lead-zinc.

Acknowledgements: At the conclusion of this work, we would like to express our sincere gratitude to the National Non-Ferrous Mining Products Company (ENOF) – Kherzet Youssef for its valuable support, availability, and scientific contribution to this study.

Digital support for water reuse – using WaterSafe tool in a wastewater treatment plant

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Thematic Area: Materials & The Environment

Abstract

Water reuse is increasingly recognised as an important strategy for improving water resource management and supporting the transition to a circular economy (CE) in the water and wastewater sector. However, implementing water reuse solutions requires adequate treated wastewater quality, regulatory requirements, and the suitability of water reclamation technologies. In this context, digital decision-support tools can facilitate initial planning and assist stakeholders in selecting appropriate treatment pathways. This paper focuses on the application of WaterSafe as a digital decision-support system for reuse in a municipal wastewater treatment plant. The tool integrates wastewater quality data, European Union (EU) regulatory requirements, and algorithm-based recommendation logic. The analysis demonstrates how operational data from wastewater treatment plants can be used to support decision-making in the context of water reuse planning. The results highlight the usefulness of WaterSafe as an initial tool to help identify key limiting parameters, assess compliance with water reuse requirements, and support the selection of appropriate technological solutions. The tool provides an accessible framework for supporting decision-making in the early stages of water reuse implementation.

Keywords: circular economy, decision-support tool, treated wastewater, water reuse, WaterSafe tool

Acknowledgements: This paper was prepared as a part of the project "Closing local water circuits by recirculation nutrients and water and using them in nature" (ReNutriWater) financed by European Regional Development Fund (ERDF), project no. #C016 and the project "Capacities for Nutrient Circularity in the Baltic Sea Region" (CirCan), financed by Interreg Baltic Sea, project no. #P012

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Activated carbons from lignocellulosic residues: Case of Lead Adsorption

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Thematic Area: Materials & The Environment

Abstract

Water pollution by heavy metals represents a major environmental concern [1]. This report presents the preparation of three high-performance activated carbons through a simple pyrolysis process, preceded by chemical impregnation with phosphoric acid, for removing these contaminants by adsorption. Batch-mode experiments will be used to study the influence of contact time, initial concentration, pH, and temperature. Heavy metals will be quantified by A.A.S. The expected results will help optimize sustainable processes for treating contaminated water. [2]. The preparation conditions were optimized based on several characterization parameters: iodine number, methylene blue index, Boehem titration and the pH_{PZC}, in order to identify the conditions yielding the best adsorbent properties. In addition, the activated carbons will be characterized using complementary techniques to assess their structural, textural, morphological, and chemical properties (FTIR, XRD, Raman, BET, and SEM) [3]. The results show that the activated carbons produced possess a well-developed specific surface area and a porous structure composed of micropores and mesopores. The pH values at the point of zero charge indicate that the carbon surface becomes negatively charged at pH values above the pH_{PZC}, along with an aromatic carbon structure evidenced by the spectroscopic analyses. A preliminary investigation was carried out to assess the removal efficiency of lead (Pb) from aqueous solutions using the three prepared activated carbons. [4].

Keywords: activated carbon, adsorption, date pits, heavy metals, Nigella sativa, olive pits.

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KEYNOTE SESSION VII

Materials, Electrochemistry and energy transition

Chair/Co-chair: A, El Moll, Marta Pazos

8th International Symposium on Materials Electrochemistry & Environment
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The Golden Triangle for Climate Action: Water Positive, Carbon Negative and Zero Waste

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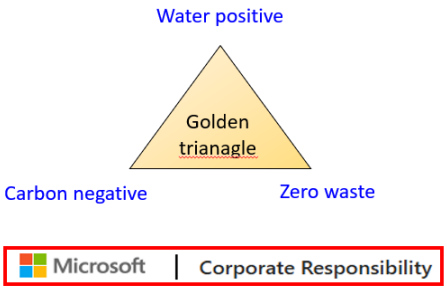
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Thematic Area: Biotechnology and Phytochemistry for Environmental Sustainability

Abstract

Microsoft's "golden triangle" represents its ambitious, holistic sustainability commitment targeting three core pillars viz., becoming water positive, carbon negative and achieving zero waste by 2030. Breaking Down the Triangle. **Water Positive:** Replenishing more water than is consumed across global operations and datacenters. By prioritizing water replenishment, expanding community sanitation access, and developing zero-water cooling solutions for AI workloads, Microsoft reached its water positive target ahead of the 2030 deadline. **Carbon Negative:** Removing more carbon dioxide from the atmosphere than the company emits. Microsoft is driving toward this target through aggressive Scope 3 emissions reductions, contracting massive amounts of carbon-free electricity, and utilizing its Climate Innovation Fund to scale emerging carbon-removal technologies. It is worth mentioning here Hydrogen economy and decarbonization strategies. **Zero Waste:** Diverting waste away from landfills by reducing, reusing, and recovering. Classic example Microplastics and Mission Star Fish. Several international giants have already established a network of global Circular Centers designed to recycle or reuse over (90%) of E-waste and related components, while also drastically reducing construction and operational waste.

Graphical Abstract



Keywords: golden triangle, carbon negative, achieving zero waste, carbon-removal technologies Hydrogen economy, decarbonization strategies, Zero Waste

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8th International Symposium on Materials, Electrochemistry and Environment – CIMEE26

Integrating materials chemistry and electrochemistry: Sustainable synergy for a cleaner and more sustainable planet.

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Thematic Area: Materials Chemistry, Electrochemistry & Environmental Sustainability

Abstract

The degradation of natural resources and environmental pollution are among the most critical challenges of the current global crisis. While environmental analytical chemistry plays a vital role in monitoring and preserving the environment, materials chemistry and electrochemistry contribute to providing sustainable solutions for chemical waste management and renewable energy production. To address this problem sustainably and protect natural resources, we integrate environmental analytical chemistry, materials chemistry, and electrochemistry to develop truly sustainable and innovative strategies. The integration of materials chemistry, electrochemistry, and analytical chemistry enables the creation of high-performance green technologies that clean up our environment, store renewable energy, and conserve natural resources. Materials chemistry designs new substances at the atomic level to capture energy or stop pollution. Electrochemistry uses electrical currents to drive chemical reactions or turns chemical energy into electricity. Analytical chemistry uses sensors to monitor and detect large type of pollutants. This interdisciplinary approach enables the fabrication of green electrochemical sensors that minimize waste, lower energy consumption, and eliminate toxic reagents. Main Areas of Synergy: Battery Technology: Advanced electrodes and solid-state materials store more renewable energy and charge much faster. Green Hydrogen: Catalyst materials help split water efficiently using electricity to produce clean hydrogen fuel with zero emissions. Carbon Capture: Porous chemical structures trap carbon dioxide and turn it into safe, reusable fuels or raw materials. Water Purification: Electrochemical cells destroy harmful pollutants and bacteria in wastewater using targeted electrical charges. This presentation offers a critical comparative analysis of these emerging tools, assessing their effectiveness and broader impacts on sustainable development. By highlighting the distinct benefits of this tri-disciplinary synergy, this work offers an approach to solving pollution and resource depletion problems on a global scale, and a framework for a cleaner and more sustainable planet.

Keywords: Analytical Chemistry; Materials Chemistry; Electrochemistry, Sustainability; Water Purification, Carbon Capture, Green Hydrogen, Battery Technology, sustainable planet.

8th International Symposium on Materials, Electrochemistry and Environment – CIMEE26

Critical Raw Materials and the Clean Energy Transition: Supply Dynamics and Sustainability

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Thematic Area: Materials Chemistry, clean energy & Environmental Sustainability

Abstract

The global transition to clean energy requires a fundamental shift: moving away from systems based on fossil fuels toward low-carbon, renewable, and efficient energy sources. However, technologies such as lithium-ion batteries and water electrolyzers rely heavily on critical raw materials in quantities that far exceed those required for traditional fossil-fuel-based energy infrastructure. **I - Main Clean Energy Technologies:** two elements will be discussed (a) Energy Storage & Smart Grids: Lithium-ion batteries, long-duration storage systems, and digital IoT/AI tools balance grid intermittency. (b) Hydrogen & E-Fuels: Green hydrogen and synthetic fuels help decarbonize heavy industry, shipping, and aviation. **II - Main Supply Chain Challenges:** (i) Geopolitical Concentration: Supply is heavily monopolized or concentrated in a single or small group of non-EU/external countries (ii) Long Lead Times & Capital Intensity: Opening new primary mines takes 10 to 30 years, creating a severe mismatch with fast-approaching net-zero targets. (iii) Low Recycling Rates: Current recycling rates for many transition CRMs remain critically low (with many materials seeing little-to-no commercial recycling), meaning circularity cannot immediately replace primary mining. **III - Pathways to a Sustainable Transition:** To bridge the gap between material scarcity and climate goals, the energy transition relies on a multi-lever strategy. This presentation highlights four critical pillars:

• Material Efficiency & Substitution: Designing technologies that require fewer critical minerals or swapping them for more abundant, sustainable alternatives.

• Scaling Circularity: Expanding recycling infrastructure and eco-design standards to recover and reuse end-of-life battery and electronic waste.

• Supply Diversification: Establishing strategic trade partnerships, regional processing hubs, and domestic production policies to mitigate single-country dependency.

• Green Finance & ESG Alignment: Directing sustainable capital to ensure all mining and processing activities adhere to strict environmental, social, and governance standards.

Keywords: Energy transition, Clean Energy Technologies, critical raw materials, climate goals lithium-ion batteries, water electrolyzers

ORAL SESSION III:

Materials, Energy and sustainable Environment

Chair/Co-Chairs: A. El Moll. Marta Pazas

8th International Symposium on Materials Electrochemistry & Environment
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Physics-Informed Machine Learning for Rapid Thickness Estimation of Fe/Cu/Ag/Au Multilayer Structures Using Simulated HE-PIXE Spectra

Diana RAGHEB[1], Mostafa RAGHEB[1], Ali JAAFAR[2], Monzer ALWAN[1]

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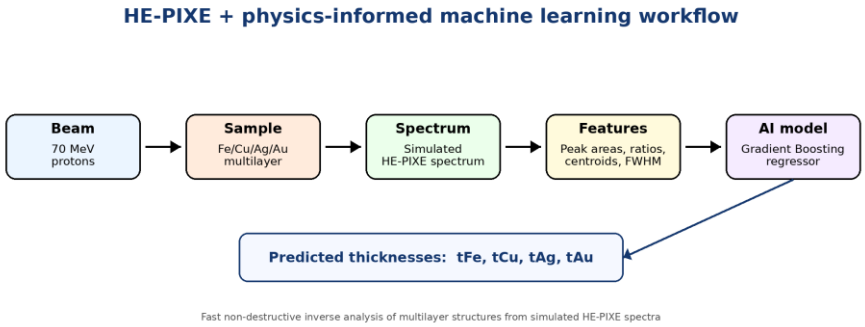
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Thematic Area: Structural, Analytical & Physical Chemistry

Abstract

High-Energy Proton-Induced X-ray Emission (HE-PIXE) is a powerful non-destructive technique for multilayer material analysis, but layer-thickness determination remains a nonlinear inverse problem affected by X-ray production, attenuation, detector response and counting statistics. This work proposes a physics-informed machine learning framework for rapid thickness estimation of Fe/Cu/Ag/Au multilayers deposited on a silicon substrate. A simulated HE-PIXE dataset was generated for an Air/Fe/Cu/Ag/Au/Si stack using 2048 channels over 0-100 keV. The model included characteristic X-ray lines, multilayer attenuation, HPGe-like Gaussian broadening, energy-dependent efficiency, continuum background and Poisson noise. Layer thicknesses were varied from 0.5-5.0 µm for Fe and Cu, 0.2-3.0 µm for Ag and 0.05-1.0 µm for Au. Physics-informed descriptors, including peak areas, heights, centroids, full widths at half maximum and intensity ratios, were extracted and used to train ensemble regression models. Gradient Boosting provided the best performance, reaching an average coefficient of determination close to $R^2 = 0.97$. The results show that physics-informed machine learning can estimate multilayer thicknesses directly from simulated HE-PIXE spectra while reducing the need for iterative spectral fitting. Geant4 and experimental validation are planned as future work.



Graphical abstract: physics-informed HE-PIXE simulation and machine-learning workflow for multilayer thickness estimation.

Keywords: Gradient Boosting, HE-PIXE, machine learning, multilayer materials, physics-informed AI, thickness estimation.

Acknowledgements :: The author acknowledges the Lebanese University for academic support.

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Physics-Informed Explainable Artificial Intelligence for Layer-Order Classification in High-Energy PIXE Spectroscopy

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Thematic Area: Materials and the Environment

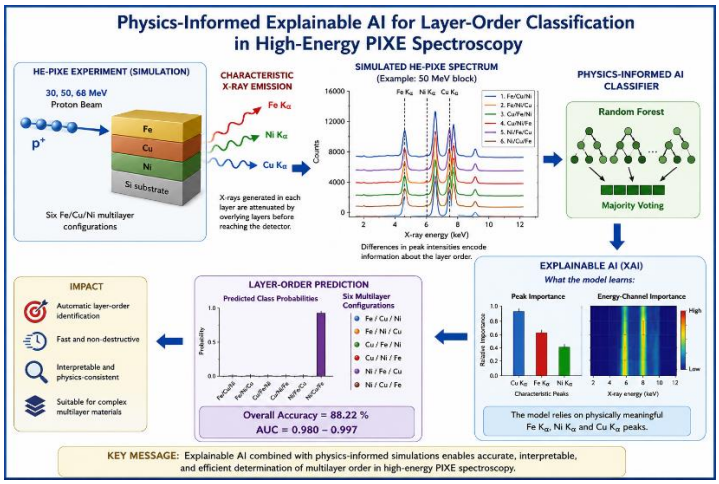
Abstract

High-Energy Particle-Induced X-ray Emission (HE-PIXE) is a powerful ion beam analytical technique for multilayer material characterization. However, identifying the order of buried layers remains a challenging inverse problem because the measured spectrum depends on X-ray production, attenuation through overlying layers, detector response, background, and counting statistics. In this work, a physics-informed explainable artificial intelligence framework is developed for automatic layer-order classification from simulated HE-PIXE spectra. Six Fe/Cu/Ni multilayer configurations deposited on a silicon substrate were simulated using proton energies of 30, 50, and 68 MeV, representative of the high-energy PIXE regime. A Random Forest classifier achieved an overall accuracy of 88.22\%. ROC analysis showed strong discrimination capability with AUC values between 0.980 and 0.997. Explainability analysis confirmed that the classifier relies primarily on physically meaningful Fe, Ni, and Cu Characteristic X-ray peaks, especially Cu K*a*, Fe K*a*, and Ni K*a*. These results demonstrate the potential of explainable AI as a fast, interpretable, and physics-consistent tool for multilayer HE-PIXE analysis.

Keywords: HE-PIXE; Explainable AI; Machine Learning; Random Forest; Multilayer Materials; X-ray Spectroscopy.

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Graphical abstract

Workshop

WORKSHOP II

Agriculture adaptation to the environmental crise Strengthening the resilience

Chair: Ahmad El Moll



Workshop: Climate Change and Agricultural Systems: What Adaptation Strategies?

Across the globe, agricultural systems are under mounting pressure from rising temperatures, erratic rainfall, and an increase in extreme weather events. To address these challenges, adaptation strategies must reduce the vulnerability of farms and sustain their productivity by strengthening their resilience. On the ground, soil and water conservation measures—such as contour bunds, mulching, and micro-catchments—are essential for retaining moisture and limiting erosion. Meanwhile, agroforestry and integrated crop-livestock systems introduce perennial elements that regulate the microclimate, mitigate the impact of climate shocks, and optimize nutrient cycling. On a larger scale, precision agriculture tools, remote sensing, and agro-climatic services guide decision-making, enabling targeted interventions across the landscape. Ultimately, the implementation of an integrated approach—linking water, energy, and food issues—highlights the critical importance of multisectoral collaboration.

September 26, 2026 — Climate change, water resources, agricultural and environmental sustainability,

WORKSHOP: Climate change is exerting a profound influence on water resources, especially in the agricultural sector, especially in the mediterranean region

In this workshop 5 presentations will be exposed:

W1: Agriculture adaptation to the Environmental Crisis: A Strategy Combining Sustainable Resource Management, Agroecology, and Innovative Technologies

W2: Agriculture adaptation to the Environmental Crises: Transition to Resilient, Sustainable, and Regenerative Systems.

W3: Agriculture adaptation to the environmental crises: The integrated chemistry–soil–water–climate approach as sustainable solution

W4: Integrated chemistry–soil–water–climate approach: Application in arid-region agriculture.

Faculty of public Health, Faculty of science, Doctoral School for Science & Technology, Lebanese university, Lebanon

W5: Integrated chemistry–soil–water–climate approach to strengthen the resilience of Moroccan agro-ecosystems to drought

Mostafa Benramel, Association for Development and Climate (Kenitra, Morocco); SabriJoude Consulting firm (Safi, Morocco)

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Agriculture adaptation to the Environmental Crisis: A Strategy Combining Sustainable Resource Management, Agroecology, and Innovative Technologies

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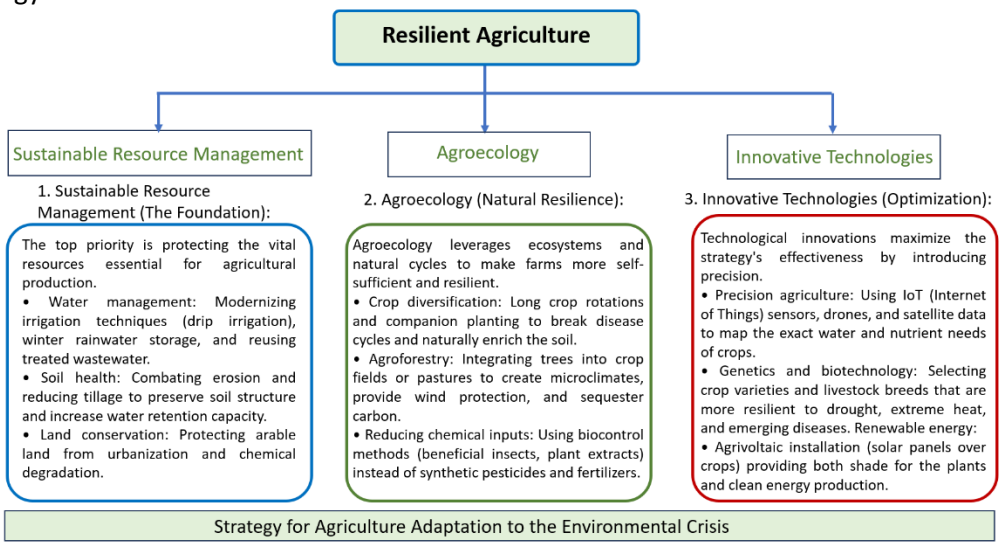
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Thematic Area: Agriculture, Water Resources, Climate Change & Environmental Sustainability

Abstract

Agriculture lies at the heart of the environmental crisis: it bears the full brunt of climate disruption—such as droughts, heatwaves, and biodiversity loss—while simultaneously accounting for a significant share of greenhouse gas emissions and soil degradation. The crisis's impact on agriculture can be summarized in three points: a) Water shortages: Heatwaves and declining precipitation exacerbate soil dryness, making irrigation difficult or insufficient. b) Heat stress: Extreme temperatures (sometimes exceeding 45°C–50°C) reach critical biological thresholds capable of destroying entire crops within days. c) Dependency and vulnerability: The intensive farming model relies heavily on fossil fuels and nitrogen fertilizers; their increasing scarcity and rising costs threaten the economic viability of farms. To adapt agriculture to contemporary environmental crises, it is essential to transform global production systems by combining sustainable resource management, agroecology, and innovative technologies. Indeed, adapting agriculture to the environmental crisis relies on a comprehensive strategy built around these three complementary pillars. This threefold approach makes it possible to reconcile food security, resilience to climate change, and biodiversity preservation.

Adaptation Strategy Structure:



Summary of co-benefits

Strategy pillar	Primary climate impact	Secondary environmental impact
Resource management	Drought resilience	Groundwater conservation
Agroecology	Carbon sequestration and storage	Biodiversity recovery (pollinators)
Technologies	Reduction of losses and waste	Lower mechanical carbon footprint

Keywords: Agriculture adaptation, environmental crisis, agroecology, water shortages, biodiversity, innovative technologies

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Thematic Area: Agriculture, Water Resources, Climate Change & Environmental Sustainability

Abstract

Adapting agriculture to environmental crises is one of the 21st century's greatest challenges for ensuring global food security while preserving ecosystems. Faced with global warming, water scarcity, and declining biodiversity, the agricultural model must shift from an intensive, production-focused approach toward resilient, sustainable, and regenerative systems. In this presentation we will explores the key operational levers for transforming agriculture in the face of current crises, grouped by major pillars: **1. Transitioning to agroecology and soil regeneration:** Agroecological practices help restore the health of agricultural ecosystems while maintaining productivity. (i) Conservation agriculture: Based on no-till (or reduced tillage) farming, permanent soil cover (cover crops), and diversified crop rotations to sequester carbon and limit erosion. (ii) Agroforestry: Integrating trees and hedgerows into agricultural plots. Trees protect crops from wind and heat (creating a microclimate), retain water, and provide habitats for biodiversity (pollinating insects, natural pest predators). (iii) Reducing chemical inputs: Replacing synthetic fertilizers and pesticides with biocontrol methods, composting, and green manures (legumes that fix atmospheric nitrogen). **2. Resilient and efficient water management:** Climate change is intensifying periods of extreme drought and torrential rainfall. (i) Optimizing irrigation: Switching from sprinkler irrigation to precision drip irrigation or subsurface irrigation to reduce evaporation. (ii) Natural water storage: Modifying the landscape (creating ponds, restoring wetlands, terracing) to slow runoff and recharge groundwater aquifers. (iii) Decision-support tools (DSTs): Using connected soil moisture sensors to irrigate only when the plant strictly requires it. **3. Diversification and adapted genetic selection:** Intensive monoculture is highly vulnerable to climate shocks and diseases. (i) Resilient varieties: Selecting and growing plant varieties (and animal breeds) that are more tolerant to drought, heat, or soil salinity (e.g., replacing corn with sorghum in dry areas). (ii) Local genetic variations (farmer-saved seeds): Reviving traditional local varieties, which are often naturally more robust and adapted to the specific conditions of their local environment. **4. The contribution of precision technologies (AgTech):** Technology helps maximize the efficiency of every resource used. (i) Imaging and drones: Precisely mapping crop health to quickly detect water stress or disease, enabling targeted intervention. (ii) Robotics and automation: Using mechanical weeding robots to eliminate the need for herbicides in a cost-effective manner. Summary of approaches: Agroecology vs. Precision agriculture. These two approaches are not mutually exclusive; they often complement each other in the field:

Approach	Primary driver	Environmental benefit
Agroecology	Natural biological and ecological processes	Restores biodiversity, sequesters carbon, and enriches the soil over the long term.
Precision agriculture	Data, sensors, and advanced technologies	Optimizes water and energy use and reduces yield losses in the short term.

Keywords: Agriculture adaptation, environmental crisis, agroecology, water shortages, biodiversity, innovative technologies

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Agriculture adaptation to the environmental crises: The integrated chemistry–soil–water–climate approach as sustainable solution

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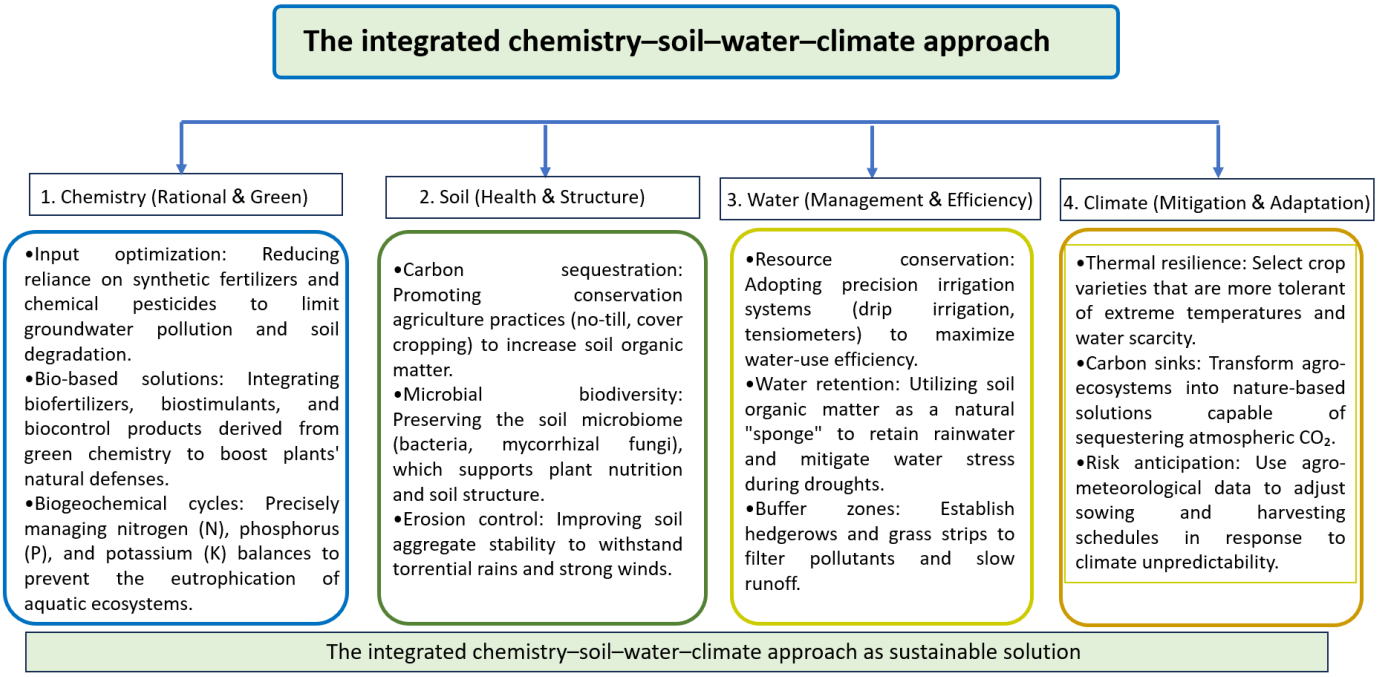
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Thematic Area: Agriculture, Water Resources, Climate Change & Environmental Sustainability

Abstract

The integrated chemistry–soil–water–climate framework treats agriculture as a unified nexus where chemical dynamics, soil health, hydrological cycles, and climatic pressures interact. Instead of addressing these elements in isolation, it deploys synchronized strategies to build resilient farming systems. By interconnecting these four fundamental pillars, the framework lays the groundwork for adapting agriculture to contemporary environmental crises while maintaining productivity and preserving natural resources.

In this presentation, we will explore the structure of this integrated approach:



Main Benefits: The integrated chemistry–soil–water–climate approach links geochemical processes, soil health, hydrological dynamics, and atmospheric conditions into a single, unified management framework. Rather than treating these elements separately, this holistic strategy recognizes that shifts in one component immediately trigger reactions across the others**. (a) Enhanced Climate Resilience & Buffering:** Healthy soil organic matter and proper soil chemistry improve water-holding capacity, allowing lands to absorb heavy rainfall and buffer against severe droughts or

temperature extremes. (b) **Optimized Nutrient Cycling & Fertility:** Understanding soil pH, redox states, and mineral interactions prevents nutrient lock-up, cuts down chemical runoff, and ensures plants get steady access to essential elements. (c) **Reduced Salinization and Toxicity:** Tracking moisture fluctuations alongside chemical leaching stops salts and toxic trace metals from concentrating in the root zone during hot, dry spells. (d) **Lowered Greenhouse Gas Emissions:** Coordinated soil-water management (such as precision irrigation and controlled drainage) limits conditions that produce nitrous oxide) and methane, while actively driving carbon sequestration in the soil. (e) **Targeted Resource Efficiency:** Evaluating local climate projections alongside soil and water chemistry lets practitioners apply exact amounts of water and eco-friendly inputs—preventing waste and protecting surrounding groundwater and surface supplies.

Keywords: Agriculture adaptation, natural resources Nutrient Cycling & Fertility, **Climate Resilience & Buffering** shortages, biodiversity, innovative technologies

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Integrated chemistry–soil–water–climate approach: Application in arid-region agriculture.

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Thematic Area: Agriculture, Water Resources, Climate Change & Environmental Sustainability

Abstract

In **arid-region agriculture**, applying the integrated chemistry–soil–water–climate approach is a powerful tool to prevent land degradation and secure food production in water-scarce zones. When rainfall is scarce and evaporation rates are high, managing soil and water as isolated components inevitably leads to crop failure and land desertification. **Main Benefits for Arid-Region Farming: (a) Precision Salinity Control:** High evaporation draws groundwater upward, depositing salts in the root zone. By tracking climate data (evaporation rates) alongside water chemistry (irrigation water salinity) and soil properties, farmers can calculate the exact "leaching fraction" needed to flush salts away without wasting precious water. (b) **Maximizing Limited Water Efficiency:** Arid soils are often sandy and poor at holding moisture. Optimizing soil chemistry—such as adding organic matter or specific amendments like gypsum—alters the soil structure, drastically improving its water-holding capacity so crops can survive longer between irrigation cycles. (c) **Preventing Nutrient Lock-up:** Arid soils are frequently alkaline (high pH). Under hot, dry conditions, essential micronutrients like iron, zinc, and phosphorus chemically lock up and become unavailable to plants. An integrated approach uses specialized drip irrigation chemistry (fertigation) to slightly acidify the root zone, keeping nutrients soluble. (d) **Microclimate Buffering:** Healthy, moisture-retaining soils regulate soil temperature. During extreme desert heatwaves, soils managed under this framework keep root zones cooler, reducing crop heat stress and preventing total yield loss. (e) **Enabling the Safe Use of Marginal Water:** Water-scarce regions must often rely on brackish groundwater or treated wastewater. By continuously analyzing the chemical composition of this water against the soil's buffering capacity, farmers can safely use alternative water sources without destroying the soil structure or poisoning the crops.

Keywords: Agriculture adaptation, natural resources Nutrient Cycling & Fertility, Climate Resilience & Buffering shortages, biodiversity, innovative technologies

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Integrated chemistry–soil–water–climate approach to strengthen the resilience of Moroccan agro-ecosystems to drought

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Thematic Area: Agriculture, Water Resources, Climate Change & Environmental Sustainability

Abstract

Morocco is facing a long-term transformation of its hydro-climatic regime, characterized by successive droughts, rising temperatures, high rainfall variability, and increasing pressure on water resources and agricultural soils. Annual per capita water availability has dropped from approximately 2,600 m³ in the 1960s to around 600 m³ in 2020—a level close to the international threshold for absolute water scarcity (500 m³ per capita per year). In the five years leading up to 2024, the country experienced four drought episodes, while dam reserves allocated for agriculture declined sharply.
This study proposes an integrated approach linking soil chemistry, water quality and availability, climate, agro-geochemistry, environmental chemistry, and resilient agricultural practices. The central hypothesis is that agro-ecosystem resilience cannot be strengthened solely through irrigation optimization; it requires a simultaneous focus on improving soil water-holding capacity, increasing organic carbon, managing salinity and contaminants, enhancing fertilizer chemical efficiency, and implementing adaptive water management. The study proposes a system of quantitative indicators incorporating, among others, SPI, SPEI, NDVI, soil moisture, soil organic carbon, electrical conductivity, pH, water use efficiency, water productivity, crop yield, and an integrated Agro-Ecosystem Resilience Index (IRA).

Keywords: Soil chemistry; agro-geochemistry; resilient agriculture; organic carbon; salinity; irrigation; agro-ecosystems; climate adaptation.

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Workshop

WORKSHOP III

Global climate change: Priorities for adaptation, equity, and resilience

Ahmad El Moll, AbdelKader Hamdouni

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Future ambitions to combat global climate change: Nature and Adaptation Priorities

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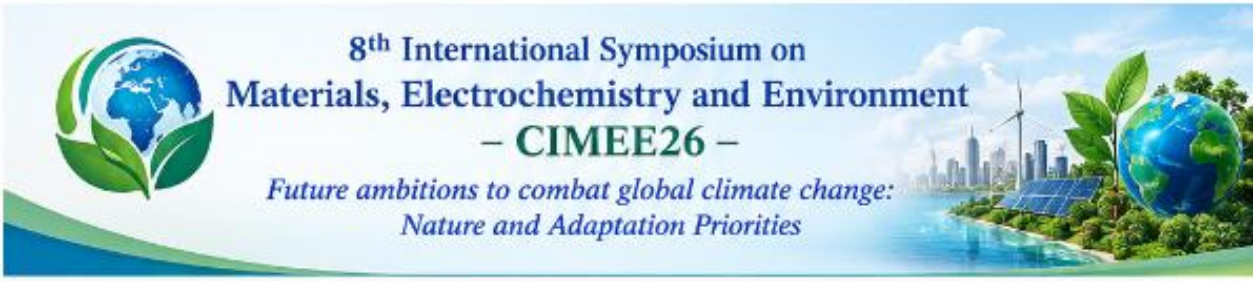
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Thematic Area: Climate change & Environmental Sustainability

Abstract

Future ambitions to combat global climate change focus on accelerating greenhouse gas emission reductions, closing critical adaptation gaps, and minimizing global temperature overshoot. The Paris Agreement aims to limit global warming to well below 2°C above pre-industrial levels, while pursuing efforts to restrict the increase to 1.5°C. However, current projections indicate that temporarily exceeding this threshold remains a significant risk. Achieving international climate objectives therefore requires urgent action to accelerate emission reductions before 2030, strengthen climate resilience, and integrate mitigation and adaptation strategies into national and local policies. Two complementary pillars are essential to achieving these ambitions. The first is accelerating the energy transition, which involves reducing dependence on fossil fuels, expanding renewable energy production, and promoting clean electrification. Emerging technologies, including green hydrogen, advanced battery storage, and carbon capture, can contribute to reducing emissions and supporting the transition towards low-carbon economies. The second pillar is strengthening adaptation and resilience. Despite progress in developing National Adaptation Plans (NAPs), significant challenges remain regarding implementation, financing, and monitoring. Priority actions include improving early-warning systems, implementing nature-based solutions, developing climate-resilient urban infrastructure, and strengthening disaster risk reduction strategies. This contribution examines the specific challenges faced by small and developing countries, which often contribute relatively little to global greenhouse gas emissions while experiencing disproportionate impacts from climate change. Rising sea levels, coastal erosion, extreme weather events, droughts, and saltwater intrusion into freshwater resources threaten their ecosystems, economies, and communities. These vulnerabilities are particularly significant for countries with limited financial resources and institutional capacities. Consequently, their climate strategies must prioritize adaptation, equity, sustainable development, and long-term resilience. The main ambitions and strategic priorities for these countries include five complementary areas. First, survival and relocation planning require anticipating long-term risks, protecting vulnerable populations, and addressing threats to freshwater resources and coastal settlements. Second, strengthening Nationally Determined Contributions (NDCs) involves regularly updating national climate commitments and integrating local priorities, resource efficiency, and circular economy approaches. Third, enhancing adaptation and resilience requires investment in early-warning systems, disaster preparedness, ecosystem restoration, and nature-based coastal protection. Fourth, improving access to international climate finance is essential for implementing adaptation projects, addressing loss and damage, and supporting climate-vulnerable communities. International cooperation and the fulfilment of financial commitments by major emitting economies remain critical to these efforts. Finally, promoting youth participation and community-based solutions can strengthen local ownership, encourage innovation, and mobilize resources for practical climate action. Initiatives supported by programmes such as the United Nations Development Programme's Climate Promise can contribute to advancing locally driven climate strategies in vulnerable countries, including Lebanon and Tunisia. Overall, combating global climate change requires a coordinated approach that combines rapid decarbonization, effective adaptation, innovative technologies, international solidarity, and community engagement. For small and developing countries, integrating environmental protection, technological innovation, and climate justice into national development strategies is essential to building a more resilient and sustainable future.

Keywords: Global climate change; energy transition; renewable energy; advanced battery storage; carbon capture; climate adaptation; climate resilience; nature-based solutions; small and developing countries; climate finance; sustainable development.



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Thematic Area: Climate change & Environmental Sustainability

Abstract

Future ambitions to combat global climate change focus on accelerating emission reductions, closing critical adaptation gaps, and minimizing temperature overshoot. While the Paris Agreement aims to cap global warming well below 2°C—and ideally at 1.5°C—scientists warn of a temporary temperature overshoot. To prevent this, current international frameworks demand rapid, mid-decade course corrections to drive emissions downward before 2030. Achieving these goals relies on two essential pillars:



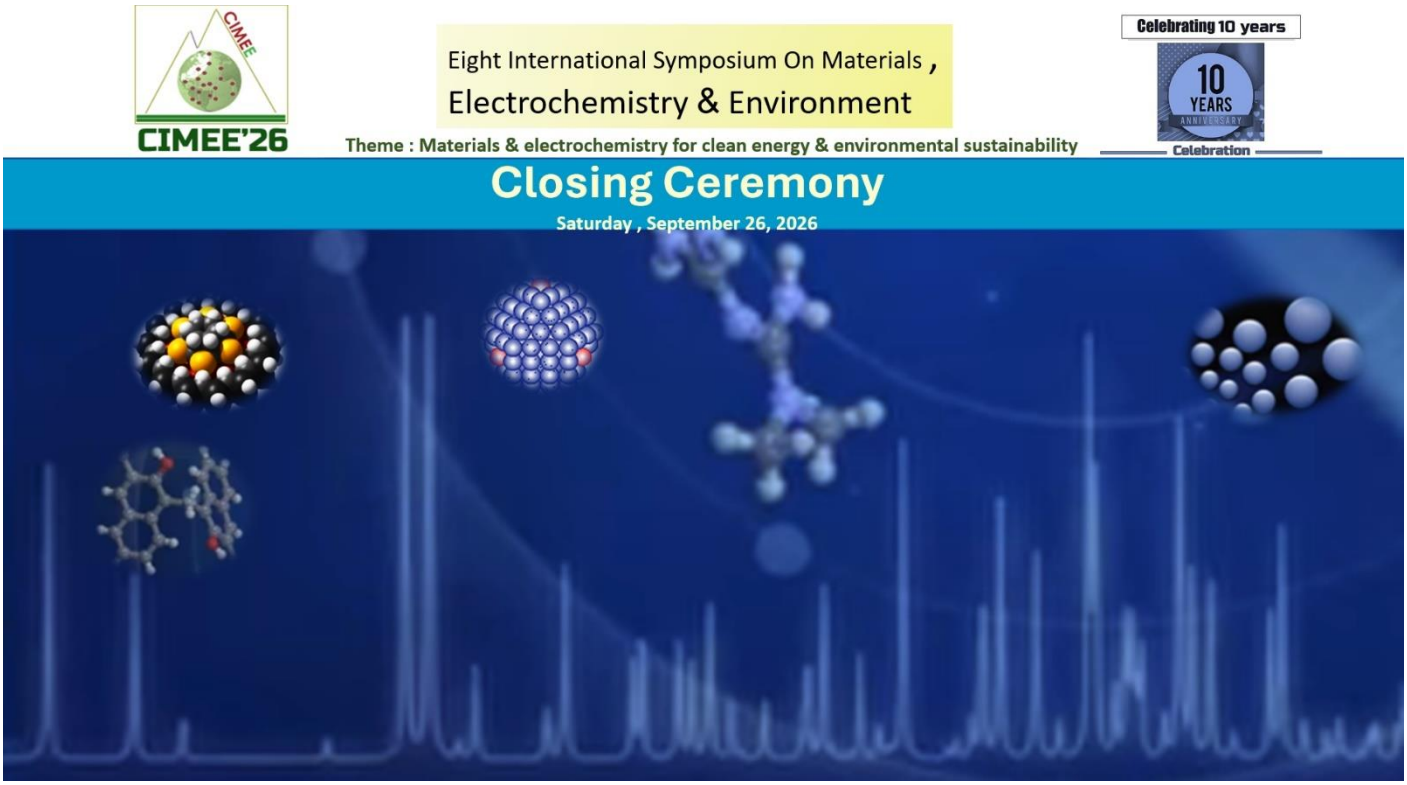
- **Fast-Tracking the Energy Transition:** Global strategies prioritize transitioning away from fossil fuels toward clean electrification. This requires rapidly scaling renewable energy and expanding critical technologies like green hydrogen, advanced battery storage, and carbon capture.
- **Scaling Adaptation and Resilience:** Although National Adaptation Plans (NAPs) now cover 87% of countries, severe gaps in implementation and monitoring persist. Future efforts must urgently integrate early-warning systems, nature-based solutions, and climate-resilient urban infrastructure into local and national frameworks.

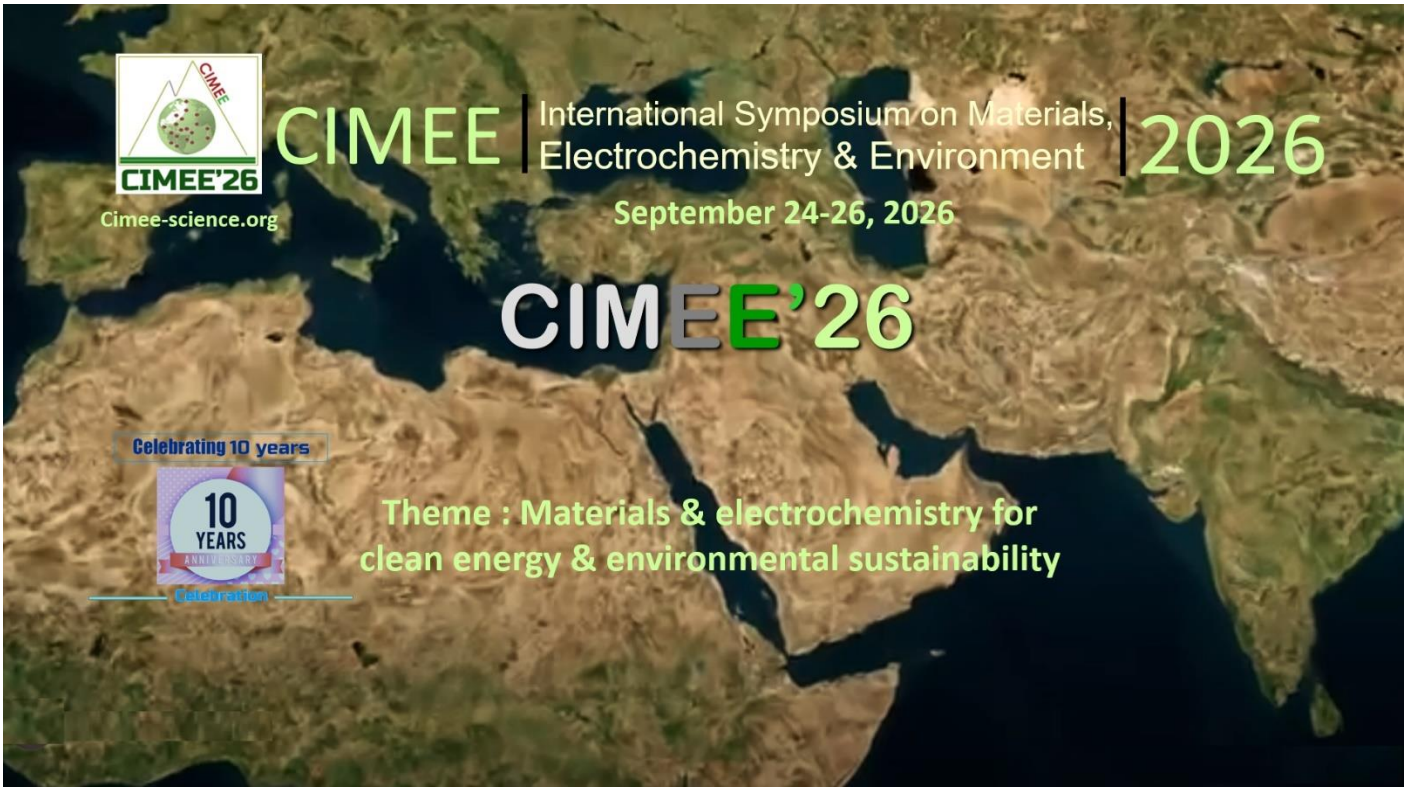
This presentation explores how climate change uniquely impacts small and developing nations. Despite contributing a negligible amount to global greenhouse gas emissions, these countries face the most severe threats from rising sea levels and extreme weather. Because of this stark imbalance, their climate agendas focus heavily on resilience, equity, and strategic adaptation.

Main Ambitions and Strategies of Small Countries

- **Survival and Relocation Planning:** Nations focus on long-term existential strategies while managing immediate threats, such as saltwater intrusion into fresh groundwater supplies.
- **National Climate Plans (NDCs):** Developing states regularly update their Nationally Determined Contributions (NDCs) to integrate specific local needs, including circular economy models.
- **Adaptation and Resilience:** Small nations prioritize climate adaptation over emission cuts, given their tiny global footprint. Key efforts center on early warning systems, disaster risk reduction, and nature-based coastal protection.
- **Accessing Global Climate Finance:** These countries actively push major economies—like the G20, which accounts for 77% of global emissions—to honor financial commitments. They advocate for functional loss-and-damage funds and adaptation support agreed upon at forums like COP29 and COP30.
- **Youth and Community Solutions:** Grassroots initiatives mobilize local communities to build resilience from the ground up. For example, programs supported by the UNDP Climate Promise actively fund local, youth-led solutions in vulnerable regions like Lebanon and Tunisia.

Keywords: global climate change; Energy Transition; advanced battery storage, carbon capture; nature-based solutions; Small countries, renewable energy.


CIMEE'26
Eight International Symposium On Materials ,
Electrochemistry & Environment
Theme : Materials & electrochemistry for clean energy & environmental sustainability
Celebrating 10 years
10 YEARS
Celebration
Closing Ceremony
Saturday , September 26, 2026


CIMEE'26
Cimee-science.org
CIMEE | International Symposium on Materials, Electrochemistry & Environment | 2026
September 24-26, 2026
CIMEE'26
Celebrating 10 years
10 YEARS
Celebration
Theme : Materials & electrochemistry for clean energy & environmental sustainability

CLOSING CEREMONY

EIGHTH INTERNATIONAL SYMPOSIUM ON MATERILS, ELECTROCHEMISTRY AND ENVIRONMENT

September 24– 26, 2026 - LEBANON

CLOSING SESSION & CONCLUSIONS

Theme: Materials & electrochemistry for clean energy & environmental sustainability

8th International Symposium on Materials, Electrochemistry and Environment (CIMEE 2026)

Speech at the Closing Ceremony of the International Symposium, CIMEE26

C I M E E

INTERNATIONAL SYMPOSIUM ON MATERIALS, ELECTROCHEMISTRY & ENVIRONMENT

Theme : Materials & Electrochemistry for Clean Energy & Environmental Sustainability



Conference program:

Major Presentations

- 4 Plenary Sessions: High-profile, featuring top-tier speakers.
- 7 Keynote Sessions: delivered by invited experts to highlight major advancements.

Research & Technical Tracks

- 3 Oral Sessions: Standard breakout sessions - multiple researchers talks on their accepted papers.
- 2 Poster Sessions: Highly interactive networking sessions - discussing the work one-on-one with attendees.

Specialized Formats

- 2 Special Sessions: focused tracks that dive deep into a highly specific sub-topic.
- 3 Workshops: Immersive, collaborative, and hands-on learning labs built for practical skill acquisition.

Closing remarks, recommendations, Perspectives and brainstorming

CIMEE'26: 4 plenary sessions, 7 Keynote sessions, 3 oral sessions, 2 poster sessions, 2 special sessions, 3 workshops

Speech at the Closing Ceremony of the International Symposium, CIMEE26

Distinguished colleagues, and dear friends,

First and foremost, I wish to express my heartfelt appreciation to everyone who contributed to the success of this event. I am deeply grateful to the technical and program organizing committees, to our esteemed speakers for their enlightening presentations, and to the session chairs for their flawless management and scheduling. Above all, I extend my warmest thanks to the participants, whose diverse ideas truly enriched this conference. This three-day event exceeded all expectations. We successfully fostered global and Mediterranean academic collaboration, exchanged vital insights on critical issues like heatwaves and pollution, and built lasting ties within the chemistry and environmental science communities. Furthermore, the final summaries from our session chairs and participants provided a remarkably comprehensive overview of our collective progress.

Serving as the true cornerstone of CIMEE26, the opening plenary session united all participants and set the stage for this year's edition. This pivotal session successfully defined our core theme, shaped the overarching vision, and highlighted the major breakthroughs to come.

Featured Plenary Sessions:

Opening Plenary Session & Welcome Speech: Assoc. Prof. Ahmad El Moll, Lebanese University, Lebanon (Conference Chair)
Topic: The Geopolitics of the Green Transition: From Resource Scarcity to Environmental Degradation
Plenary Session 1 : Prof. Najla Fourati, Conservatoire National des Arts et Métiers (CNAM), Paris, France
Topic: Electrochemical Sensing Devices for Sustainable Agriculture: Emerging Platforms and Deployment Challenges
Plenary Session 2: Prof. Marta Pazos Currás, CINTECX, Department of Chemical Engineering, Universidade de Vigo, Spain
Topic: Towards a Greener Future: Eco-friendly Materials for Water Remediation and Renewable Energy Projects.

In Conclusion: Bringing the ceremony to a close, the Organizing Committee conveyed its deepest gratitude to all delegates and partners who supported the conference. CIMEE'26 concludes as a memorable milestone, celebrating the spirit of cooperation, creativity, and dedication that defines the regional chemistry community.
We would now like to share our personal reflections on this edition.

Most of the scientific fields in which we work—ranging from materials science and electrochemistry to environmental analytical chemistry and renewable energy—are of paramount importance for achieving sustainable development and creating a better, more dignified, and healthier environment and way of life, both in the Mediterranean region and across the globe. Consequently, these efforts can contribute significantly to addressing the current challenges facing our planet, such as climate change and water and soil pollution.

Climate-related risks to the environment and health do not stop at borders. Therefore, adaptation and mitigation policies must be regional in scope, grounded in active cooperation among all Eastern Mediterranean countries. The policy proposals highlight the need for a substantial reduction in carbon emissions across the region:

• Integrate efforts to combat land degradation and environmental pollution throughout the region;

• Encourage the development and use of innovative, efficient, and sustainable technologies for water management and the energy transition;

• Establish comprehensive strategies to create regional networks for monitoring and controlling major sources of air pollution, as well as for monitoring greenhouse gases.

• Protect the Mediterranean coastline from wastewater discharges by combining modern technology (connected sensors, imaging) and artificial intelligence (AI)—with AI enabling a shift from reactive management to predictive, automated management at the source.

Finally, given the negative impact of extreme heatwaves, water scarcity, and air pollution on human health in the Eastern Mediterranean region:

• Support regional efforts to develop climate change mitigation and adaptation measures and achieve climate goals, while striving to maintain a sustainable balance between production and consumption.

• Leading research towards reducing greenhouse gas (GHG) emissions, in accordance with United Nations guidelines (via the IPCC and the UNFCCC), relies on a dual approach: drastic reduction at the source and the deployment of carbon management technologies such as CCU, and converting captured carbon dioxide and green hydrogen into synthetic fuels

• This initiative aims to focus scientific research on three interconnected areas: thermal resilience, carbon capture and storage (CCS), and biomass valorization—which acts as a natural bridge between carbon capture and clean energy production.

• Combat the adverse effects of rising temperatures (adaptation) through resilient agriculture, cooling materials and urban planning, and nature-based solutions (such as urban forests and mangroves) to maximize microclimate cooling.

Recommendations for the next edition of CIMEE:

• Continue strengthening international cooperation in advanced materials science and electrochemistry research, and intensify research efforts given their crucial role in environmental protection, with a focus on developing applied research in the fields of energy, the environment, and agriculture.

•CIMEE invites PhD students to collaborate with our international research group on high-impact topics like CCU, CCUS, and BECCS, we support emerging scholars by providing cost-free opportunities for research participation and publication. Additionally, students receive expert guidance and structured mentorship to ensure their work aligns with international standards of academic excellence.

We hope to see you at the next CIMEE conference.

Sincerely,

Organizing Committee Chairs

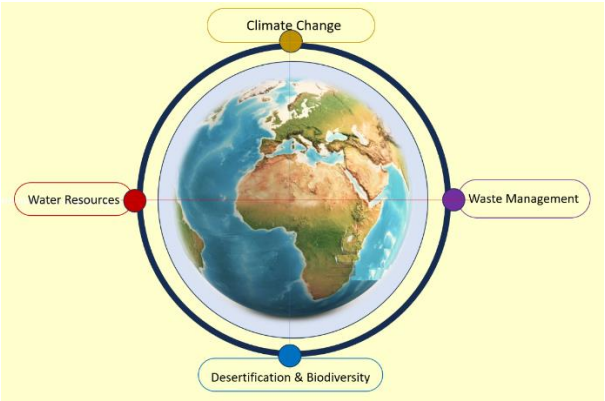
C I M E E

INTERNATIONAL SYMPOSIUM ON MATERIALS, ELECTROCHEMISTRY & ENVIRONMENT











CLOSING SESSION







MATERIALS, ELECTROCHEMISTRY & ENVIRONMENT

CLOSING CEREMONY



« Future Action CIMEE'26 »

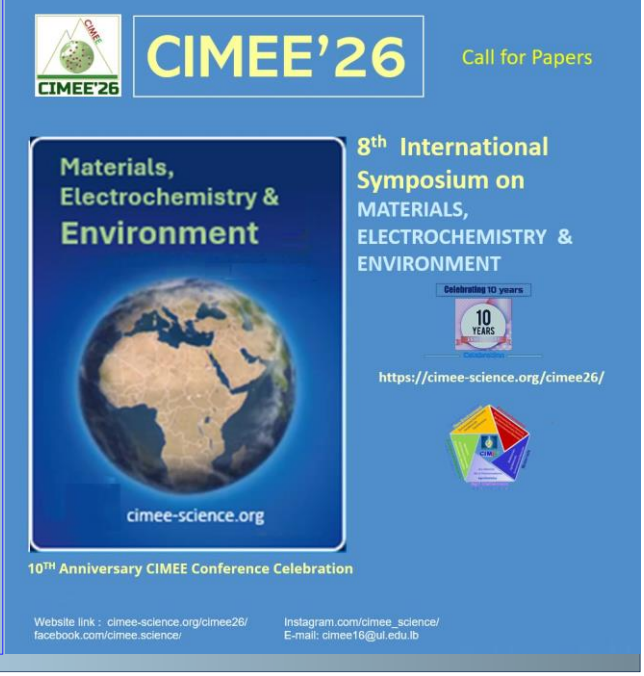
CALL for Papers

The CIMEE conference brings together a distinguished network of leaders, changemakers, policymakers, and advocates dedicated to building a sustainable future aligned with the United Nations 2030 Agenda. Supported by its official partners across five universities, the CIMEE Group unites top scientific and community leaders to offer a unique international collaboration platform.

Building on the success (10 years) and experience of 8th previous editions, this upcoming event features three days of intensive discussions centered on the theme: "Materials & Electrochemistry for Clean Energy & Environmental Sustainability." This focus directly supports global targets and the United Nations Sustainable Development Goals (SDGs). Hosted online from Tripoli, this virtual conference serves as a dynamic platform designed to foster collaboration, innovation, and advancements in materials science, electrochemistry, and environmental analysis technologies.

In alignment with the 2030 global vision, the event invites participants to explore new milestones, redefine leadership, and co-create lasting sustainable solutions. More than a traditional conference, CIMEE is an immersive experience driven by the vision of inspiring educators. The program features interactive presentations, keynote addresses, hands-on workshops, and robust networking opportunities. Additionally, the CIMEE Group aims to spark new research initiatives, cultivate cutting-edge academic projects, and build the foundational platforms required to turn the SDGs into reality.

The Editorial Committee of CIMEE Group cordially invite researchers, professors, and young enthusiasts' researchers to submit their manuscripts and research proposals. The Call for Papers is now open, and the submission deadline is December 31, 2026.



Dear Partners

Dear colleagues,

This edition, CIMEE26, marks ten years of commitment across three branches of chemistry, aimed at providing sustainable solutions to the global crisis.

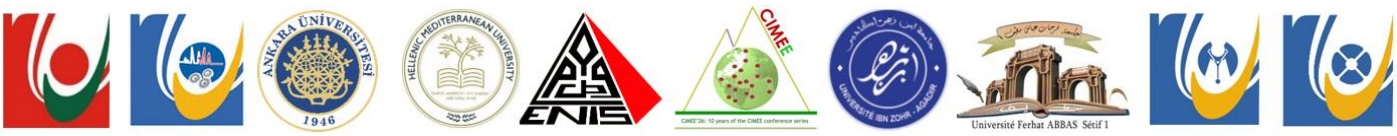
I would like to express my deepest gratitude for your invaluable partnership and unwavering support throughout our conference series since 2016. The contributions from each team—ranging from technical guidance and the peer review of papers to their subsequent publication in scientific journals—have played an essential role in bringing this significant undertaking to fruition. We are profoundly grateful for the time, expertise, and dedication you have invested in this remarkable collaboration.

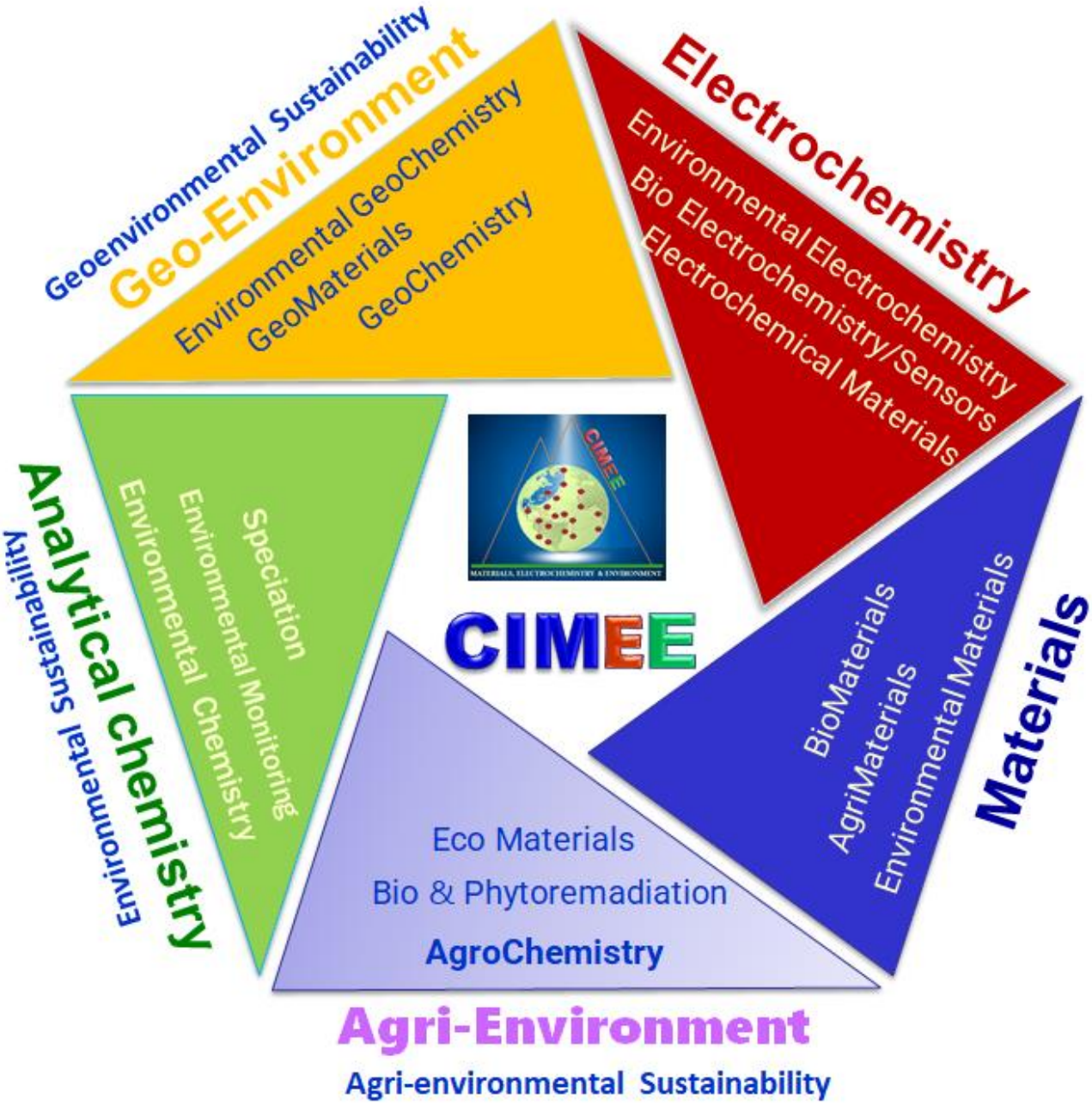
Through our joint efforts, we have successfully established a platform across three continents (Asia, Europe, and Africa) focused on three major branches of chemistry: Materials Chemistry, Electrochemistry, and the Environment. This initiative has brought together a large number of researchers from these fields, encouraging them to collaborate and actively contribute to developing sustainable solutions for the challenges facing our planet.

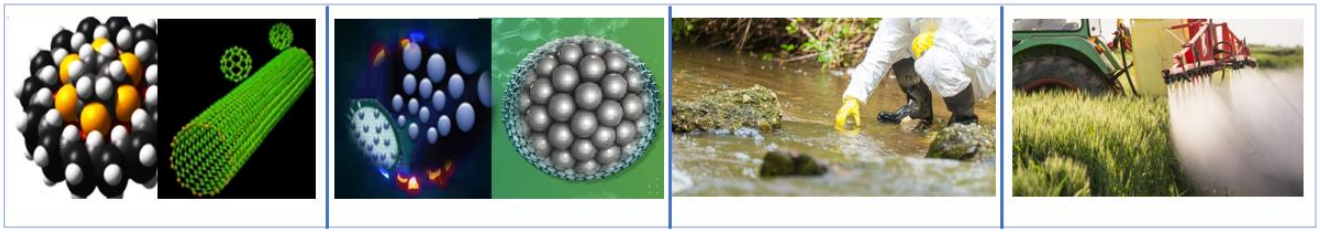
Over the past decade, we have had the privilege of gathering high-caliber scientific contributions and publishing this work through special issues with renowned publishers such as Elsevier, Springer, and Taylor & Francis. This momentum has fostered a true multidisciplinary school of chemistry—a major achievement that aligns perfectly with the Sustainable Development Goals (SDGs). This ambitious project could never have reached such a level of maturity without your dedication and steadfast commitment. The high scientific standard and the expertise gained in these fields drive us to continue investing in research and to leverage the new technologies that society requires.

We place the utmost importance on our relationship with our partner universities (Algeria, Greece, Morocco, Tunisia, Turkey) and all the teams involved, and we look forward to our future collaborations.

Sincerely,




Geoenvironmental Sustainability
Geo-Environment
Environmental GeoChemistry
GeoMaterials
GeoChemistry
Electrochemistry
Environmental Electrochemistry
Bio Electrochemistry/Sensors
Electrochemical Materials
Analytical chemistry
Environmental Sustainability
Speciation
Environmental Monitoring
Environmental Chemistry
CIMEE
Materials
BioMaterials
AgriMaterials
Environmental Materials
Eco Materials
Bio & Phytoremadiation
AgroChemistry
Agri-Environment
Agri-environmental Sustainability



Program & Abstract Book

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FPH, DSST, Lebanese University, Lebanon
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Printed in Lebanon

Theme of the meeting:

Materials & Electrochemistry for Clean Energy & Environmental Sustainability

SYMPOSIUM PARTNERS

This book compiles the CIMEE26 program, abstracts of the plenary, keynote, oral, and poster presentation, special sessions, and workshops from the 8th International Symposium on Materials, Electrochemistry and Environment (CIMEE26), held in Lebanon from 24 to 26 September 2026. All abstracts are reproduced as accepted by the Symposium's Scientific Committee.

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