# Materials for the Environment and the Society

## HiFunMat 2024 summer school

Program

01 to 04 July 2024

Book of abstracts



Matériaux hiérarchiques et fonctionnels pour
la santé, l'environnement et l'énergie | HiFunMat

Instituts **thématiques interdisciplinaires** | ITI
de l'**Université** de Strasbourg & cnrs & **Inserm**

Collège Doctorale Européen | Strasbourg

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Program ↘

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## 01 July

### Socio-economical aspects of the environment

| | |
|---|---|
| 08h30 | Registration |
| 08h45 | Welcome & Introduction |
| 09h00 | From sustainable development towards sustainable ecological transitions<br>Julien Delord \| Unistra |
| 10h00 | Droit et transition écologique<br>Marie-Pierre Camproux Duffrene \| SAGE |
| 11h00 | *Coffee break / Poster session* |
| 11h30 | Economie comportementale : comment impulser le changement ?<br>Anne Rozan \| ENGEES |
| 12h30 | *Lunch / Poster session* |
| 13h30 | Circularity & challenges of eco-design<br>Valérie Massardier \| INSA Lyon |
| 14h30 | *Coffee break / Poster session* |
| 15h00 | Life cycle analyses<br>Arthur Laporte \| APESA Toulouse |
| 16h00 | Interdisciplinary workshop 1 |
| 17h30 | Being a scientist today<br>Public conference by<br>Jérôme Santolini \| CEA |

## 02 July

### Materials Environmental Analysis & Remediation

| | |
|---|---|
| 08h30 | Daily sign-in participants |
| 08h45 | Introduction to todays theme |
| 09h00 | Ecological engineering for urban waters sustainable management / Case studies in Strasbourg<br>Adrien Wanko \| ICube |
| 10h00 | A citizen science project : the impact of urban pollution on plants<br>B. Lebeau & L. Gondet \| IS2M & IPHC |
| 11h00 | *Coffee break / Poster session* |
| 11h30 | Transformation, impacts and remediation: the challenges of micropollutants in soil and water<br>Gwenaël Imfeld \| ITES FERED |
| 12h30 | *Lunch / Poster session* |
| 13h30 | How to apply LCA in an anthropized watershed: engineered TiO2 Nps in the Thur valley<br>Gaetana Quaranta \| IPHC |
| 14h30 | Air pollution control: capture of fine particles<br>Charlotte Pham \| SICAT SAS |
| 15h30 | *Coffee break / Poster session* |
| 16h00 | Materials for air and water remediation: zeolites & clays<br>A. Simon-Masseron & J. Brendlé \| IS2M |
| 17h00 | Interdisciplinary workshop 2 |

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## 03 July

### Recycling & Recovery

| | |
|---|---|
| 08h30 | Daily sign-in participants |
| 08h45 | Introduction to todays theme |
| 09h00 | Biobased Polymers for a greener future<br>Luc Averous \| ICPEES |
| 10h00 | Valorisation énergétique de la biomasse<br>Barbara Ernst \| IPHC |
| 11h00 | *Coffee break / Poster session* |
| 11h30 | $CO_2$ chemistry for climate. A transition, really?<br>Alessandra Quadrelli \| IRCELYON |
| 12h30 | *Lunch / Poster session* |
| 13h30 | Strategic heavy metals recovery<br>Maria Boltoeva \| IPHC |
| 14h30 | Indoor air quality<br>Stéphane Le Calvé \| ICPEES |
| 15h30 | *Coffee break / Poster session* |
| 16h00 | Interdisciplinary workshop 3 |
| 20h00 | Gala dinner - Kammerzell |

## 04 July

### Healing the Environment

| | |
|---|---|
| 08h30 | Daily sign-in participants |
| 08h45 | Introduction to todays theme |
| 09h00 | Ecological restoration: better equipment for better practices<br>Isabelle Combroux \| LIV |
| 10h00 | Transformation des territoires : vers la sobriété et la neutralité carbone<br>Nadège Blond \| LIVE |
| | *Coffee break / Poster session* |
| 11h00 | Student synthesis on the |
| 11h30 | interdisciplinary workshops |

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## From sustainable development towards sustainable ecological transitions

**Julien Delord** | TEDS - Unistra / INSPE Strasbourg

Following the School strikes for Climate in 2018-19, the French government decided to introduce a mandatory short class explaining the basic tenets of climate change and ecological transitions for all higher education students in France. This new interdisciplinary course entitled « Ecological Transition for a Sustainable Development » and structured around the competences of the European GreenComp framework, presents the major scientific findings on the origins and impacts of the climate, biodiversity and resource crisis in its first part. The second part, devoted to the trajectories of a just and equitable transition simply recommends following the framework of the 17 SDGs, but does not offer any narrative capable of identifying the most desirable transition trajectories, the most relevant socio-technical factors, and the obstacles and denials of all kinds that stand in their way. It is some of these key questions to achieve effective transitions that we will address during this presentation.

## Droit et transition écologique

**Marie-Pierre Camproux Duffrene** | SAGE - Unistra

Cette intervention correspond à une réflexion sur la transition écologique par une juriste environnementaliste. Elle permettra de reflechir sur la notion de transition écologique (dans le prolongement du développement durable ) en sachant qu'actuellement notre développement n'est pas durable. Nous verrons ensuite comment le droit en s'appuyant sur certains constats ou concepts (anthropocène, limites planétaires, justice écologique-justice sociale) peut être un instrument d'accompagnement de cette transition écologique.

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## Economie comportementale : comment impulser le changement ?

**Anne Rozan** | ENGEES, SAGE- Unistra

Comment impulser les changements de comportement ? De nombreuses politiques publiques sont élaborées sur la base des concepts de l'économie comportementale (behavioral economics). L'économie comportementale s'est en effet développée en réponse aux limites de l'économie standard reposant sur l'hypothèse de rationalité individuelle. Elle est venue enrichir celle-ci en s'appuyant sur les contributions en psychologie sociale et plus largement en sciences du comportement. En particulier, les travaux menés par Daniel Kahneman et Amos Tversky ont mis en évidence différents biais (biais cognitifs, biais moraux, biais de conformité) qui permettent de mieux comprendre les processus de décision des individus. Ces apports contribuent à l'élaboration de politique publique ainsi qu'à l'évaluation de celle-ci.

## Circularity & challenges of eco-design

**Valérie Massardier** | INSA Lyon

After a brief presentation of the limits of linear production-consumption systems and the growing complexity of materials and objects (alloys, composites, multi-layers, etc.), the need for circularity to maintain "material stocks" will be highlighted, with developments on i) "circularity phases", ii) eco-design, iii) recycling with particular emphasis on the circularity of polymer materials and the strategies developed within the Laboratoire Ingénierie des Matériaux Polymères IMP UMR 5223. The importance of eco-design for circularity, the environmental impacts of "circular systems"/"linear systems", and the identified limits of circularity will be discussed, underlining the need for a multidisciplinary and interdisciplinary approach.
The BIOLOOP PRIME CNRS laboratory, which brings together laboratories in the humanities (TRIANGLE UMR 5206 and GREDEG UMR 7321) and materials science (IMP UMR 5223), will then be presented, demonstrating that the dissemination of innovations often requires socio-economic analysis of the production and recycling system to be combined with innovations in materials science.

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## Life cycle analyses

**Arthur Laporte** | APESA Toulouse

Are we able to determine which (among a defined list) product have the lowest impact on the environment ?
Partially yes, but there is a need to define what "environmental impact" means and how we can measure it.
Life cycle analysis is a tool linked to eco design strategies that involve taking the environment into account from the first stage of a product or a system design.
LCA allows one to choose the best trade-off between different products or systems while integrating environment as a full part KPI.
During this topic, we will approach the ISO standard that frames a LCA and its 4 main stages, from the setting of the LCA scope to the results.
Also, we will discuss the different levels of LCA : Attributional LCA, Consequential LCA, Organizational LCA, Social LCA and the linked requirements.

## Being a scientist today

**Jérôme Santolini** | CEA

The climatic, ecological, social and political crises we face today are shaking up our collective perceptions and calling into question the place of knowledge and scientists in modern society.
While the figure of the researcher in his or her ivory tower laboratory has become part of the collective imagination, it has now been overtaken by the many ways in which scientists are involved in the public arena.
Caught between a Knowledge Economy that wants to put scientists at the service of an industrial and commercial model and the desire to contribute to the societal transformation needed to pass on a desirable world to future generations, scientists are seeking to reinvent their profession.
So what does it mean to be a scientist today?
Whatever your status or background, we invite you to come and imagine together what science and knowledge might look like in 30 years' time, and to discuss the different ways
of being a scientist, now and in the future.

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## Ecological engineering for urban waters sustainable management / Case studies

**Adrien Wanko** | ICube - CNRS, Unistra

The alarming observation of the loss of 65,000 hectares of land each year in France, equivalent to a department every 10 years, cannot be ignored. This urban expansion significantly exacerbates the consequences of rainwater runoff on the water cycle and the water quality, as well as on public safety. Soil impermeability, by limiting infiltration, leads to increased runoff, higher flow rates at outlets, a decline in groundwater levels and often overloaded sewage systems, resulting in pollution discharges into our ecosystems. These water run-off issues are associated with climate change, which impacts water resource management. Initiating profound changes is imperative to preserve our water resources, mitigate the effects of climate change, and ensure a sustainable future for our territories. These challenges require addressing both qualitative and quantitative aspects of stormwater management. Therefore, it is necessary to develop our understanding of the quality of stormwater using advanced analytical tools and integrate nature-based solutions as ecological sustainable solutions to enhance stormwater management in urban area and then implement a safety permeable and sponge city.

## Phytopol : a citizen science project to study the impact of urban pollution on plants

**Bénédicte Lebeau & Laurence Gondet** | IS2M & IPHC - Unistra, UHA, CNRS

The PhytoPol Citizen Science project invited children (4th-5th grade) to become real scientists by participating in the design of an experiment based on one of the most common urban plants, the ribwort plantain, to understand how it resists urban pollutants. To achieve this, they were accompanied by researchers and students from Strasbourg and Mulhouse. The children took care of growing the plants and monitoring their growth. The researchers and students, on the other hand, characterized the metabolic and structural responses of these plants, compared to cultures under controlled conditions (mini-greenhouse and in vitro cultures). Various parameters were studied: 1. phytotoxicity symptoms; 2. plant defense reactions (accumulation of phytoliths, antioxidant activity, biosynthesis of phytochelatins); 3. characterization and quantification of pollutants (initially focusing on cadmium) present in the plant.

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## Transformation, impacts & remediation: challenges of micropollutants in soil & water

**Gwenaël Imfeld** | ITES & FERED - Unistra

Micropollutants, including pharmaceuticals, pesticides, and industrial chemicals, pose significant challenges for soil and water ecosystems due to their persistence, transformation, and potential impacts on biodiversity. These contaminants can undergo complex chemical transformations, leading to the formation of byproducts that may be more toxic than their parent compounds. The ecological impacts include altered microbial communities, reduced species diversity, and disrupted ecosystem functions. Effective remediation strategies are critical and involve advanced techniques such as bioremediation, phytoremediation, and the use of engineered nanomaterials. However, the heterogeneous nature of micropollutant contamination and site-specific variables complicate these efforts. Addressing these challenges requires an integrated approach, combining reflexive principles for circular economy, robust monitoring, innovative treatment technologies, and comprehensive risk assessment frameworks to mitigate the environmental and health risks associated with micropollutants.

## How to apply LCA in an anthropized watershed: engineered TiO2 Nps in the Thur valley

**Gaetana Quaranta** | IPHC - Unistra, CNRS

Engineered TiO2 nanoparticles (TiO2 NPs) are currently one of the most extensively used metal oxide nanoparticles and one of the most produced and imported in France. They are used in several fields like construction, cosmetic and food which leads to releases generating the potential for adverse environmental impacts. To quantify them, the Life Cycle Assessment is a powerful method that is able to characterize TiO2 NPs according to their fate in environmental media and to their effects on ecosystems and human health. In this presentation LCA is used to assess the potential impacts of TiO2 NPs in freshwater, soils and sediments. Two approaches are used: 1) an analytical approach which made it possible to determine the behavior of these particles in different matrices 2) a modeling approach was used to calculate TiO2 NPs effect factors at a local and global scales for terrestrial ecotoxicity by adapting the USEtox method. A bibliography study on the toxicity of TiO2 NPs on the most common soil species (earthworms, Caenorhabditis elegans, and bacterial communities) has been conducted to identify ecotoxicological reference values (NOEC, EC50 and LC50). The specific effect factor (EFs) has been calculated (12.46 PAF.m3.kg-1) according to properties (shape, size) of TiO2 nanoparticles produced in the Thur valley (Haut-Rhin, France) and the ecosystem physical conditions of this region as acidic to ochreous brown soil, specific species of soil fauna...

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## Air pollution control: capture of fine particles

**Charlotte Pham** | SICAT SAS

Air pollution by fine particles is detrimental to human health, being responsible for 277 000 premature deaths annually in Europe, especially in densely populated areas due to concentrated anthropogenic emissions (mainly from residential heating and traffic) combined with large numbers of people exposed. Policies to improve air quality as well as the deployment of different technical solutions have already made it possible to significantly improve the situation over recent decades, but further efforts are still needed. Our project provides a contribution to address this environmental challenge thanks to the development of a passive filter that traps the fine particles in outdoor air. When the filter becomes saturated, it can be washed with water and re-used, and the particles collected in water are safely eliminated. The presentation focusses on the results from two prototypes of these passive filters implemented close to high traffic roads in Strasbourg. It was carried out in collaboration between two SMEs and an academic laboratory, all based in Strasbourg: TrapAparT for the technology development, AIR&D for the simulations of upscale deployment and ICPEES (CNRS/Université de Strasbourg) for laboratory tests and analysis. It is concluded that the filters can reduce a significant fraction of the fine particles generated by local traffic, providing they are installed in strategic locations.

## Materials for air and water remediation: zeolites & clays

**Angélique Simon-Masseron & Jocelyn Brendlé** | IS2M - UHA, CNRS

Environmental pollution is inducing short-term and long-term adverse effects on soils, air, water, and living organisms. Among all the nanoporous materials, a special attention is paid on zeolites and clays as, beside their unique porosity and surface properties, they provide sustainable and efficient solutions for mitigating environmental pollution. After a short introduction on their structures, main characteristics and specificities aiming at understanding why these compounds are of interest, some relevant examples of applications will be given, in the field of heavy metal cations and radionuclides remediation as well as on the removal of antibiotics from an aqueous medium, underlining how the differences between clays and zeolites impact the manner in which these two classes of minerals interact with water in the environment. A focus will be made on the volatile organic compounds' decontamination, before a general conclusion.

## Biobased Polymers for a greener future

**Luc Averous** | ICPEES - Unistra, CNRS

This course will briefly present some of the fundamentals on polymers derived from biomass, from a few solid definions to various various short- (biodegradable and biobased polymers) and long-term (sustainable and biobased polymers) applications, integrating different aspects of polymer science and engineering.

## Valorisation énergétique de la biomasse

**Barbara Ernst** | IPHC - Unistra, CNRS

Dans le contexte actuel de la transition énergétique, la valorisation énergétique d'une ressource renouvelable telle que la biomasse est envisagée dans un objectif de production d'énergie bas carbone ou verte. Cette intervention scientifique donne un aperçu des procédés thermochimiques et biologiques pour certains à maturité technologique et d'autres en développement pour la production de vecteurs énergétiques (méthane, hydrogène). Le couplage de ces procédés de façon séquentielle sera discuté dans la dynamique d'une valorisation complète de la biomasse.

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## CO2 chemistry for climate. A transition, really?

**Alessandra Quadrelli** | IRCELYON

Anthropogenic emissions of carbon dioxide, CO2, are destabilizing natural CO2 cycles, including those of living organisms - which emit and absorb CO2 via respiration and photosynthesis - and of the oceans. Chemistry has been using CO2 as a raw material since the 19th century (to make aspirin, for example). The scientific, academic, industrial and political communities are currently reflecting on the usefulness, limits, potential, blind spots and dangers of a chemistry designed to compensate for this imbalance in the CO2 cycles.
This course will provide a general overview of the fundamentals of CO2 chemistry in the context of global climate change, a chemistry-driven analysis of the transition scenarios around the carbon cycle , CO2-based chemical research avenues currently proposed as a mitigation (co-)solutions, and in conclusion some interdisciplinary analyses with selected examples drawn from history, epistemology and situated knowledge theories that explore the limits of this disciplinary approach to the permanently entangled societal developments, synthetic CO2 cycles and natural ones.

Ref « An anthropocene-framed transdisciplinary dialog at the chemistry-energy nexus »
Mathieu S. Prévot et al. Chem. Sci., 2024,15, 9054-9086
https://doi.org/10.1039/D4SC00099D

## Strategic heavy metals recovery

**Maria Boltoeva** | IPHC - Unistra, CNRS

Humans mine and use massive quantities of metals every year, while the need for metals and materials is growing with population growth, urbanisation and electrification. To meet this growing demand for strategic metals, it is crucial to improve its recovery processes. On the other hand, some metals are identified in many countries as critical and strategic materials due to their both high economic importance and supply risk. Thus, it is of key importance to ensure reliable, secure and sustainable access to these materials. Examples are cobalt, nickel, copper, and rare earth elements. This presentation will review the existing strategic and critical metals, conventional physicochemical and alternative technologies of metal recovery from secondary resources such as solvent extraction, adsorption, ion exchange, etc. as well as recent advances in the field with a focus on electronic and spent batteries materials.

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## Indoor air quality

**Stéphane Le Calvé** | ICPEES – Unistra, CNRS

The aim of this conference is to discover the challenges of indoor air quality through an interactive course. We hope it will open your mind to a new, less polluting way of living at home.

After a general introduction, the main differences between indoor and outdoor air pollution will be presented. The key parameters of indoor air quality will then be detailed. Finally, health issues and regulations relating to indoor air quality will be explored.

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## Ecological restoration: better equipment for better practices

**Isabelle Combroux** | LIVE - Unistra

On June 17th 2024, The EU adopted its new Nature Restoration Law. One of the objectives of this european regulation is to restore 20% of EU's degraded ecosystems by 2030 and all degraded ecosystems by 2050.

Ecological restoration is a young applied science which has greatly evolved in the last decades stating new integrated approaches and promoting ecological engineering technics and nature based solutions.

This talk will present the main scientific concepts and principles underpining good Ecosystem Restoration and focus on some ecological engineering technics commonly used in Ecological Restoration Projects : What are the less invasive technics used in ecosystem restoration ? How can we limit the residual environmental impacts du to the materials used in these kinds of projects ?

## Transformation des territoires : vers la sobriété et la neutralité carbone

**Nadège Blond** | LIVE - Unistra

Les changements globaux obligent tous les acteurs des territoires à revoir le fonctionnement de leur territoire, et ce dans leur ensemble (modes de vie, activités par secteur, productions, consommations, émissions, risques, représentation des risques, etc.) et à envisager des stratégies d'atténuation et adaptation aux aléas auxquels leurs territoires sont exposés. La zone Atelier Environnementale Urbaine (ZAEU) est un réseau de recherche pluridisciplinaire qui vise à étudier plus spécifiquement les socio-écosystèmes urbains (SESu). Les recherches sont co-construites avec l'Eurométropole de Strasbourg, interdisciplinaires, pour caractériser les dynamiques des SESu et envisager des trajectoires plus sobres en énergie, neutres en carbone, et globalement plus durables. L'intérêt de recherches interdisciplinaires sera discuté.

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