PHOENIX

COST ACTION CA19123

PROTECTION, RESILIENCE, REHABILITATION OF DAMAGED ENVIRONMENT

cost
EUROPEAN COOPERATION IN SCIENCE AND TECHNOLOGY

COST is supported by the EU Framework Programme Horizon 2020

+PHOENIX-

Cover page

Picture: Cloister and the water well, landmark symbol of the Faculty of Civil and Industrial Engineering, Sapienza University, Via Eudossiana 18, Rome.

The Faculty is located where the San Lorenzo in Panisperna old convent was built. The convent was built on the ruins of the *Domus Aurea*, which was emperor Nero's palace, and which is now the church of St. Peter in Chains. The Faculty was built around a beautiful Renaissance cloister (attributed to Giuliano da Sangallo), one of the most beautiful cloisters of Renaissance architecture in Rome. On the ground floor, the cloister has a rectangular porch with seven or eight arches supported by columns that are characterised by beautiful Ionic capitals that bear the crest of Della Rovere. At the centre of the courtyard there is a beautiful well, with an elegant octagonal plan sculpted by Simone Mosca, surmounted by a simple stand made of two pairs of columns that support a simple architrave with a cymatium, attributed to Michelangelo Buonarroti.

Photo by Paola Grenni.

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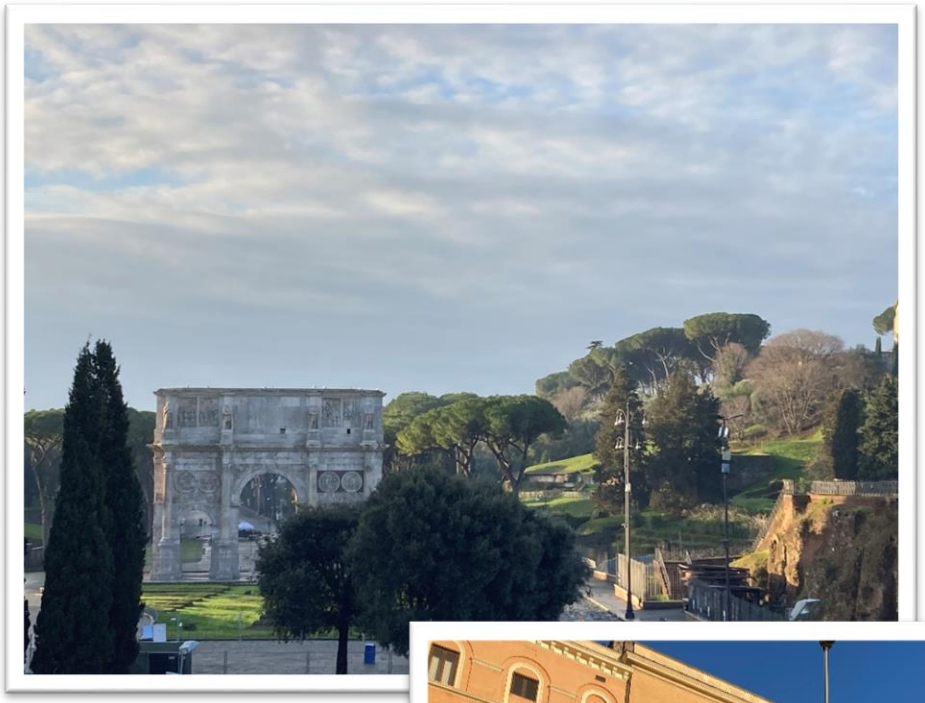
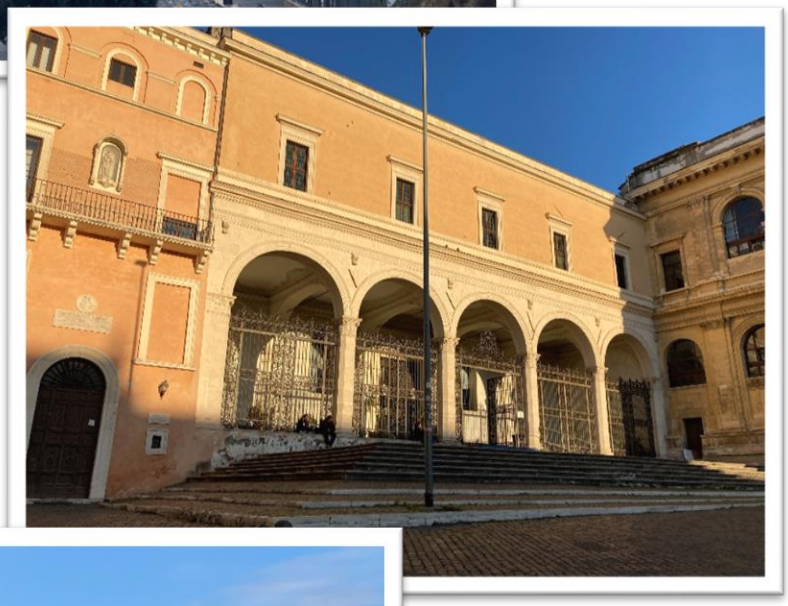
Proceedings of the 2022 Rome Meeting

19-21 January 2022

Edited by

Paola Grenni and Slaven Gašparović





Scientific and Organising Committee of the 2022 Rome Meeting PHOENIX COST Action CA19123 "*Protection, resilience, rehabilitation of damaged environment*"

Chairs of the Meeting

Andrea Pietrelli, Laboratoire Ampere, Université Claude Bernard Lyon 1, École Centrale de Lyon, France

Ioannis Ieropoulos, Bristol BioEnergy Centre (BBiC), Bristol Robotics Laboratory, T Block, Frenchay Campus, University of the West of England, United Kingdom[1]

Local organizers

Vincenzo Ferrara, Dept. of Information Engineering, Electronics and Telecommunications, University of Rome "La Sapienza" Rome, Italy

Domenico Borello, Mechanical and Aerospace Engineering Dept., University of Rome "La Sapienza" Rome, Italy

Conference Venue

Faculty of Engineering, Sapienza University of Rome, via Eudossiana 18, Rome, Italy

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[1]Ieropoulos is now at the University of Southampton, Bolderwood Innovation Campus, SO16 7QF, UK

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WG 3 - Environmental monitoring and sensing

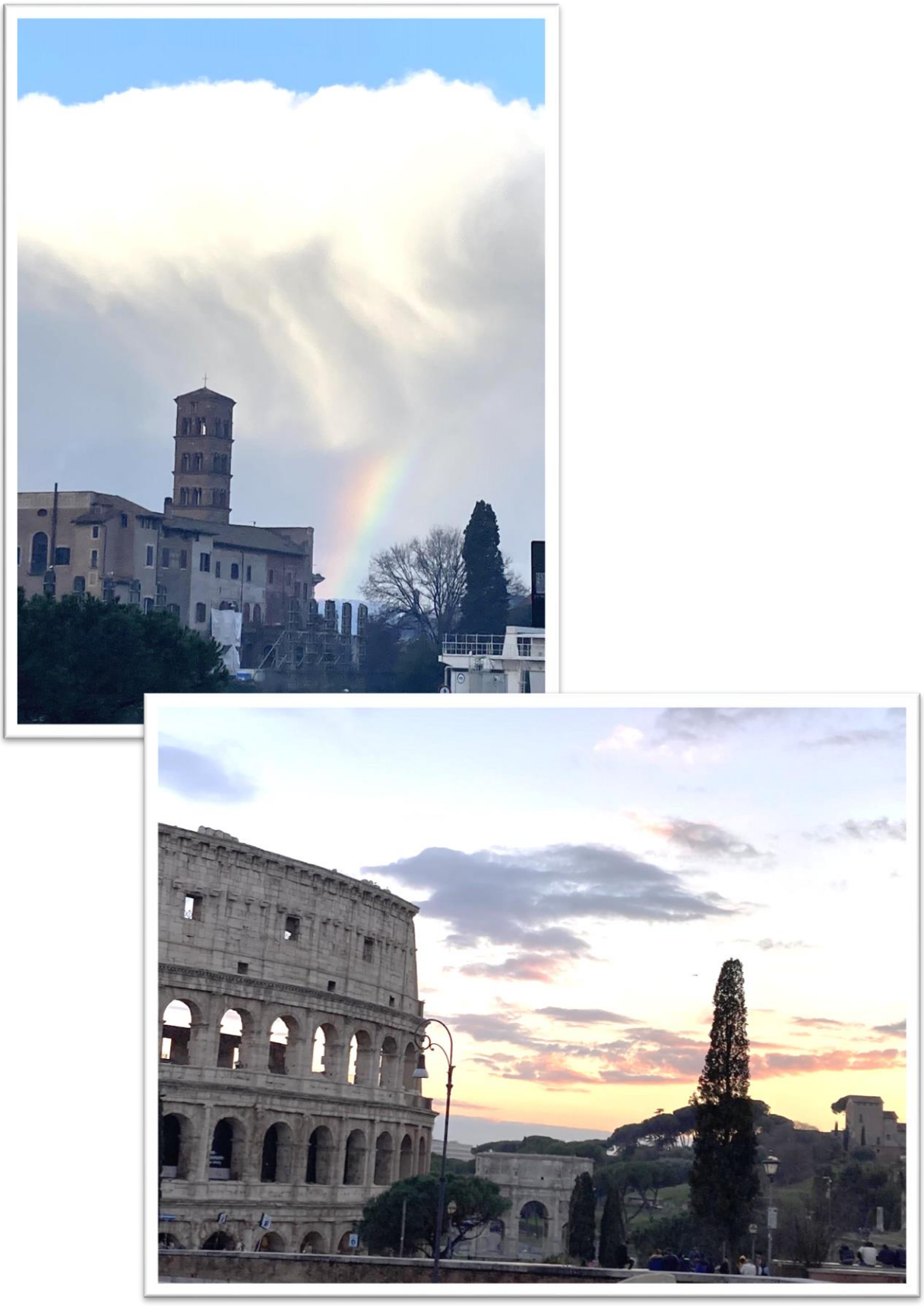
WELCOME

On behalf of the Organizing and Scientific Committee we are honoured to announce the organization of the COST Action CA PHOENIX 19123 meeting (PHOENIX Main Conference 2022) in Rome (Italy) from 19th to the 21st January 2022. After an exciting start to our project, a number of productive online meetings, and more importantly several successfully completed short term scientific missions, during one of the most challenging times in human history with the Covid-19 pandemic, we are delighted to host the first official, main conference. We will address the objectives of the COST Action "Protection, Resilience, Rehabilitation of damaged environments", with a focus on remediating and repairing our environment, using naturally powerful microbes inside bioelectrochemical systems.

The conference will include plenary talks by international experts as well as oral and poster presentations chosen from the abstracts submitted by our COST network of more than 300 members.

Rome is one of the most historic cities in the word located in Italy. Once the global centre of the Roman Empire, Rome is home to the Colosseum as well as to Gaius Cestius's Pyramid, which is more than 2000 years old and the only pyramid outside of Egypt. At this global epicentre, natural environments, such as "Lago Ex SNIA" have emerged from derelict constructions, once used for weapon manufacturing – quite a symbolic exemplar of natural comebacks and of course a case study environment for our COST Action. We are delighted to invite you to the PHOENIX 2022 Main Conference and look forward to welcoming you in Rome.

Andrea Pietrelli & Ioannis Ieropoulos
Chairs of the Meeting
Vincenzo Ferrara & Domenico Borello
Local organizers



Pictures: some beautiful views near the Faculty of Engineering, Sapienza University of Rome (Photos by Paola Grenni).

INTRODUCTION

The January Phoenix conference in Rome was an excellent opportunity for all of us to meet face-to-face and also on-line to explore new opportunities for collaboration. Several researchers participated in presence and on-line with their talk and poster presentations. This abstract book aims at summarising all the presentations performed and the first year of the Project activities.

Here we would like to briefly summarise the main aims of the project, and the different Working groups. In fact, the different posters and talks presented were divided with WGs. The main aim of the project is to connect people working in the framework of Bio-electrochemical systems (BESs) and their application for producing electricity from wastes or organic contaminants.

BESs, and in particular Microbial Fuel Cells (MFCs) are low environmental impact tools that exploit the biological activity of microorganisms naturally present in water and soils for pollutant reduction, recycling useful elements, synthesis of new products and production of electricity.
The activities of PHOENIX are related to the characterization of BES technologies and their implementation as bio-remediator, bio-sensors, and bio-reactors connected to sustainable urban planning, educational and socio-economic aspects. The integration of bio-technologies in the urban context is a key priority for appropriate rational urban planning and minimum environmental impact.
Different skills are connected in this pan-European project, from electrical engineering, microbial ecology, Educational and socio-economics aspects.

The working groups (WGs) are listed below:

WG1 – Educational and socio-economics aspect of environmental science for sustainable city planning
This WG supports the methodological and applicative aspects concerning the technology itself and the user's implications and impact qualification (in terms of costs vs gains) according to the deployment of technological devices, also focusing on the relationships between technological development, environment, urban planning and empowerment of local actors (groups of inhabitants, NGOs, etc.).

WG2 - Bio-Electrochemical Systems to reduce the environmental impact of pollutants and bioresource valorisation
The WG2 programs concern aspects like bioremediation techniques and surface science related to BESs, which can lead to environmental sustainability. Aspects that concern WG2 are electro remediation, bioremediation, bioprocesses, electromagnetic interactions on biofilm, BESs and electrodes materials, bioresource valorisation, electro-fermentation, biological interaction, water valorisation for coffee industry, drilling waste biodegradation, gene expression of microbial communities of MFCs, kinetic modelling of regulatory mechanisms of microbial communities involved in MFCs.

WG3 - Environmental monitoring and sensing
This WG focuses on the activities of monitoring and sensing, evaluating and exploring the different patches to exploit the energy converted from BESs and its sensing capabilities, in synergy with the other WGs

WG4 - Point-of-load
It focuses on the electrical management aspect of energy harvesting techniques with MFCs. Assuming as primary objective the improvement of electrical outputs performance and energy storage systems: develop MFC systems with higher than state-of-the-art power outputs, considering miniaturization of systems, increase in capacity and decrease in energy losses.

WG5 - Dissemination
The WG5 are preparing yearly dissemination and exploitation plans with the purposes of: a) boosting engineering, industrial and scientific research on BESs by sharing knowledge with scientific research communities and programming shared research programs; b) promoting private investments, levering on the innovative outputs of the Action and appealing emerging market; c) increasing biotechnology acceptance and spreading, networking between citizens, communities, academics, governments, integrating biotechnology and energy harvesting techniques in the urban texture, evaluating correct city planning.

Paola Grenni and Slaven Gašparović

MEETING PROGRAM

Wednesday 19.01.2022.

09:00 - 10:00 Welcome and Registration

10:00 - 10:30 Presentation of the PHOENIX Cost Action
Chair: Andrea Pietrelli
Co-chair: Ioannis Ieropoulos
Local Organisers: Vincenzo Ferrara and Domenico Borello

10:30 - 11:00 Coffee break

11:00 – 13:00 Plenary Session
Chaired by Andrea Pietrelli

Teresa Dillon
School of Art and Design, University of the West England, Bristol (UK)
In the Midst of Concrete Monters

Ferdinando Boero
University of Naples Federico II, Stazione Zoologica Anton Dohrn, CNR-IAS, Naples, Italy
It is the general's maximum responsibility to know the terrain thoroughly, which he must study as carefully as possible

13:00 - 14:00 Lunch

14:00 - 15:30 Short online poster presentation

15:30 - 16:00 Coffee break

16:00 - 17:00 Poster Session (Cloister)

17:00 - 17:30 WG workshops

Thursday 20.01.2022

09:00 - 09:30 Detailed presentation of the WG1 Coordinator (Rawad Chaker, Maître de Conférences en Sciences de l'Education, Université Lumière Lyon 2, ISPEF)

09:30 - 10:30
Maria Impedovo, ADEF, Aix Marseille Université, France, Task 1.1

Formal and informal education. Sustainable education, innovation, learning community

Minas Angelidis, National Technical University of Athens, School of Architecture, Department of Urban and Regional Planning, Greece, Task 1.2
Sustainable city policies and planning and implementation of sustainable city actions in European Union with emphasis on the role of technologies

10:30 - 11:00 Coffee break

11:00 – 12:30 Oral presentations WG1
Chaired by Rawad Chaker

Slaven Gašparović University of Zagreb, Faculty of Science, Department of Geography, Croatia
Geography and urban planning: the importance of social aspects in sustainable urban planning for resilient cities and environment protection

Stefano Simoncini, Sapienza University of Rome, Italy
LABSU for Mentelocale: Collaborative Mapping for Green Areas Masterplan of Centocelle (Rome)

Shiri Zemah-Shamir, School of sustainability, Reichman University (IDC Herzliya), Israel
Economic aspects of urban planning: environmental-economic perspective and tools

Zvi Weinstein, Israeli Smart Cities Institute, Israel
Community Garden - A Tool to Enhance Environmental Citizenship

Discussion

12:30 - 14:00 Lunch

14:00 - 14:30 Detailed presentation of the WG2 Coordinator (Argyro Tsipa, Department of Civil and Environmental Engineering, University of Cyprus, Nicosia, Cyprus)

WG2 overview and Bioremediation and circular bio economy at EmBIOSysTech Environmental Biotechnology laboratory at University of Cyprus

14:30 - 15:30 Oral Presentations WG2
Chaired by Argyro Tsipa

Snežana Maletić, Srđan Rončević, University of Novi Sad, Faculty of Sciences, Republic of Serbia
Overview of the bioremediation research at University of Novi Sad Faculty of Science

Paola Grenni, Water Research Institute, National Research Council (IRSA-CNR) Monterotondo, Rome, Italy
Identification of the soil microbial community structure of fuel cells amended with compost

Grzegorz Pasternak, Laboratory of Microbial Electrochemical Systems, Faculty of Chemistry, Wroclaw University of Science and Technology, Poland
Surface modification of polyvinyl/ceramic microbial fuel cell membranes with rhamnolipid biosurfactant for improved power generation

Szymon Malinowski, Department of Construction Materials Engineering and Geoengineering, Faculty of Civil Engineering and Architecture, University of Technology, Poland
Plasma polymerization in biosensor construction

15:30 - 16:00 Coffee break

16:00 - 17:30 Oral Presentations WG2
Chaired by Argyro Tsipa

Petros Samaras, Laboratory of Technologies for Environmental Protection and Food Byproducts Utilization, Department of Food Science and Technology, International Hellenic University, Sindos Thessaloniki, Greece
Energy upgrading of municipal wastewater treatment plants by anaerobic digestion of side products

Marika Kokko, Tampere University, Finland
Microbial electrosynthesis in fluidized and fixed granular activated carbon bed reactors

Catarina Paquete, Instituto de Tecnologia Química e Biológica António Xavier, Universidade Nova de Lisboa, Portugal; **Sebastià Puig**, LEQUiA, Institute of the Environment, University of Girona, Spain
Bio-electrochemical dialogues for water remediation

Discussion

20:00 - 23:00 Social dinner

Friday 21.01.2022

09:00 - 09:30 **Detailed presentation of the WG 3 Coordinator** (Fabien Mieyeville, JRU CNRS 5005, Univ Lyon, INSA Lyon, Universityé Claude Bernard Lyon 1, Ecole Centrale de Lyon, France)

09:30 - 10:30 Oral Presentations WG 3
Chaired by Fabien Mieyeville

Gordana Kaplan, Eskisehir Technical University, Turkey
Remote Sensing for Protection, Resilience, Rehabilitation of Damaged Environment

Linda Grinberga, Latvia University of Life Sciences and Technology, Latvia
Nutrient mitigation practice in constructed wetlands in Latvia

Arben Gjukaj, Faculty of Electrical and Computer Engineering, University of Pristina, Republic of Kosovo
Advantages of using new technologies in the production of renewable energy, recultivating degraded lands with generation systems with solar panels (photovoltaic systems) - Kosovo Case

Fabien Mieyeville, JRU CNRS 5005, Univ Lyon, INSA Lyon, Universityé Claude Bernard Lyon 1, Ecole Centrale de Lyon, France
Water Monitoring through MFC powered devices: stakes and potential

10:30 - 11:00 Coffee break

11:00 - 12:30 Oral Presentations WG 3
Chaired by Fabien Mieyeville

Vincenzo Ferrara, Department of Information Engineering, Electronics and Telecommunications, Sapienza University of Rome, Italy
MFC as energy harvesting for powering WSNs

Giampiero de Cesare, Department of Information Engineering, Electronics and Telecommunications, Sapienza University of Rome, Italy
Transparent Thin Film Heater with Integrated Temperature Sensors for Thermal Treatment of Biomolecules in Lab on Chip Systems

Giampiero de Cesare, Department of Information Engineering, Electronics and Telecommunications, Sapienza University of Rome, Italy
Integrated Optoelectronic Device for On-Chip Detection of Fluorescent Molecules

Discussion

12:30 - 14:00 Lunch

14:00 - 14:30 **Detailed presentation of the WG4 Coordinator** (Domenico Borello, Mechanical and Aerospace Engineering Dept., Sapienza University of Rome, Italy)

14:30 - 15:30 Oral Presentations WG4
Chaired by Domenico Borello

Chyntol Kanhimbe, University of Birmingham, United Kingdom
Low-cost Raspberry Pi controlled Microbial Fuel Cell monitoring system

Alba Ceballos Escalera Lopez, LEQUiA Institute of the Environment, University of Girona, Spain
Bioelectrochemical nitrogen removal from contaminated waters: hints and tricks

Jesús David Ramírez Páez, Univ. Lyon, Ecole Centrale de Lyon, INSA Lyon, Université Claude Bernard, Lyon 1, CNRS, Ampère, UMR5005, France
Galvano-Fenton technology in situ production of hydrogen peroxide

Grégory Bataillou, Univ. Lyon, Ecole Centrale de Lyon, INSA Lyon, Université Claude Bernard, Lyon 1, CNRS, Ampère, UMR5005, France
Impact of sharing soil when stacking Plant Microbial Fuel Cell for electricity production with Lobelia Queen cardinalis

15:30 - 16:00 Coffee break

16:00 - 17:30 Oral Presentations WG4
Chaired by Domenico Borello

Gabriele Gagliardi, DIMA, Sapienza University of Rome, Italy
Terrestrial microbial fuel cells: An effective tool for the remediation of contaminated soil and energy production

Discussion

List of poster presentations (presented on-line or in presence)

WG1

Claire Polo, ECP, Université Lumière Lyon 2, Lyon, France
Towards an Effective Framework for Environmental Education: A Literature Review to Point Key Results and Challenges

Mona Khalife, Lebanese University, Beirut, Lebanon
Eco-citizenship education for Lebanese high school students. Analysis of the effects of the educational system, the associative movements and the social media networks

Lili-Ann Wolff, University of Helsinki, Helsinki, Finland
SveaSus Sustainable World heritage Learning though a phenomenon-based approach

Jinan Karameh Shayya, Lebanese University, Beirut, Lebanon
Lebanese association for educational studies (LAES) scientific program

WG2

Aleš Berlec, Department of Biotechnology, Jožef Stefan Institute, Ljubljana, Slovenia
Biotechnology and genetic engineering of Gram-positive bacteria

Aleksander de Rosset, Laboratory of Microbial Electrochemical Systems, Faculty of Chemistry, Wroclaw University of Science and Technology, Wroclaw, Poland
Modified Polyvinylidene Fluoride Nanofiber Membranes in Microbial Fuel Cell

Pedro N. Carvalho, Department of Environmental Science, Aarhus University, Roskilde, Denmark; WATEC - Centre for Water Technology, Aarhus University, Aarhus C, Denmark
Controlling the emission of antibiotics into aquatic systems by hybrid bioelectrochemical constructed wetlands

Christian Vogelsang, Norwegian Institute for Water Research, Oslo, Norway
Improved hydrogen production in MECs by introducing gel-entrapped anodes – plans and current status

Sónia G. Barbosa, CEB - Centre of Biological Engineering, University of Minho, Braga, Portugal
Application of carbon nanomaterials in CH4-producing bioelectrochemical systems

WG3

Juris Burlakovs, University of Latvia, Latvia
Methane degradation and sensor measurements necessity for biocovers

Marina Šćiban, *University of Novi Sad, Faculty of Technology Novi Sad, Serbia*
Environmental monitoring and sensing: Core Competences

Aleš Lapanje, Laboratory for Colloid Biology, Department of Environmental Sciences, Jozef Stefan Institute, Ljubljana, Slovenia
"LEGO-microbes" - a new approach for building a microbial structures for successful remediation of the environment

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Rome, 19-21 January 2022

PLENARY LECTURES

Chairs: *Andrea Pietrelli & Ioannis Ieropoulos*

In the Midst of Concrete Monsters

Teresa Dillon

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School of Art and Design & Digital Culture Research Centre
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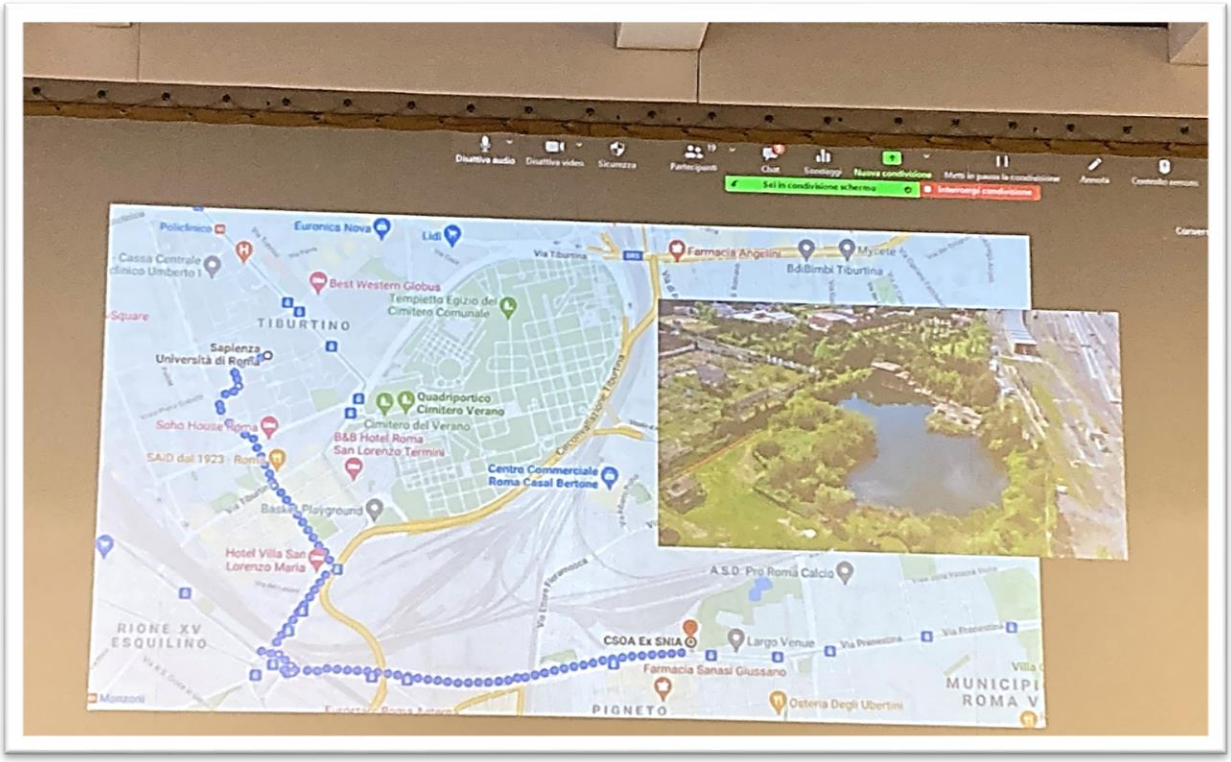
ABSTRACT

In the midst of concrete monsters
This water now reflects the cloud
It's nature that fights
This neighborhood is less dark
In the midst of concrete monsters
The lake is a dream come true
It's nature that resists
Rome is less dark tonight

The opening title of this presentation is taken from the hip hop group Assalti frontali and the rock band Il Muro del Canto's song "*Il lago che combatte* (The lake that fights)", which was released in 2014 and formed part of the activist and community movement to save the *Lago Ex SNIA*, a lake in the Pigneto-Prenestino neighborhood of Rome. The lake plays a central role in the Pigneto-Prenestino neighborhood history of urban renewal and speculation, taking its name from the former chemical and textile SNIA Viscosa factory, where it is situated.
Operating from 1923 until its closure in 1954-55, the factory used a highly toxic carbon disulfide (CS_2) process to manufacture rayon, resulting in the soil and water in the area becoming poisonous. After its closure, the factory and the area were largely left to nature and a rewilding process occurred, which with time has enabled the landscape to heal. However, in the 1970s, part of the site was sold by the local council to a private property and construction company owned by the tycoon Antonio Pulcini, who in the early 1990s began digging up the site in an attempt to build a shopping centre and car park. During construction the company hit an underground aquifer,

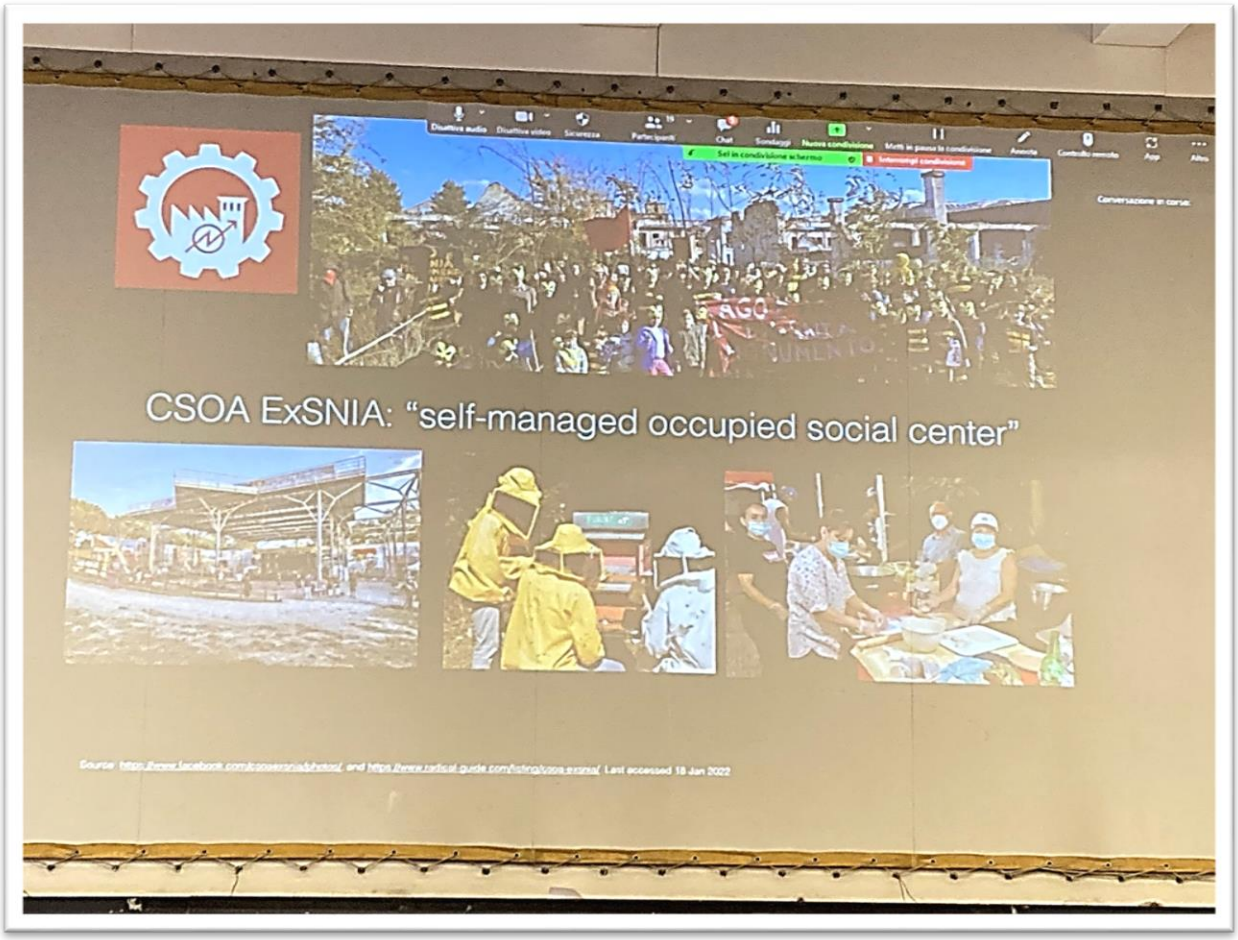
resulting in the flooding of the area and the creation of the now infamous lake. As Pulcini and the municipality of Rome wrangled over the site's zoning and flooding, local people began to care for and use this "wild" urban space. Such activities over time led to a number of rich and expansive community activities, with local activists, taking over parts of the factory situated outside of Pulcini's land and transforming them into various social, education and cultural centres. With the cultural centre Ex-SNIA becoming a central hub in the fight to democratise the whole area and turn it into a public park. It is from this base at *Ex SNIA* that local communities along with others continue to work tirelessly to retain the lake and the park as a public good.



Ex SNIA lake

In 2021 the Berlin-based group Soft Agency (who the author is a member) were invited by the Copenhagen Architecture Festival's to curate a collection for our Journal that would contribute to expanding our understanding of the notion of 'care' in relation to architecture and urban space. For this collection titled "Landscapes of Care" the author (Dillon) wrote a short paper on this history and activism of *Lago Ex SNIA* and its unique urban context as well as the proposed interest in the site by members of the COST Action Phoenix

group, including Professor Ioannis (Yannis) Ieropoulos, Southampton University and Dr. Andrea Pietrelli, Centrale de Lyon and Sapienza University of Rome. In keeping with their project, specific attention was paid to the role that microbial fuel cell (MFC) and bio-electrochemical systems (BES) can play in a more expanded notion of caretaking. Building on the paper for the Copenhagen Architecture Festival, the presentation at the COST Action Phoenix meeting in January 2022 in Rome, further expands on the idea of MFC's and BES's as co-caretakers, who alongside humans could provide ways to imagine more radical approaches to land, soil and water remediation.



To support this discussion, the work drew on the feminist technoscience scholar Michelle Murphy's notion of "chemical infrastructure" and anthropologist Adriana Petryna's term biocitizenship. Murphy's chemical infrastructure refers to how toxics in soil for example result from the accumulated result of hundreds of years of industrialized production. The impacts of which often then to sit outside of scope of regulation, or to be more

specific easily identifiable regulation. With biocitizenship relating in Petryna's case to her work on how people in Ukraine took their body's response in relation to radiation into account, when demanding entitlements from the state in the wake of Chernobyl.
Environmental humanities scholar Miriam Tola, who wrote about the *Lago Ex SNIA* site, uses Murphy's historical approach to "chemical infrastructure" in her discussion of the legacy impacts of chemical toxicity on the residents of Pigneto-Prenestino neighbourhood and the associated narratives and positioning from within and outside of the community. This alongside Petryna's concept of biocitizenship provides further framing for how MFC's and BES's could further expand our notion of such human-chemical-landscape entanglements. With speculations addressing how such concepts, alongside interdisciplinary perspectives from engineering, spatial practices, art and the environmental humanities could expand every day, public understandings of MFC's and BES's in co-creating creating less extractive and energy intensive, restorative futures.

The full edition of the aforementioned paper for the Copenhagen Architecture Festival can be found here: https://www.cafx.dk/post/in-the-midst-of-concrete-monsters. Many thanks to the COST Action Phoenix for the opportunity to attend the Rome meeting and to architects, Marco Gissara and Lorenzo Romito for their time, sharing's and tour of *Lago Ex SNIA*.

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"IL LAGO CHE COMBATTE" (2014), Assalti frontali & Il Muro del Canto. https://www.youtube.com/watch?v=Dcb_Thrq2P8 extract and translation taken from "The Curious Case of Rome's Rebel Lake", Lidija Pisker (2021), Italics Magazine: https://italicsmag.com/2021/04/06/the-curious-case-of-romes-rebel-lake/ (Last accessed July 29, 2021).

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It is the general's maximum responsibility to know the terrain thoroughly, which he must study as carefully as possible

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ABSTRACT

The title is taken from Sun Zu's *The art of war*. Ecology studies "the terrain" in which we conduct all our activities: the environment. Charles Darwin used the word "war" in his book On the Origin of Species: *What a struggle between the several kinds of trees ... what war between insect and insect... between insects, snails, and other animals with birds and beasts of prey... all striving to increase, all feeding on each other or on the trees and their seeds and seedlings...*

Humans are at war with nature so as to gain as many resources as possible (the natural capital). The "hostile" species are exterminated, whereas those that satisfy our needs, promoting the growth of the economic capital, are tended. This war against nature altered the ecosystems to such an extent that they are failing in providing crucial resources for our well being. We won many battles but we cannot dream to win a war against nature. If we fight nature, we fight against ourselves, since our life is impossible without the rest of nature.

This simple truism is becoming increasingly accepted and Europe is planning for an ecological transition that should lead to a harmonic relationship between us and the rest of nature. The transition requires that we move from a given state to another, abandoning a dangerous terrain so as to reach a safer one.

The label "ecological" assigned to the transition implies that ecology is given a paramount position: its current prominence is simply due to the fact that, so far, it has been disregarded. All concerns about the integrity of nature have been, and often still are, considered as an obstacle to progress and economic growth. Economics has been the leading form of knowledge when decisions are taken. The growth of the economic capital, often in terms of GDP, is the goal of all political decisions. Ecology teaches that if the economic capital

grows, then the natural capital degrows. And, at a certain point, nature fails in providing the goods and services that are vital for us. Economy cannot growth to the infinite: When the natural capital is compromised, the economic capital collapses.

Technological advances boost economic growth but these must be developed while considering the impacts on the integrity of the natural capital. Plastic revolutionised our ways of production but, now, the oceans are turning into a plastic soup! Cleaning up the remnants of our activities would cost more than the gains we obtained by carrying them out: bad ecology leads to bad economy.

The ecological transition calls for knowing the environment very well (ecology) so as to develop economic and technological strategies that will not spoil it. The ecological transition, then, is a real revolution in the way we conduct our actions. Technologists and economists will still design the "solutions" to our "problems", but these must be carefully evaluated by ecologists in order to predict their possible impacts on the integrity of natural systems. The collaboration of ecologists with technologists and economists will lead to sustainable ways of life. Instead of moving war against nature, we must live in peace with it.

***Keywords**: Ecology, Technology, Economics, Ecological Transition, Sustainability*

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The thoughts expressed here are expanded in the following documents:

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WG1
Educational and socio-economics aspect of environmental science for sustainable city planning

Chair: Rawad Chaker

Formal and informal education. Sustainable education, innovation, learning community

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ABSTRACT
The context of this project is the project PHOENIX. The project proposes to build a network of sustainable development based on innovative technology. Inside this project, we question formal and informal education about sustainable education inside the consortium. In particular, WI contributed to Environmental education and its role in the pedagogy/didactic for students (future actors of a green revolution), teachers, and citizens (the society itself), informal, informal and non-formal education (Irwin & Wynne,1996).
About formal education, the focus is to introduce students and teacher-students curriculum transformation with a focus on sustainable development. About Teacher education, it is widely national oriented, and some policy issues arise in international higher education curricula (Barthes, 2022). The professional development of teachers about sustainable development could be questioned in an international orientation, finding shared spaces for dialogue. The international collaborative project between researchers and teacher-educators (Barthes & Lange, 2018) and teacher in-service - proposed in Phoenix - could foster teachers' critical and reflective thinking in becoming aware of practical actions through global education. The Teacher standards of some representative partners in the consortium will also be discussed about the European Sustainability Competence Framework (2021) -Bianchi (2020). Research questions are: *How much is current teacher education aligned to sustainable development UNESCO Goal 2030? How could innovative international collaborative projects about sustainable development be promoted in current teacher education? How are teacher-students involved in formal or informal local discussion communities about sustainable development?.* Parallel investigation will be proposed on primary and secondary curricula.
About non-formal education, the research aims to contribute to education for environmental citizenship from a comparative European perspective. Environmental education, education to sustainability, and education in a

time of Anthropocene are connected to the complex knowledge issue. In a socio-scientific context, we analyse different knowledge uses and knowledge productions, innovation and learning communities in environmental education. We analyse cases studies concerning phoenix implementation and its social acceptance related to local contexts. We illustrate and discuss the evaluation of types of knowledge used in environmental education and sustainability projects and analyse the power-related components of knowledge use. The case studies are compared, and conclusions are drawn in the final part. About informal education, we will value with surveys the project's impact on the stakeholder of the consortium.

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Working Group 1

Formal and informal education

Sustainable education, innovation, learning community

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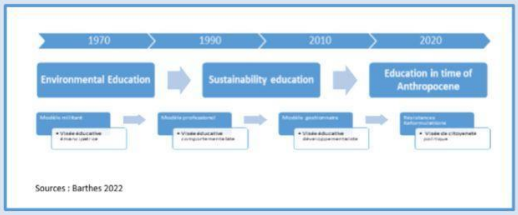
Formal education: Teacher education

There is an increasing need for teacher education to meet the emerging challenges of increased international interconnections, like the **Unesco Sustainable Development Goal.** Recent professional development literature stresses the role of collaboration in the increasing interconnected but fragile nature of global society. This contribution aims to discuss the a) space of **Goal 7 Energy** in teacher education standards; the implication on teacher education of innovative international collaborative projects related to energy; teacher involvement in glocal communities elated to the topic.

- *How much is current teacher education aligned to sustainable development UNESCO Goal 2030?*
- *How could innovative international collaborative projects about sustainable development be promoted in current teacher education?*
- *How are teacher-students involved in formal or informal glocal discussion communities about sustainable development?*

Environmental education, education to sustainability, anthropocene education

The aim of the research is to contribute to education for environmental citizenship in a comparative european perspective. Environmental education, education to sustainability, and education in time of anthropocene are connected to the complex issue of knowledge.



In socio-scientific context, we analyse different knowledge uses and knowledge productions, innovation and learning communities in environmental education.

We analyse cases studies concerning phoenix implementation and its social acceptance related to local contexts. We illustrate and discuss the evaluation of types of knowledges used in environmental education and sustainability projects, as well as analysing the power-related components of knowledge use. In the final part the case studies are compared and conclusions are drawn.

NEXT STEP:

- INSPE de Nantes, 2022 - *Conférence européenne sur la formation des enseignants et des équipes éducatives à l'éducation au développement durable*
- WEEC Prague

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Sustainable city policies and planning and implementation of sustainable city actions in European Union with emphasis on the role of technologies

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ABSTRACT

Scope of the presentation is not only to contribute to the discussion of sustainable urban planning but also to feed the discussion on the links of WG1 (Balance and Planning) of the PHOENIX Action with the other WGs. Objective of the presentation is to explore the strategies and objectives towards sustainable and resilient cities and especially the implementation of city actions and their environmental, social, and economic impact.

First, we approach the concept of urban sustainability on the base of documents of United Nations (UN), EU, OECD and the scientific community. Urban sustainability is multi- disciplinary, consequently is approached differently according to different disciplines.

Therefore, we considered useful to suggest a quite generally accepted conceptualization based on the UN (and EU) 2030 Agenda which proposes 17 Sustainable Development Goals (SDGs) - Figure 1.

Figure 1: UN Sustainable Development Goals (2015)

While the SDG 11 / “Sustainable cities and communities” of this Agenda is considered as the basis of urban sustainability, other SDGs contribute

insights useful to conclude to a global / holistic urban sustainability' approach which could serve as a framework of research activities (as in PHOENIX) and city actions. To further operationalize this framework, we propose incorporating into it the notions of smart city, green city and just (inclusive) city. It goes without saying that this framework should be seen as open and stimulating critics.

Further to the above, we could stress, even concisely here, that PHOENIX which aims to promote the protection, resilience, rehabilitation of damaged environments, because it emphasizes on technologies' driven and, simultaneously, nature-based solutions to rehabilitate damaged areas lies at the forefront of the urban sustainability research.

Second, we examine how EU has promoted smart, green and just urban development for most through the support of numerous innovative urban actions – see, indicatively, a Map of 650 European cities participating in European and global city initiatives related to climate-change adaptation - Figure 2.

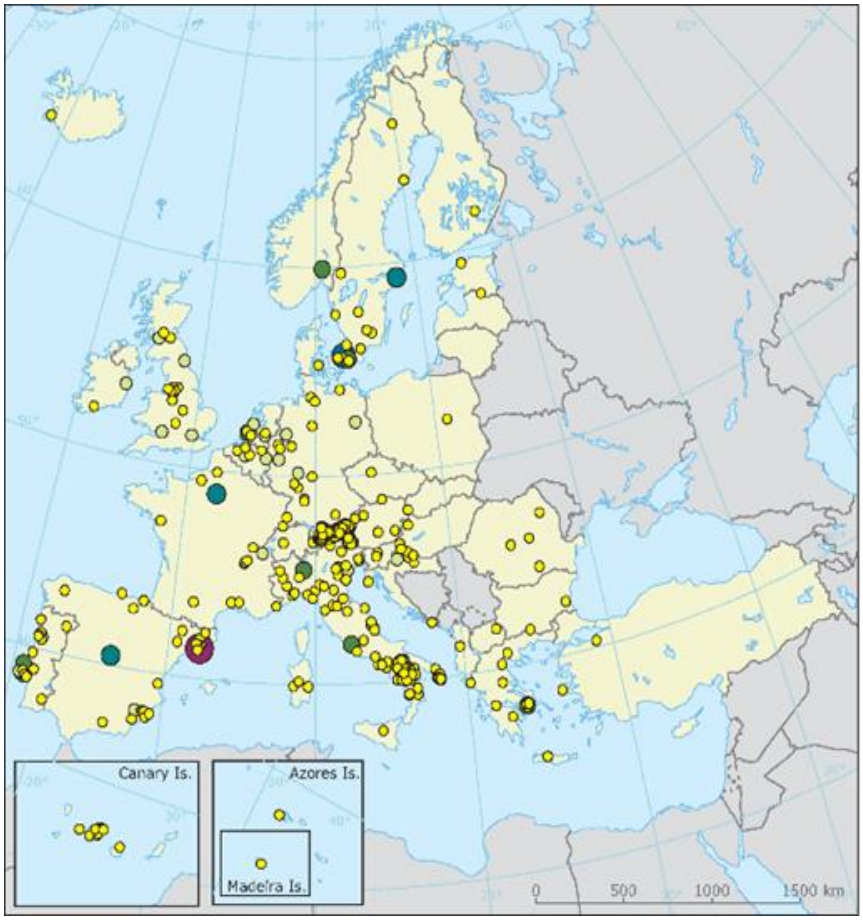

Figure 2: Participation of European cities in European and global city initiatives related to climate-change adaptation

Third, we make a critical presentation of EU urban agendas as well as of the EU "Green strategy" and the "Next Generation EU" instrument' objectives and

tools aiming to promote urban sustainability. This is now only a positive "declaration of intend".

Concluding, we stress that appropriate dissemination of the findings of urban sustainability research could considerably help city stakeholders to achieve positive «real effects" from relevant actions to be implemented. Inversely, PHOENIX could profit from a continuous interaction with a network of cities interested in the sustainable rehabilitation of damaged urban areas.

Geography and urban planning: the importance of social aspects in sustainable urban planning for resilient cities and environment protection

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ABSTRACT

One of the core tasks of geography is urban planning. Urban planning is a complex field in which physical and social aspects are interrelated: planning of transportation, economics, housing, land use, environmental and energy issues, urban sprawl, etc. As the number of people living in cities is rapidly increasing, geography considers sustainable urban development as one of the most important challenges facing both local and global communities in the coming decades. Well-planned cities and good local decisions are essential factors in improving the global and local environment, as well as a means of improving the liveability of cities at the local level. Geography and urban planning use many different methods and approaches for this research, both physical and social.

The social aspects are closely related to environmental patterns. They focus on individuals, social groups, their interactions, and their spatial and organisational arrangements, which are key factors for understanding cities and their urban regions, as well as the use of the whole environment and natural systems, which could be a crucial factor for sustainable urban planning. For the purpose of this research, two aspects are presented.

The first is the aspect of education, where the longitudinal survey was conducted among the students at the University of Zagreb. The survey was related to their knowledge of environmental citizenship, their knowledge and perception of environmental rights and duties, and examples of positive and negative environmental practises, especially in relation to some key areas related to the environment, in particular sustainable transport and tourism. Students showed high perceptions of environmental issues, but indifferent or low awareness toward present practices in tourism and transport and low willingness to change their behaviour in the future.

GEOGRAPHY AND URBAN PLANNING

The main motive of the survey was Environmental Citizenship, one of the leading concepts of pro-environmental actions and awareness of people in their daily lives and the responsibility of stakeholders for decisions that have a direct or indirect impact on the environment.
On the other hand, place-making and landscape meaning can contribute to ecological and environmental justice by making people aware of their surroundings and how their activities contribute to environmental health. For example, green spaces are symbolic of a time and place and reflect cultural and social norms, including attitudes and behaviours toward nature. In addition, the habit of using green spaces is becoming more prevalent. Therefore, the survey was conducted to gain insights into the recreational function of green spaces and the habits of visitors in the City of Zagreb at three different green spaces: a park in the city centre, a recreational and sports zone in the periphery of the city, a neighbourhood park in the

residential area. The research results show that there is a correlation between the different types of green spaces, their recreational functions and the reasons for choosing a particular green space for recreational purposes from the visitors' point of view. The results can contribute to a better understanding of visitor habits and mobilities directed towards certain types of green spaces, as well as to the process of urban planning and environmental protection.

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LABSU for mentelocale: Collaborative Mapping for Green Areas Masterplan of Centocelle (Rome)

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ABSTRACT

LABSU (Sapienza University of Rome) is an interdisciplinary working group of experienced scholars and young researchers, coordinated by Prof. Carlo Cellamare, interested in the development of action-research projects and urban studies training programmes, involving local communities in order to support and develop existing bottom up projects.

The project Mentelocale, realized thanks to a collaboration between the LABSU and Paolo Bulgari Foundation, aims to develop a bottom-up production model of territorial knowledge that effectively supports local initiatives and projects of active citizenship networks and movements.

In the territory of the eastern Rome, we are using digital and critical tools and processes in order to co-design with inhabitants a bottom-up masterplan of an ecological network surrounding the neighbourhood of Centocelle.

The contribution aims to illustrate the research and action of LABSU and, specifically, the features and results of Mentelocale project in eastern Rome (see Figures 1 and 2).

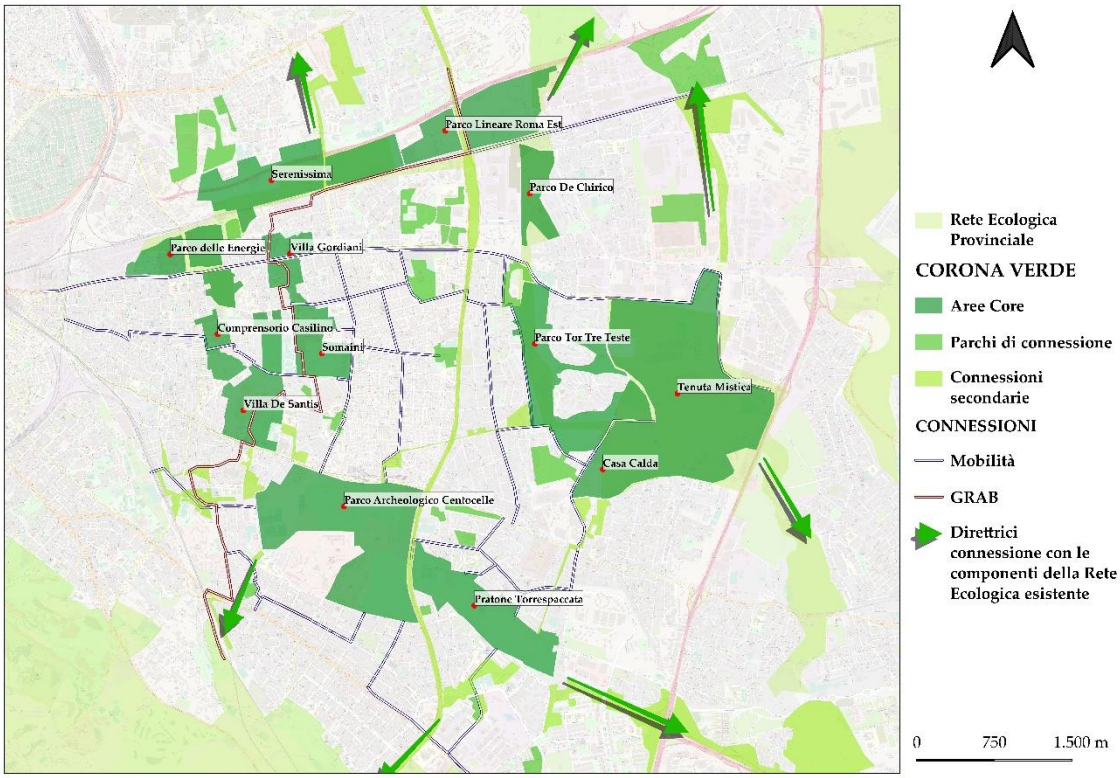

Figure 1. Mentelocale project in eastern Rome (Centocelle area).

Economic aspects of urban planning: environmental-economic perspective and tools

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ABSTRACT

Economic consequences, both at community and territorial levels and quantification and valuation of the negative and positive externalities are important in order to learn about potential urban planning, in general, or applying NbS (Nature based Solutions) interventions in urban ecosystem as green infrastructure, in particular. In order to explore, explain and engage stakeholders and policymakers, valuation of the socio-economic effects are important.

I will present Social Cost-benefit analysis that can be conducted of different projects, and social aspects of the potential applications and the use of Ecosystem services Hot Spots.

In addition, I will present a case study regarding valuation of an Urban Natural Resource with an Economic-Ecological Component in Tel Aviv. Our study examined the added value of Edith Wolfson Park as an urban natural resource with an economic-ecological component. We learnt that the park reduces noise by about 0.15823 decibels on average per meter of proximity to it, thereby increasing the economic value of an apartment located around it by about 9.25% on average. Another benefit derived from local climate regulation, by providing climate control and reducing temperature by about 2.216 Celsius degrees, which means saving electricity costs of about NIS 105.5 per household per year. As a natural resource, the park's aggregate impact on home prices up to 1.7 km is about 0.021 percent, and the calculation using the Hedonic price method showed an improvement of NIS 23,339 per apartment according to 2015 data. The data agrees that the park's added value is NIS 121,498 per year. That is, Edith Wolfson Park generates a positive ongoing annual benefit and affects the increase in the value of real estate.

Community Garden - A Tool to Enhance Environmental Citizenship

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ABSTRACT

The paper examines and analyses the community garden (CG) phenomenon among sites that are included in the Israeli National Project Renewal for Disadvantaged Neighbourhoods (PR) where Ethiopian immigrants settled. It examines them as both social practice and spatial expression and its environmental citizenship implications.

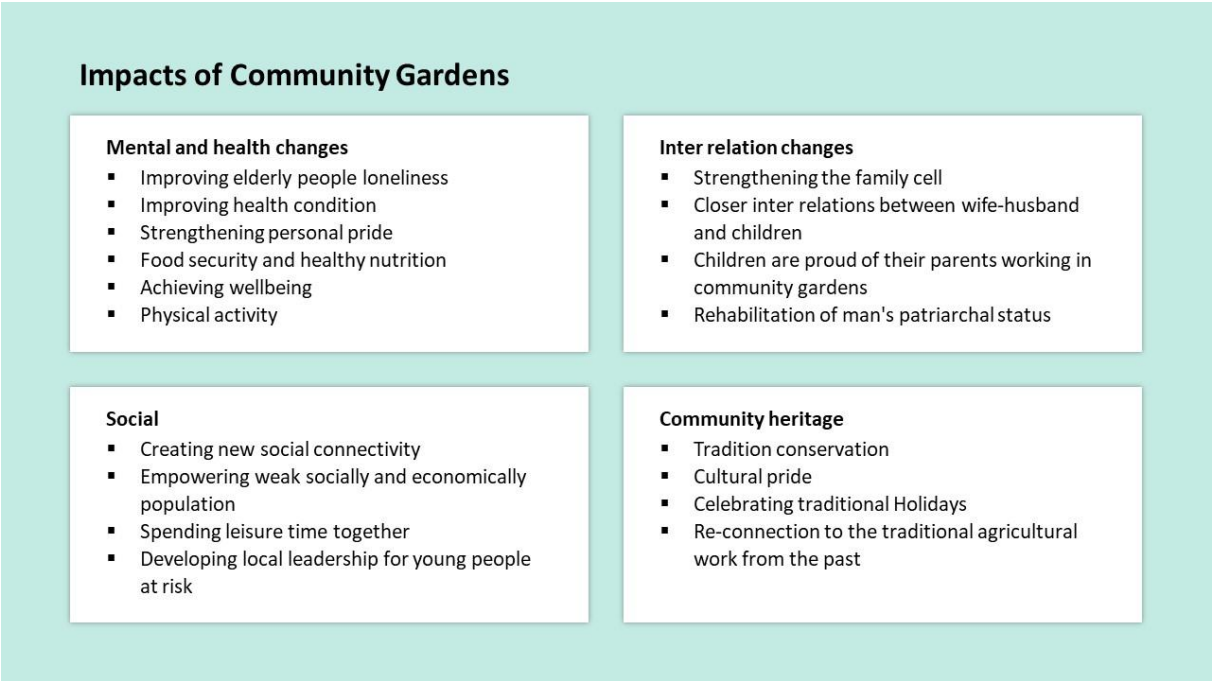
The case study relates to the Ethiopian population arrived to Israel during the big immigration waves in the early 1990's. People who came from traditional agricultural society, surrounded by natural landscapes and who have no knowledge about what urban environmental- life looks like, found themselves with no suitable employment while housed in urban neighbourhoods.

The Ethiopian belongs to a low-income stratum. While low socio-economic status and disadvantaged geographical locations is usually associated with a low level of political power of residents (Eisenberg, 2013), the production of CGs changed the status of these residents within the urban power structure. Through their activities in the CGs they produced themselves as aware, involved and indismissable urbanists (Eisenberg, 2018). Major part of their activity was invested to study how traditional agriculture values brought originally from Ethiopia could be adopted and dissimilated together with environmental citizenship values consist of education, competence, democracy and civic ecosystem of a modern era. CG programs appear to facilitate collective efficacy, the creation of social networks and improved organizational capacity that are particularly important to marginalized urban population such as elderly, immigrants and the poor (Armstrong, 2000; Kingsley, 2006).

CGs among Ethiopian immigrants were established in order to assist their absorption process in the city (Rinat, 2009), to prevent their excluded social status and to lead a process of mixed old and new environment citizenship (Arjen E. Buijs et. Al., 2016).

The initiative to occupy the elderly Ethiopians with CGs program is part of attempts to engage immigrants in urban activities. The literature (Imas

Agustina, 2011) argues that the gardens provide space for immigrants to meet other people and thus foster social inclusion, while in the same time preserve their cultural identity. In the Israeli case, it came from teams of the social workers, Joint Israel Organization, local and central governments, connected to PR aiming to build, to empower and to create healthy communities with strong social capital.
Ethiopians have faced many significant cultural difficulties and obstacles to cope with the Israeli way of life in transforming from a patriarchic society to an equal and modern one. CG became accepted solution in periods of social crisis and social problems that needed urgent amendment.
The data were obtained and based on the author long work experiences with Project Renewal, site visits, personal interviews with few dozens of social workers, environmentalists, Ethiopians who worked in community gardens, Project Renewal mangers, observing citizen participation meetings, literature reviewing and other stakeholders.
Findings show that CG enables dissemination of environment values in two ways: using traditional gardening values bottomed-up imported from Ethiopia and environmental citizenship from top-down while in Israel. Both have been met successfully in the Israeli CGs (Ina Filkobski, Yodan Rofe, Alon Tal, 2016).
Thus, community gardens are both a social tool and a vehicle to build new concept of sustainability and environmental citizenship.



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WG2
Bio-Electrochemical Systems to reduce the environmental impact of pollutants and bioresource valorisation

Chair: **Argyro Tsipa**

Bioremediation and circular bio-economy at the laboratory of Environmental Biotechnology (EmBIOSysTech), University of Cyprus

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ABSTRACT

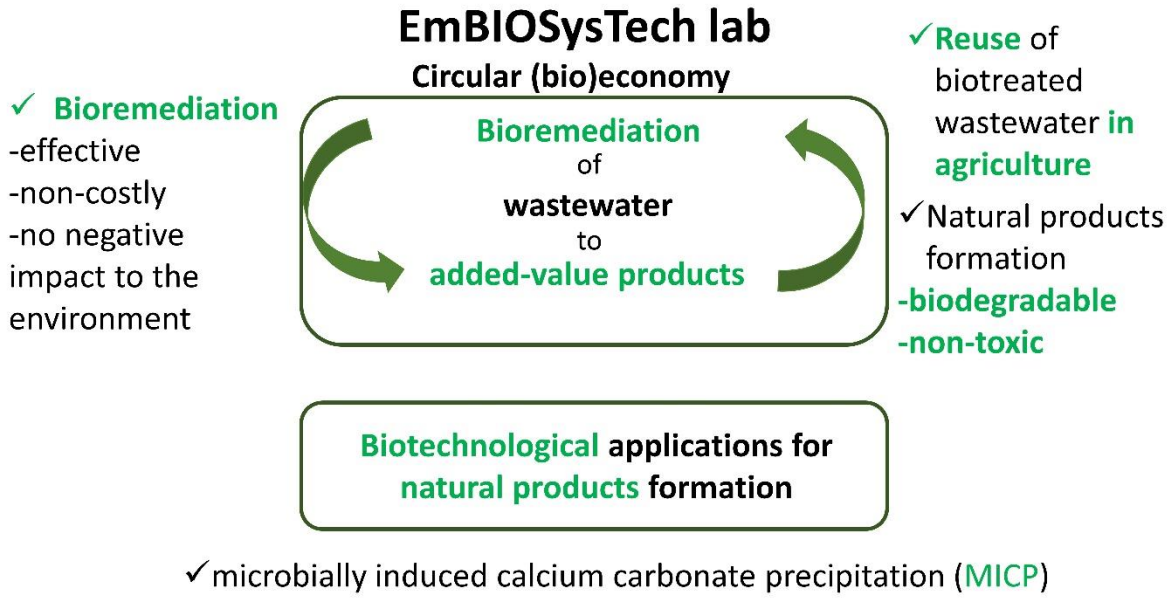
The laboratory of Environmental Biotechnology (EmBIOSysTech) at University of Cyprus, is working on the development, use and regulation of biological systems for (1) remediation of contaminated sites, and (2) development of environmental-friendly processes. Primary goal is the isolation of *in-situ* microbial communities or strains. These biological systems are the mean to achieve efficient biological treatment of different types of wastewater such as oily or seafood processing wastewater.

Upon use of oily wastewater, the % COD removal can reach up to 90% using *Pseudomonas citronellolis* 620C strain, which was isolated in the lab. *Ex-situ* biodegradation of oily wastewater results in formation of added-value products such as biosurfactants and medium chain length polyhydroxyalkanoates (mcl-PHA), thus contributing to circular bio-economy. The biosurfactant is also an antimicrobial agent able to deactivate several bacterial pathogens. Upon use of saline non-sterile seafood wastewater (SFW), several consortia were isolated dominated by either *Pseudomonas* or *Aeromonas* species. Consortia biodegradation potential using 20 and 80% (v/v) SFW reached % COD removal up to 89%. The consortia are salt-tolerant enhancing biological treatment and resulting in significant reduction of salt content (up to 92%). The biotreated SFW supernatant could be reused in agriculture as the germination index (GI) of lettuce and tomato seeds was higher than 50%. Thus, the biological treatment may also contribute to circular bio-economy.

Furthermore, our lab has isolated bacteria able to biomineralize calcium carbonate ($CaCO_3$). Calcium carbonate ($CaCO_3$) is the mineral component of limestone which is mainly used as construction aggregates, and in lime and

cement production. *Arthrobacter chrystallopoietes*, *Bacillus licheniformis* and *Micrococcus luteus* are the species isolated with the first being the most promising. After 8 days of culture, $CaCO_3$ reached 2.3 mg/ml production outperforming the rest. Biomineralization of CaCO3 using *Arthrobacter chrystallopoietes* was applied to natural Cypriot stones such as Gerolakkos and Lympia. After 15 days of biotreatment, water and drilling resistance were increased showing promising potential for conservation of old buildings made by these stones.

To sum up, EmBIOSysTech lab uses natural microorganisms and biological systems for bioremediation and production of compounds, which are biodegradable and non-toxic for the environment.



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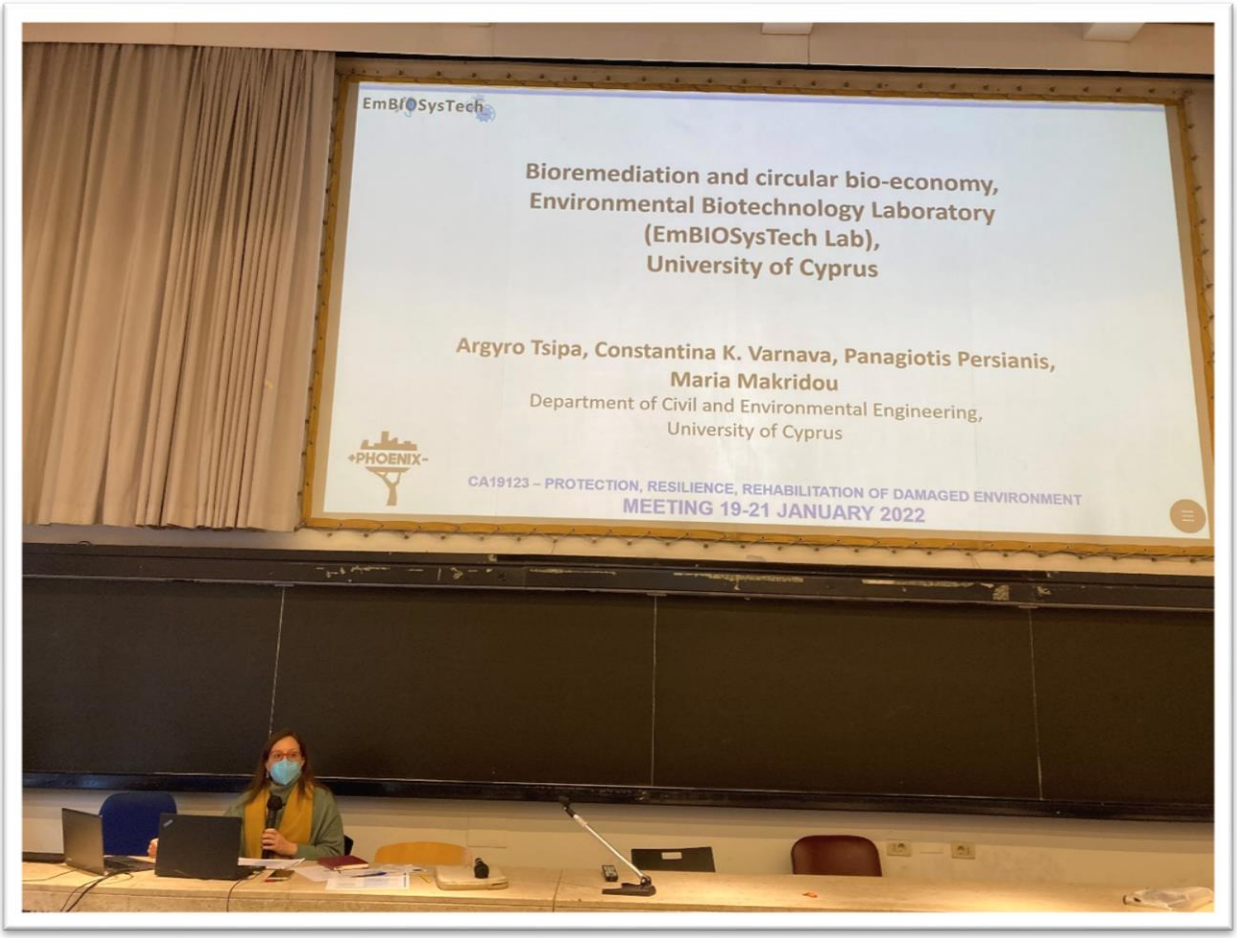
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CA19123 – PROTECTION, RESILIENCE, REHABILITATION OF DAMAGED ENVIRONMENT
MEETING 19-21 JANUARY 2022

Overview of the bioremediation research at University of Novi Sad Faculty of Sciences

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ABSTRACT

Within UNSPMF, Environmental protection research group has long been a regional leader in environmental research and has over twenty years of experience in the field of different bioremediation technology investigation and application. Here will be presented the main studies done in this field, which can be divided in the two main groups: (1) bioremediation of the soil and groundwater contaminated with petroleum hydrocarbons and (2) bioremediation of wide range organic pollutants (polycyclic aromatic hydrocarbons (PAH), organochlorine (OCP), and organophosphorus (OPP) compounds etc.) in aquatic sediments. Both research focus on dealing with freshly and historically aged pollutions. The first one encompasses four long-term different bioremediation study of soil and ground water contaminated with various petroleum products and products of their combustion as a consequence of the accidental oil spill in the Novi Sad Oil Refinery (Serbia) in 1999. Bioremediation studies included laboratory scale processes groundwater, and a bench-scale experiment to simulate in sity the soil and groundwater biostimulation processes after 5 years of contamination (Rončević et al., 2005) and pilot scale biopiles and landfarming techniques and the effect of contaminants weathering after 8 years of contamination (Maletić et al., 2009, Maletić et al., 2011). The research related to the bioremediation of the aquatic sediment encompass various studies:

(1) developing methodology for assessing the bioavailable fractions using various chemical sorbents (HPCD, βCD, MCD, XAD4 and TenaxTA) (Tričković et al., 2007; Spasojević et al., 2015);

(2) optimization conditions for PAH biodegradation in freshly and historically polluted sediment in aerobic and anaerobic conditions (Rončević et al., 2016; Čučak et al., 2017; Maletić et al., 2018a,b; Maletić et al., 2021);

(3) aerobic an anaerobic biodegradation of the OCP and impact of carbonaceous material on OCP fate in the sediment (Grgić et al., 2019);

(4) application of carbonaceous material for the (bio)remediation of the sediment polluted with OPP (Kragulj Isakovski et al., 2020).

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Identification of the soil microbial community structure of fuel cells amended with compost

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ABSTRACT

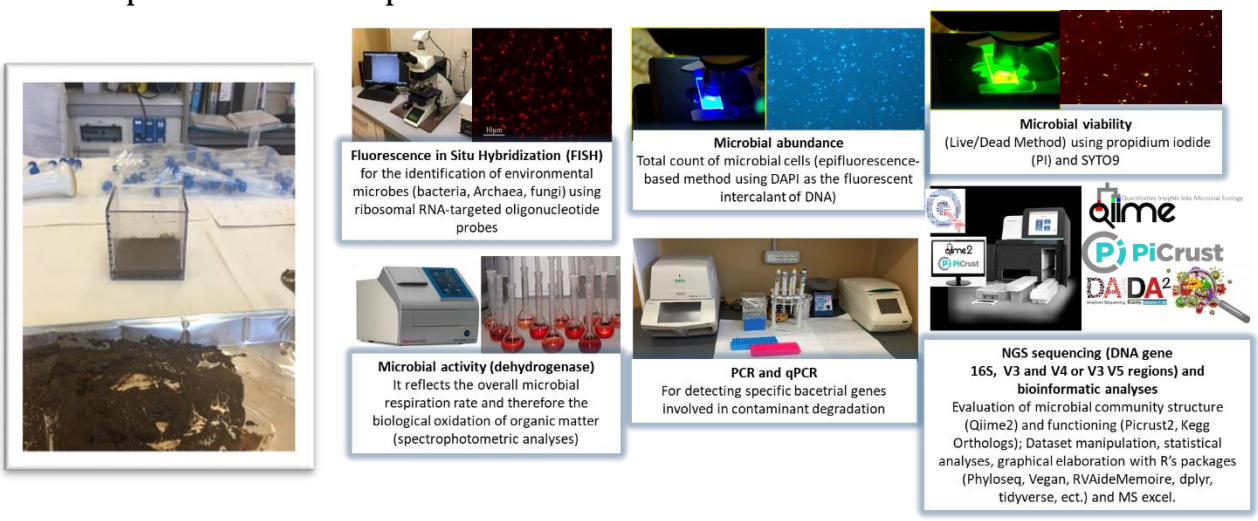
Soil microbial communities have a key role in several ecosystem services, including the recovery of soil from contamination. In fact, microbial communities have a great metabolic versatility and adapt promptly to different environmental stress, including presence of contaminants, developing degrading capabilities (biodegradation).

Microbial fuel cells (MFCs) are bioreactors that use the bacteria capabilities to oxidize organic and inorganic matter, generating electrical energy. Electrons produced by bacteria from substrates are transferred to an anode (negative terminal) and flow to a cathode (positive terminal) linked by a conductive material. Because MFCs can continuously generate power at normal temperature and atmospheric pressure without any additional maintenance, producing only CO_2 and H_2O, they are a promising alternative renewable energy sources.

Terrestrial MFCs (TMFCs) are MFCs in which soil is used as electrolyte and, thanks to exo-electrogen microorganisms naturally occurring in soil, organic compounds are degraded, including organic contaminants.

TMFC is a promising system for bioelectricity production as well as soil remediation. In TMFCs, the anode is buried in water-saturated soil connected via external circuit to cathode on top of soil. In the buried anode, a biofilm is generated and organic matter is degraded (oxidation) by exo-electrogen bacteria capable to donate electrons, which are then simultaneously transferred to the cathode compartment via an external circuit. Protons produced by exo-electrogen bacteria in the anode, diffuse through soil to the

cathode where oxygen is primarily used as the oxidant, due to its abundance and high reduction potential. The flow of electrons generate electricity.
Several studies reported that biofilms at anode are typically enriched by bacteria belonging to *Geobacter*, *Skermanella*, *Desulfucapsa*, *Desulfobulbus* and *Desulfuromonas* genera. However, few works have investigated the microbial community in MFCs.
In this work, we have analysed the prokaryotic community structure of TMFCs amended with compost, at three different points: anode, cathode and bulk soil, at 2 months from the experimental set-up. Control TMFCs consisting of only soil were also performed. Electric measurements (power and voltage) were measured daily. Microbial abundance, viability, activity and structure (NGS analysis of the 16S rDNA) were evaluated at the start and end of the experiment. The results showed significant differences in the compost-TMFC microbial community at anode, cathode and bulk soil. At the anode, a higher cell abundance and activity than cathode and bulk soil were found. Moreover, an increase in the *Bacillus*, *Clostridia*, *Bacteroidia* and *Deltaproteobacteria* and a decrease in *Alphaproteobacteria* and *Actinobacteria* genera were observed. *Gammaproteobacteria* were also reduced in presence of compost at the cathode and bulk soil. Interestingly, microbial soil activity was positively correlated to voltage and power generated by the MFCs. The genus *Geobacter* was found at anode and bulk soil in presence of compost.



On the left: Pictures of some Terrestrial MFCs used in pollutant degradation experiments. On the right: Molecular and biochemical methods for evaluating structure and functioning of microbial communities.

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Surface modification of polyvinyl/ceramic microbial fuel cell membranes with rhamnolipid biosurfactant for improved power generation

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ABSTRACT

The Microbial Fuel Cell is a device in which the chemical energy stored in chemicals is being converted to electrical energy with the use of so-called electroactive bacteria. Microbial fuel cells are subjected to an ongoing drop in power output, which is related to the multiple chemical, physical, and biological interactions taking place in this complex environment. One of the important limiting factors is the chemical and biological fouling of the membranes, which in result decrease their performance in MFCs. Among multiple strategies to inhibit the occurrence of these phenomena, changing the surface-free energy of the material has proven its effectiveness in various types of membranes[1,2]. In this study, we are using a natural compound that can be produced in situ in MFCs: a rhamnolipid biosurfactant to modify polyvinylidene fluoride (PVDF) nanofiber membranes. A surface-modified membranes investigated in the long-term studies have reached the highest power output among all of the tested materials, including nonmodified PVDF placed on ceramic support. These results suggest that affecting the hydrophobicity with the biosurfactant produced in situ may inhibit the negative chemical and biological fouling effects and lead to improved power performance over time.

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Plasma polymerization in biosensor construction

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ABSTRACT

Plasma polymerization is a novel tool used in the broad field of materials engineering. In recent years, its application has been extended to the deposition of biologically active coatings (receptor layers) by using a biological precursor. One of the technological solutions for deposition of thin biological layers is Soft Plasma Polymerization technique presented schematically in Figure 1. Its basis is the application of corona discharge plasma of low electron density and temperature not exceeding 40oC. This technique is based on polymerization of biologically active precursor in the plasma discharge zone and deposition of polymerized particles on the solid support surface. Possibilities of using this type of discharge in obtaining receptor layers of the laccase enzyme have been presented in the work [1]. The findings of the research indicate that the biological activity of the obtained receptor layers is affected by a number of plasma and process factors, i.e. the voltage applied to the electrodes, the carrier gas flow rate, the deposition time of the receptor layers and the concentration of the biological precursor solution. However, the results obtained were very promising in terms of biosensor design. Therefore, further research, the findings of which were reported in [2], included the investigation of the possibility of using plasma polymerization in the construction of biosensors and the assessment of their analytical parameters. Electrochemical measurements carried out towards the quantification of rutin indicated that plasma polymerization is an excellent tool for biosensor design. Importantly, biosensors constructed by plasma polymerization have similar or better analytical parameters, i.e. linearity range or sensitivity. Moreover, electrochemical measurements carried out have also indicated their high stability. The results of the conducted research confirm that the application of plasma polymerization in the construction of biosensors allows to shorten their construction time to about 2 minutes without any loss of analytical parameters.

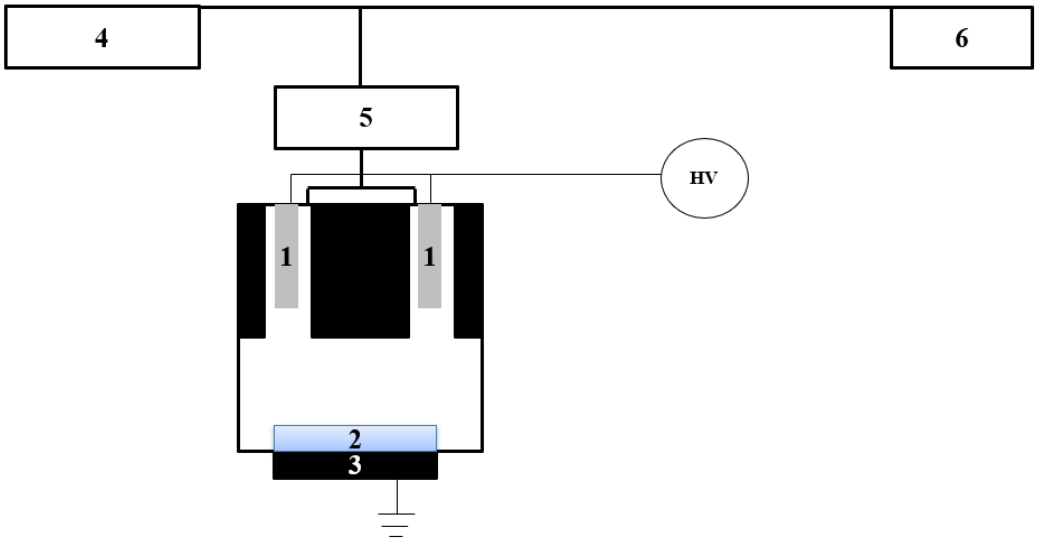

Figure 1. Scheme of Soft Plasma Polymerization equipment (1-pointed tungsten electrodes, 2-conductive solid support, 3-grounded electrodes, 4-laccase solution, 5-atomizer, 6-He gas)

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Energy upgrading of municipal wastewater treatment plants by anaerobic digestion of side products

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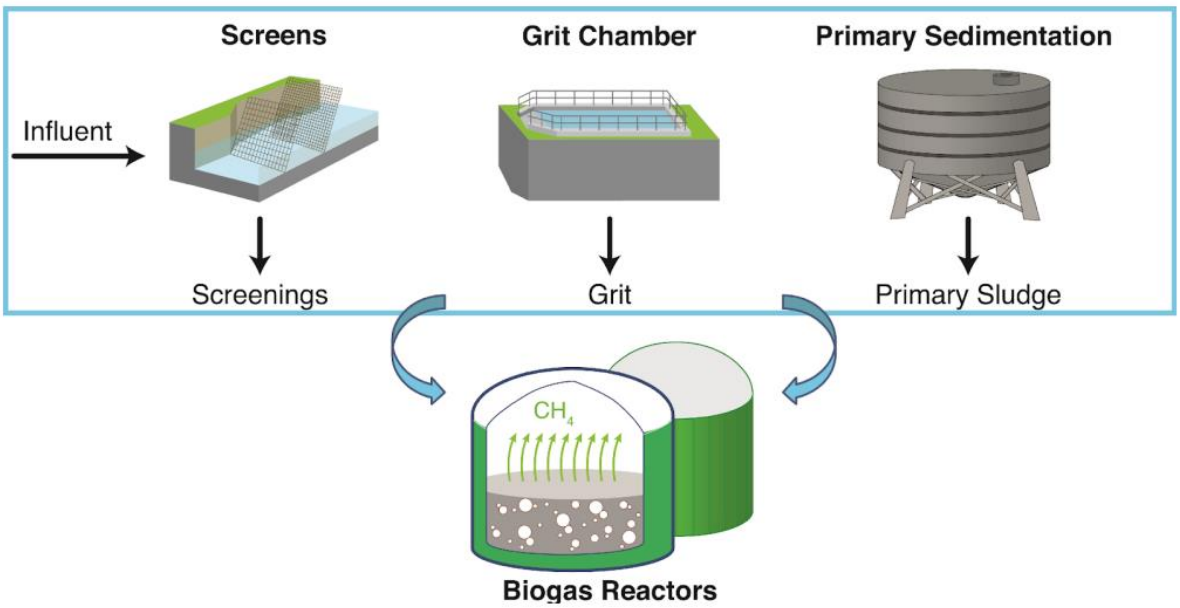
ABSTRACT

The aim of this work is the examination of the potential for the utilization of the energy content of residues and byproducts from municipal wastewater treatment plants by anaerobic digestion, as an effort to upgrade the energy status of these plants. Primary screenings, residues such as fat, oil and grease (FOG), and solids collected by fine screening using 0,3 mm screens were examined for their biomethane production potential in mesophilic temperatures.



Energy utilization of a WWTP byproducts favoring biogas production

The former byproducts collected in 3-5 mm racks and aerated grit removal devices respectively during primary treatment, are usually disposed in sanitary landfills increasing the environmental footprint of the plants. Fine screens with 0,5 to 1 mm openings are often installed in treatment plants requiring additional solid removal capacity to reduce fouling potential in systems employing membrane bioreactors. The removal of fine solids at early stages may be beneficial due to the requirement of lower aeration demand at the following activated sludge stage. Samples collected from different sewage plants, were analyzed for the determination of their volatile solids content (VS), and then were subjected to anaerobic degradation for the estimation of biomethane production potential (BMP) using standard procedures. The results showed that all samples exhibited increased biogas production potential, reaching up to 700 L/kg VS of methane. The addition of these residues in existing sludge anaerobic units may greatly enhance the biogas rate in these plants, converting them from an energy demanding to a zero energy system.

Microbial electrosynthesis in fluidized and fixed granular activated carbon bed reactors

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ABSTRACT

Microbial electrosynthesis (MES) can use renewable electrical energy to drive the microbial conversion of carbon dioxide (CO_2) into value-added multi-carbon products [1]. Ensuring sufficient supply of nutrient, CO_2, and reducing equivalents by the cathode is crucial to ensure high productivities and successful upscaling. Therefore, the cathode material and its configuration play a key role in the optimization of MES system.

Granular activated carbon (GAC) is an attractive cathode material due to its high biocompatibility, conductivity and high specific surface area [2]. In addition, the fluidization of the GAC bed may improve mixing and mass transfer and result in the enhanced conversion of CO_2 into multi-carbon products. Fluidized and fixed GAC bed cathodes were compared for MES of acetate from CO_2. Higher acetate production rates (204 ± 2 mg L^{-1} d^{-1} vs. 119 ± 20 mg L^{-1} d^{-1}) and current density (34 ± 13 mA cm^{-2} vs. 18 ± 2 mA cm^{-2}) were obtained in the fixed GAC bed reactor. However, higher 16S rRNA gene copies in biofilm and planktonic cells were obtained with fluidized GAC bed reactor. The results indicate that fluidization of the GAC bed likely decreases the conductivity in the granular bed or the contact between the granules, which charges the bed less efficiently compared to fixed GAC beds.

To enhance the conductivity of the granules, GAC was impregnated with copper or nickel. In abiotic experiments, considerably higher current density and hydrogen evolution were obtained with than without (control) metal impregnated granules in the following order: Ni > Cu > control.

In MES, preliminary results also showed higher acetate production rates with metal impregnated GAC, but the results still need to be verified. In addition, the long-term stability of the metal impregnated granules has to be evaluated.

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Bio-electrochemical dialogues for water remediation

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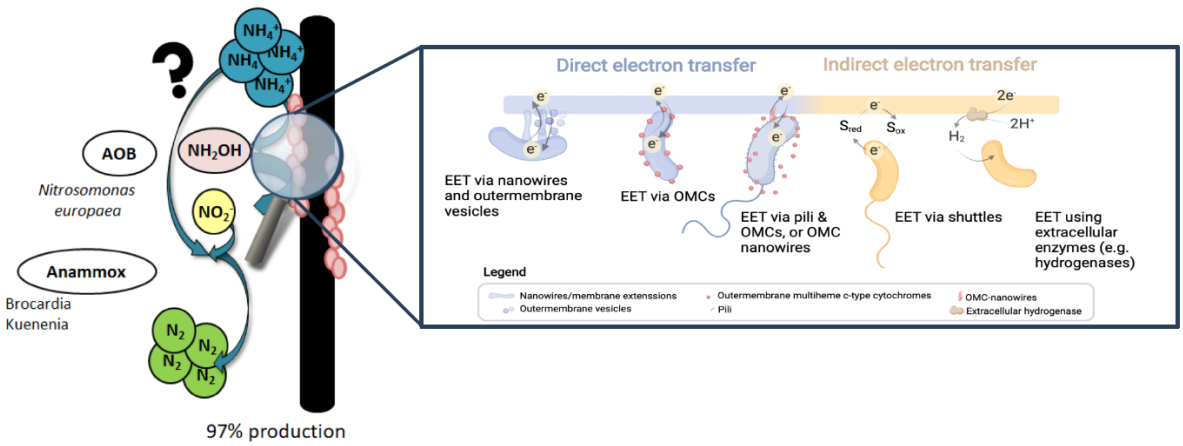
ABSTRACT

Many microorganisms exchange electrons, a talent that contributed to develop a broad range of practical applications from bioenergy and bioelectronics to water treatment. Electrochemically active microorganisms play key roles in environmental bioremediation, having significant impacts on yields and process efficiencies. However, the way that microorganisms "chat" and how they exchange energy is almost unknown in water environments. Here we focus on the extracellular electron transfer processes and cell interactions that enable electroactive organisms to communicate with each other, in a biofilm on an electrode in bioelectrochemical systems (BES). A critical examination of the potential networks for the dialogues between electroactive microorganisms is also highlighted, where special attention will be given to electro bioremediation. Some examples will be shown to prove the relevant role of electrochemically active microorganisms in the sustainable remediation of contaminated sites.



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WG3
Environmental monitoring and sensing

Chair**: Fabien Mieyeville**

Remote Sensing for Protection, Resilience, Rehabilitation of Damaged Environment

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ABSTRACT

Environmental deterioration and protection are shared concerns for many scientists and one of their key study subjects. Remote sensing data and techniques have gotten increased attention due to technological advancements in recent decades. One of the most significant sectors in which remote sensing is used is environmental monitoring, particularly environmental deterioration. The Earth Observation satellite systems were created to increase Earth understanding and management by examining the planet's resources, detecting and forecasting climatological and oceanographic occurrences, and monitoring human activities and natural phenomena.

It consists of a number of satellites as well as ground control resources for satellite programming and control, picture generation, and delivery. In this study, we discuss ongoing research topics such as the urban development of Rome, and the effect of small areas (such as Lago Ex Snia) over Urban Heat Island, soil salinity prediction from satellite imagery, and the effects of war activities over the environment. Using remote sensing data, mapping and monitoring depollution and remediation over agricultural areas has been overtaken as a possible research topic. It is considered that the results can be of great importance for evaluating the potential of satellite imagery, thus adding valuable data to the Earth Observation remote sensing community. Also, the mapping and monitoring of several environmental events over different study areas will be of great importance on an international level.

Keywords: Remote sensing; Satellite imagery; Urban development; Soil remediation; Environmental degradation.

Nutrient mitigation practice in constructed wetlands in Latvia

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ABSTRACT

Meteorological and hydrological factors and their effects on nutrient retention in surface flow constructed wetland treating agricultural non-point source pollution were analysed in this study. The main objectives were to determine the factors that contribute to nutrient removal and provide maintenance recommendations that could optimize performance of constructed wetlands. To estimate removal efficiency of nitrogen and phosphorus compounds water samples were collected from the surface flow constructed wetland located in Zalenieki County, Latvia, twice per month since June, 2014. Water quality parameters such as total suspended solids, nitrate nitrogen, ammonium nitrogen, total nitrogen, orthophosphate phosphorus, and total phosphorus were monitored. The V-notch weir and water level loggers were installed at the inlet and outlet of the wetland to measure water flow. Daily precipitation and air temperature were obtained from the nearest meteorological station to determine the impacts of meteorological conditions on nutrient retention.

Surface flow constructed wetland reduced the concentrations of measured water quality parameters on average per study period. The seasonal impact on nitrogen transformations in surface flow constructed wetland was detected. In the study period the retention efficiency of surface flow constructed wetland for ammonium nitrogen was observed during the non-vegetation period by 60% but during a vegetation period concentration increased at the outflow of the wetland. It could be explained by a low discharge during the summer months of June, July and August. The concentrations of suspended solids were higher after the wetland during April and May, which is related to occurrence of high flow conditions in the spring period.

Advantages of using new technologies in the production of renewable energy, recultivating degraded lands with generation systems with solar panels (photovoltaic systems) - Kosovo Case

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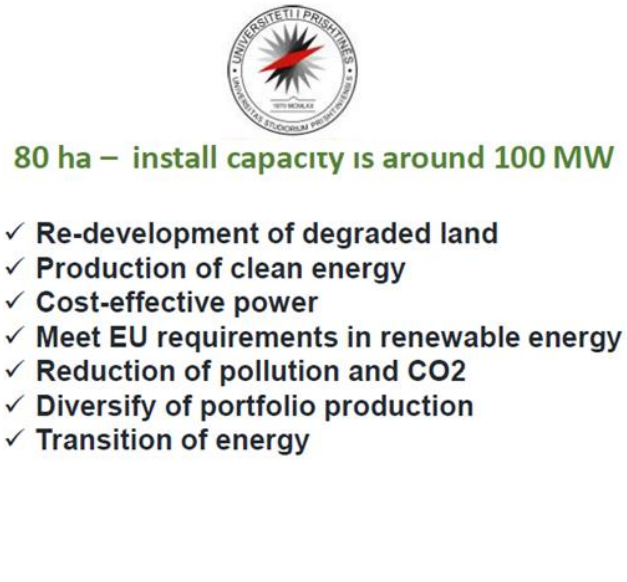
ABSTRACT

This paper addresses the need for the application of systems for a generation with sufficient capacity of sustainable or renewable energy that is a prerequisite for the harmonious development of society as a whole. Given the direct dependence of economic development and economic well-being that is inherently related to sufficient, sustainable, and quality availability of electricity. On the other hand, the current production of electricity from conventional sources in Kosovo due to coal burning and obsolescence has a significant impact on environmental pollution. The issue of environmental pollution is quite complex and presents one of the greatest current challenges of humanity. Given that Kosovo is a country that emerged from the conflict and a developing country, where the trend of increasing production and consumption of electricity is pronounced and has a continuous increase. This trend, given the full prevalence of power plants in the country that the basic resource of electricity production have coal-lignite of average quality, both chlorine value and pollutant/lignite, conditions a large degree of pollution and impacts on the environment at the local level as well as in a wider distribution. Equipment using technology outdated from the 1970s, such as coal mining and electricity generation, has degraded significant areas of land around the plants. The recultivation or recovery of these spaces and the return to the pre-pollution state that is one of the most prominent in our country has a high cost and consists of a very complex process. This paper aims at the possibility of using new technologies that are already available, using these already degraded spaces, which are also a continuous source of pollution and environmental impact, to re-cultivate them and produce energy clean from renewable sources through the construction of systems and generation capacities from solar panels

(photovoltaic systems). This would also enable KEK to diversify its generation portfolio and help the company make a transition to clean generation.



The complex and multidimensional goal consists in reducing pollutant emissions without hindering the economic development of the country, thus preventing environmental pollution despite the prevailing thermal energy generation as lignite-based pollutants by the Kosovo Electricity Corporation (KEK) and its compliance behaviour with EU directives and permitted environmental norms. This means a significant increase in RES production as an obligation under EU directives and the recultivation of areas degraded by past pollution.

Keywords: Renewable energy sources, sustainable electricity production, photovoltaic solar panels, environmental pollution, recultivation of degraded lands.

Water Monitoring through MFC powered devices: stakes and potential

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ABSTRACT

Wireless Sensor Networks (WSN) are widely spread as first layer of IoT architecture in environmental monitoring. With hardware capacities spanning from ultra-low power, small computation capacity unit (microcontroller 8-16 bits) to ARM0 architecture enabling powerful embedded computation, their main design stakes remain energy autonomy.
While WSN have been and are used as "smart sensors" just able to collect data and to gathered it in a data fusion center often nested in the cloud, intermediary hardware solutions such as microcontroller solution such as ESP32 (embedding both 32bits double core processor and ultra-low power processor) has opened the ways for new calculation paradigm, switching from a centralized processing paradigm to a distributed processing paradigm, each node of the WSN being able to fulfil calculations in-situ and able to take decision from a consensus built in the network without any centralized operator needed.
Water is an essential component of human survival, needed for drinking, washing, sanitation and other domestic and industrial processes. Despite the importance of water, there are 2.2 31 billion people globally without safely managed drinking water, including 785 million without basic drinking water particularly in sub-Saharan Africa. Regardless of the water scarcity, the major plaque in these countries is the high level of the rate of water loss and non-revenue water (NRW) is mostly due to leakages on the Water Distribution Network (WDN), which sometimes exceed more than 37 70% of the total NRW. Implementation of autonomous and low cost WSN-based water pipeline monitoring (WWPM) systems is currently the most suitable technique to detect and to localize leakages in pipelines.

In this contribution the authors will explore how Microbial Fuel Cells can contribute to the autonomy of such deployed WSN with two configurations (cf. figure 1):
- first the use of MFC as biopile enclosed in cylinder of 4 cm diameter by 8 cm height powering each node of the WSN;
- secondly taking benefit from the proximity of used and clean water pipes to power monitoring systems of clean water pipes with MFC embedded in used water pipes.

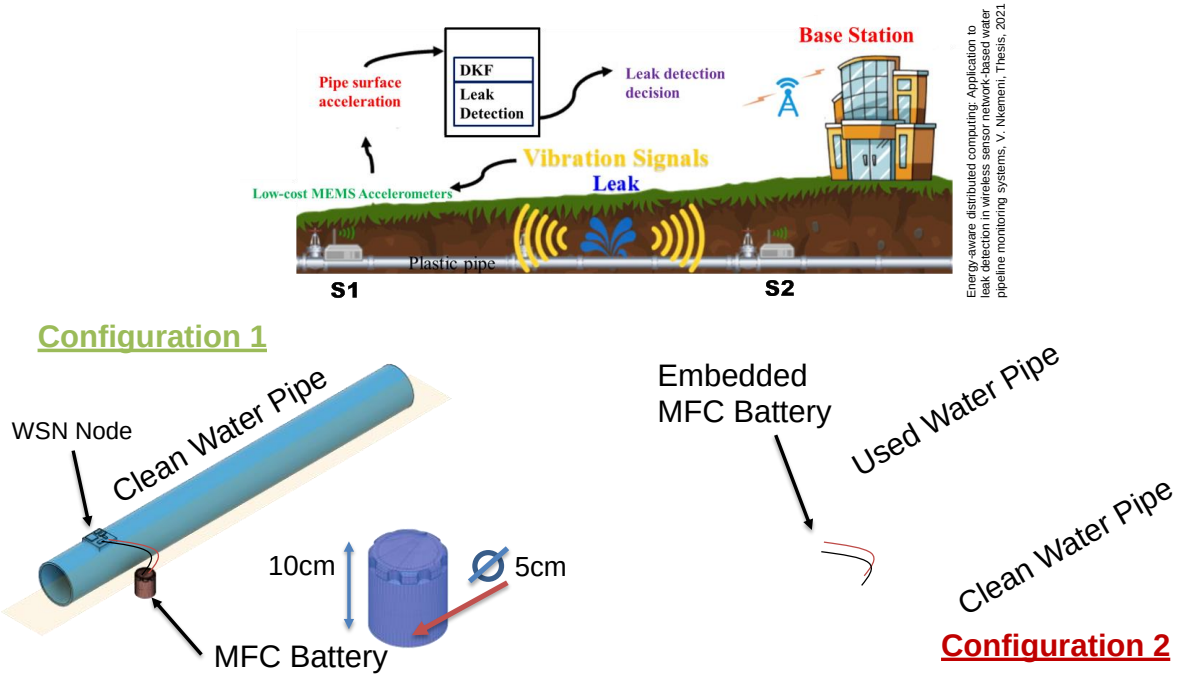

Figure 1: MFC powered Wireless Sensor Networks configuration for Water Pipe Monitoring.

MFC as energy harvesting for powering WSNs

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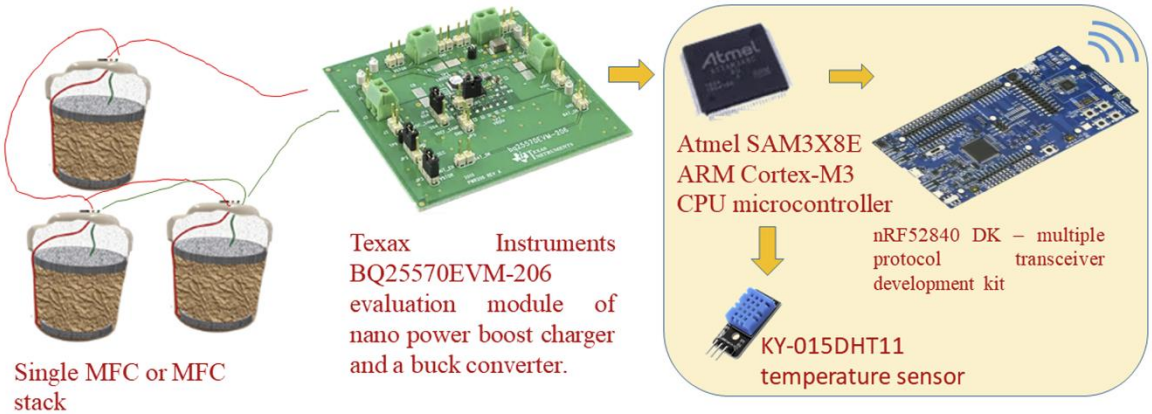
ABSTRACT

WSN environmental monitoring is increasingly adopted, as an alternative to remote sensing for in situ direct measurement, but more frequently as a cooperative method with the latter. The energy autonomy of WSN systems is important to allow their localization imposed only by issues related to optimization problems of in situ measurements and their validation on more extended territorial areas by means of i.e. interpolation and forecasting algorithms. Using terrestrial MFCsto sustainably power these systems can expand the opportunities for their applications. However, both the output voltage and power of an MFC are lower than those required by a commercial WSN node. Consequently, on the one hand the WSN node must be designed/chosen to reduce the DC voltage and current consumption as much as possible, and on the other hand the optimal configuration of the single MFC or of a stack of these must be studied.



This work presents the studies currently in progress and some solutions of the research group: the basic design of the dc-dc converter for powering a system

that includes all the essential devices of a WSN node, i.e. microcontroller, sensors and transceiver. The activity is in progress.
As for the transceiver, at the moment we have oriented to ourselves to the NRF52840 transceiver by Nordic semiconductor company, which uses multiple protocols, suitable for many applications that require until 2Mbs data transmission speeds, and is the most convenient because the power consumption is very low (TX Vdc=3V, Idc=4.8 mA@0dBm, Idc=14.8 mA@+8dBm; Sleep mode Idc=0.03÷1.5 uA), lower than other with slower data rates (e.g. LoRa RFM 95). Regarding DC-DC converter, BQ25570 by Texas Instruments is a nano power boost charger and buck converter suitable for energy harvester powered WSN applications, which provides as great advantage the stable maintenance of the supply voltage. TMFC and PMFC cells will preferably be used for the implementation of the energy harvesting system.

Transparent Thin Film Heater with Integrated Temperature Sensors for Thermal Treatment of Biomolecules in Lab-on-Chip Systems

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ABSTRACT

In this work we present a device, fabricated on a single glass substrate, which include a transparent thin film heater and a temperature sensors, that can be integrated in Lab-on-Chip systems for thermal treatment of biomolecules. The heater is constituted by ITO/Au/ITO stacked film, whose thicknesses have been optimized in order to achieve at the same time good electrical conductivity (about 106 S/m) and high transparency degree (higher than 80%) in the visible region of the spectrum, useful for the on-chip optical detection of biomolecules.

The effect of heater geometry on the spatial temperature distribution has been preliminarily investigated by using COMSOL Multiphysics. A double-spiral design has been chosen for the heater in order to achieve a uniform temperature distribution on a large area. Indeed, this geometry ensures a temperature variation of 90 ± 1.4 °C in about 3 cm diameter circle.

Two different structure for the thin film temperature sensors are designed and fabricated:

1) a resistive temperature sensors, constituted by the same stacked structure of the heater, with a distributed meander-shaped geometry, that ensures a temperature sensitivity as high as 0.12 kW/°C;

2) an amorphous silicon (a-Si:H) p-i-n diode, whose voltage-temperature characteristics, measured at constant forward bias current, show a sensitivity around -3,3 mV/°C.

The proposed device shows the capability to work as a large-area transparent heater, which, connected to an ad-hoc designed electronic circuit, allows a precise control of the substrate temperature.

Integrated Optoelectronic Device for On-Chip Detection of Fluorescent Molecules

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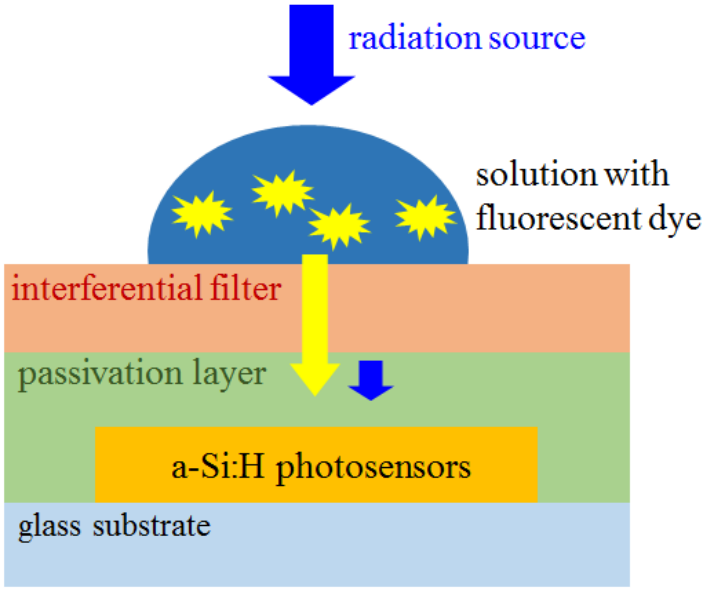
ABSTRACT

This work presents the development of a compact optoelectronic device for the on-chip detection of fluorescent molecules. The device structure includes two different components integrated on the same glass substrate: thin film photosensors and a long-pass multi-dielectric filter. The compatibility of the technological processes determines the materials and the temporal sequence of the fabrication.

In particular, the photosensor is constituted by a p-type/intrinsic/n-type stacked amorphous silicon layers deposited by plasma enhanced chemical vapor deposition at temperatures ranging from 210 to 300 °C, while the interferential filter, constituted by alternating layers of ZnS and MgF2, has been deposited by electron-beam physical vapour deposition at room temperature. The basic structure proposed for the on-chip detection is qualitatively illustrated in the Figure.



The system, integrated on a glass substrate, includes:
a. the radiation source, to excite the fluorescent dye of the labeled molecules;
b. the interferential filter, with a cut-off wavelength between the excitation and emission spectra;
c. the a-Si:H photosensors, for the on chip molecules detection.
The developed device, coupled with a microfluidic network, has been tested in a system for the detection of ruthenium complex, a molecule frequently used as DNA intercalating dye. Results demonstrate the correct operation of the integrated system both in rejecting the excitation radiation and in detecting the fluorescence signal. In particular, concentrations of double-stranded DNA down to 10ng/μL has been successful detected, demonstrating the suitability of this optoelectronic platform in practical biomedical applications.

WG4
Point-of-load

Chair: **Domenico Borello**

Low-cost Raspberry Pi controlled Microbial Fuel Cell monitoring system

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ABSTRACT

Microbial Fuel Cell (MFC) systems generate an electrical current and pure water (Oxygen Reduction Reaction) through the electrochemical oxidation of organic material. The performance of MFC systems can be monitored using low-cost digital multimeters to measure the MFC cell voltage; however, they are unable to log the measured data. Digital multimeters with data logging capabilities are expensive and usually only have one channel available for voltage measurement. In this study, we have designed a low-cost MFC monitoring system with 8 differential channels, that can simultaneously measure the potential and temperature of up to 4 cells. At the heart of this MFC monitoring system is a labjack U3-LV multifunctional data acquisition board and a raspberry pi single-board computer. The raspberry pi was selected to control the labjack device and log measured data because of its vastly lower footprint and cost than a personal computer (PC). The raspberry pi can also run for a longer period without needing to be restarted which is ideal for long-term experiments. The electrical current produced by a microbial fuel cell can be determined using Ohm's law if a known external resistance is applied to the circuit. The system that we have developed can automatically vary the external resistance and monitor the cell performance over a selected resistance range, thus automatically recording an I-V-curve.

See also the poster in the following page

LOW-COST MICROBIAL FUEL CELL MONITORING DEVICE

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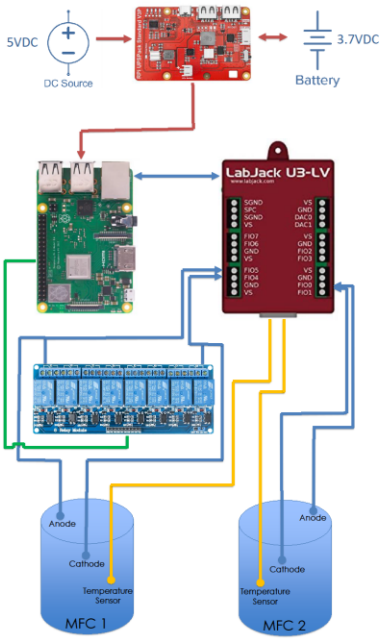
Introduction

Microbial Fuel Cell (MFC) systems generate an electrical current and pure water through the electrochemical oxidation of organic material. Conventional MFC monitoring systems are expensive and usually only have one channel available for voltage measurement. We designed a low-cost MFC monitoring device with 8 differential channels, that simultaneously measures the voltage and temperature of up to 4 cells. The device developed can automatically vary the external resistance and monitor the cell performance over a selected resistance range, thus recording an I-V-curve.

Device Setup

At the heart of this MFC monitoring device is a Labjack U3-LV multifunctional data acquisition board and a Raspberry Pi single-board computer.



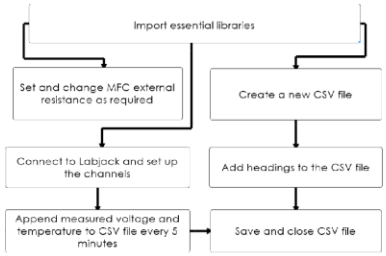
With known external resistance

Open circuit voltage

The Raspberry Pi was selected to control the Labjack device and log measured data because of its lower footprint and cost than a conventional computer. The Raspberry Pi can run for longer periods without needing to be restarted which is ideal for long-term MFC research.

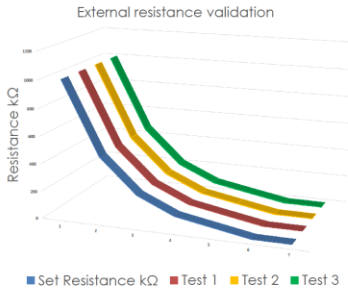
Python Code

Device operations are controlled by a custom-made python code that we developed. The following flow chart illustrates how the python code functions are executed.

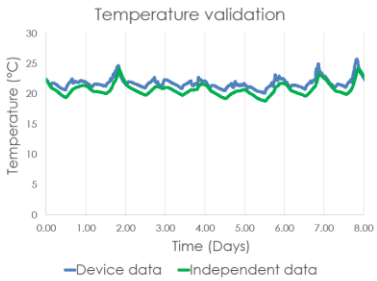


Device Validation

External resistance: To assess the device's capability to control the external resistance, tests were carried out to compare the resistance set by the device against measurements made by a multimeter.

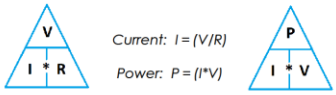


Cell Temperature: To test the device's accuracy when measuring MFC temperature, the temperature data was compared with independent measured data.



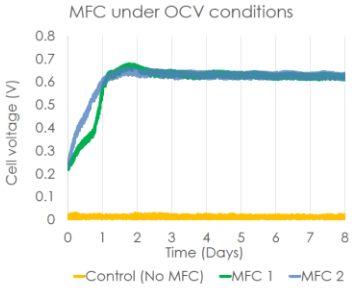
MFC Performance Monitoring

MFC performance is evaluated by monitoring the current and power output, which are determined using Ohm's law.

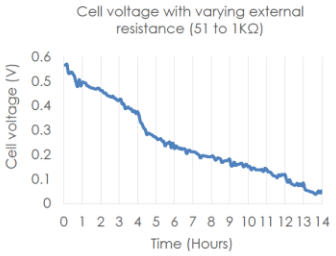


Results

Open circuit voltage (OCV): The cell voltage was measured in the absence of a current.



Voltage with external resistance: The external resistance applied to the MFC was varied over a selected range,



Conclusions

- The total component cost of the device was £320, which is considerably cheaper than conventional MFC monitoring systems.
- The device accurately measured and recorded differential cell voltage and temperature of connected MFCs simultaneously.
- OCV increased from a starting voltage of 0.25 V to maximum of 0.64 V where it remained for an extended period.
- When no MFC was connected, the device accurately showed a voltage around 0 V.

UNIVERSITY OF BIRMINGHAM
cost EUROPEAN COOPERATION IN SCIENCE & TECHNOLOGY
Funded by the Horizon 2020 Framework Programme of the European Union

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Bioelectrochemical nitrogen removal from contaminated waters: hints and tricks

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ABSTRACT

Nitrogen is one of the main contaminants present in wastewater. Water contamination with nitrogen compounds (ammonium, nitrite, nitrate) is a worldwide environmental challenge. This abstract contains a critical examination of the current application of microbial electrochemical technologies (METs) based on our experience over the last ten years. Data from lab-scale and pilot-plant studies will be shown from urban wastewater treatment using microbial fuel cells to electro bioremediation of nitrate (and coexisting pollutants) in contaminated groundwater. Here, we will focus on the key operational parameters to intensify the process performance, elucidate the key players present in such systems, identify the boundaries of the technology, and highlight the potential niches of the technology from a perspective of process optimisation and future scale-up.

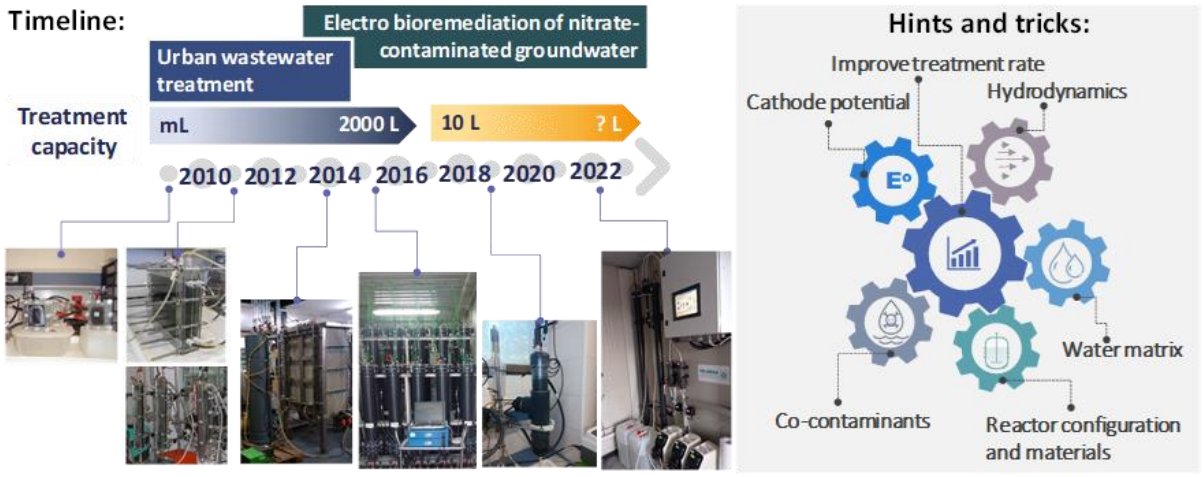

Figure 1. Summary of the work involving the nitrogen removal by bioelectrochemical systems (left) and the main hints and tricks of using these treatments (right).

Acknowledgements

A.C-E. was supported by a PhD grant from the University of Girona (IF_UDG2020). S.P is a Serra Húnter Fellow (UdG-AG-575) and acknowledges the funding from the ICREA Academia award and the European Union's Horizon 2020 project ELECTRA [no. 826244]. LEQUiA [2017-SGR-1552] has been recognized as a consolidated research group by the Catalan Government.

Galvano-Fenton technology in situ production of hydrogen peroxide

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ABSTRACT

The treatment of urban and industrial wastewater as well as its depollution before reintroduction to the nature face today major environmental challenges. In fact, wastewater treatment plants (WWTPs) are considered as one of the principal emitting sources of organic micropollutants (OMPs) (such as pesticides, endocrine disruptors, plasticizers, antibiotics…), towards aquatic media. They are not designed to ensure the treatment of micropollutants which are recalcitrant and non-degradable compounds. In this regard, advanced oxidation processes (AOPs) have emerged as a possible response, showing significant degradation performances and efficiency to mineralize OMPs. Nonetheless, the energy consumption and high cost of these processes are limiting factors for large effluent treatment, as it is for urban and industrial WWTPs.

An alternative technology was developed at the Ampere Laboratory, the Galvano-Fenton technology, which employs the Fenton reaction based on cheap materials, without requiring energy to activate the reaction, and additionally allowing electric energy production (Figure 1.).

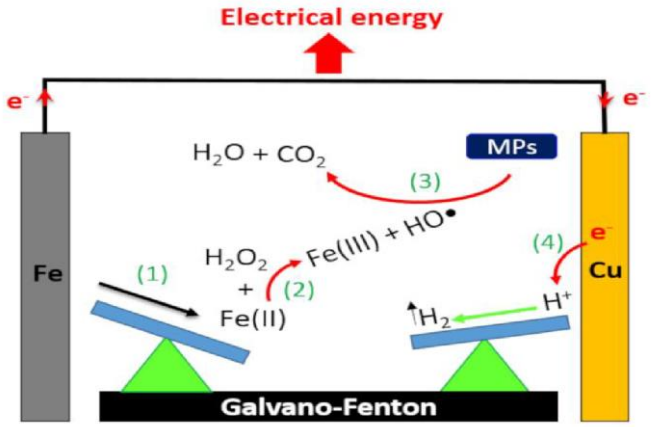

Figure 1. Schematic representation of classical Galvano-Fenton technology.

The objective of this work is to study different amelioration points for this new technology. The first part of the work accounts for the in situ production of hydrogen peroxide in the GF process, through the use of functionalized cathodes with catalyzers that can assure the two electron reduction of oxygen (Figure 2.). Effort has been focused on developing fabrication methodologies and further electrochemical characterization of carbon based electrode materials for implementation in the Galvano-Fenton technology to obtain an in situ hydrogen peroxide supply (avoiding stocking and manipulation constraints), with the inclusion of previously non-reported methodologies, with the use of PTFE in spray as binder in the final electrode structure.

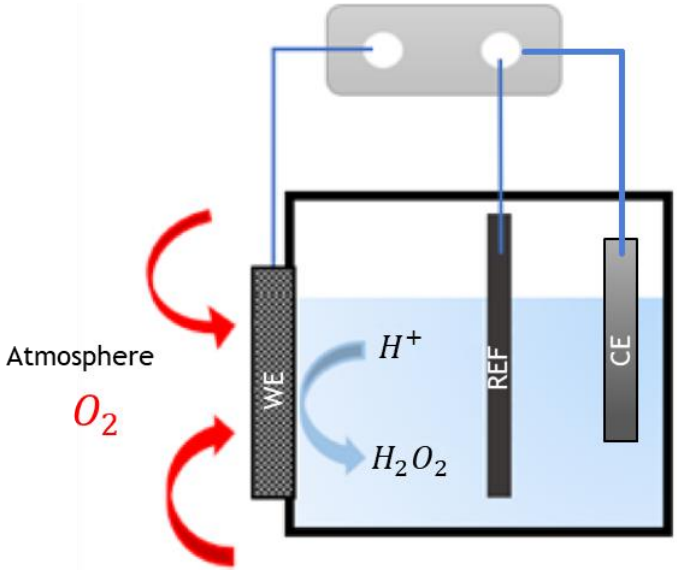

Figure 2. Schematic representation of the hydrogen peroxide in situ production compartment for Galvano-Fenton technology.

Impact of sharing soil when stacking Plant Microbial Fuel Cell for electricity production with Lobelia Queen cardinalis

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ABSTRACT

Plant Microbial Fuel Cell (PMFC, Fig. 1) creates electricity from oxidation of root exudates by microbia anaerobic digestion, and reduction of dioxygen to water. In this study, *Lobelia Queen cardinalis* (Fig. 1) was used as a plant model to investigate the impact of ionic connection between stacked Plant microbial fuel cell (shared soil).

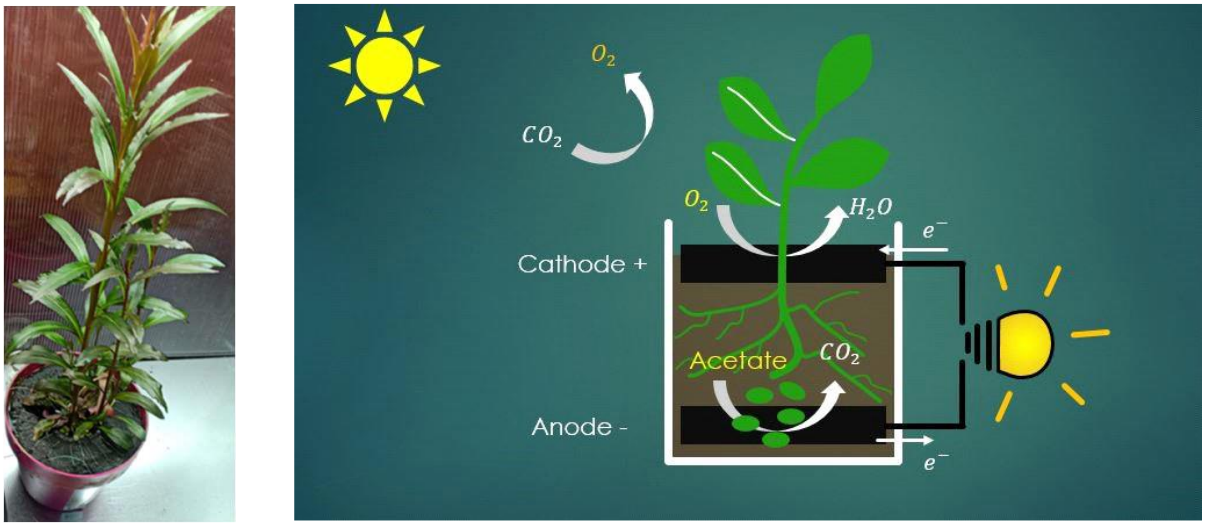
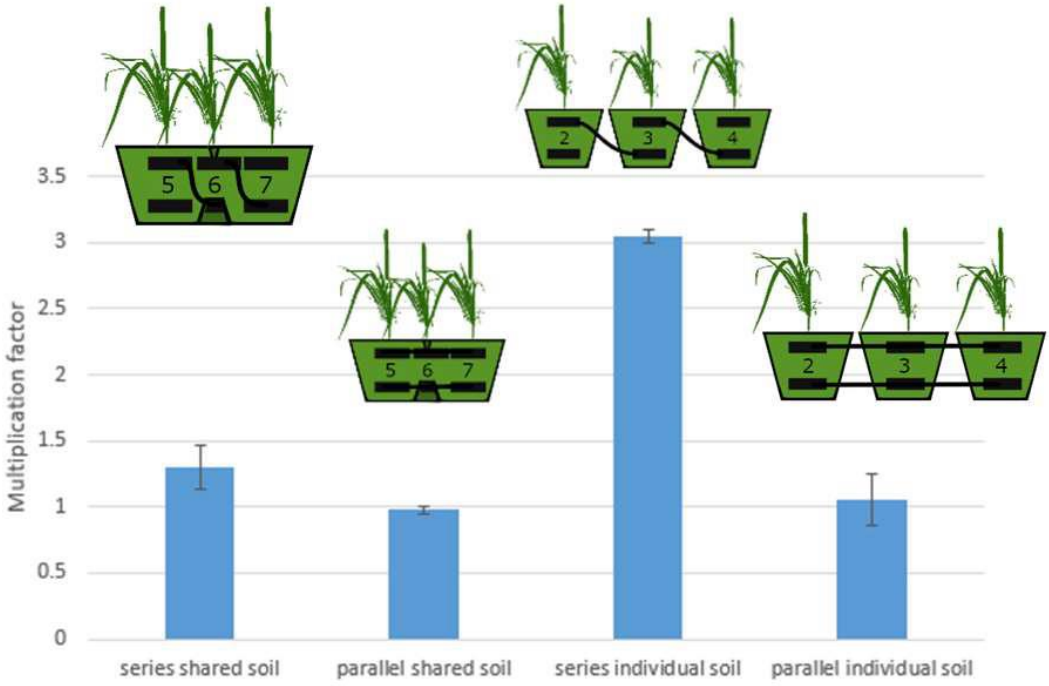


Fig. 1. On the left: *Lobelia Queen cardinalis*. On the right: scheme of the plant microbial fuel cell.

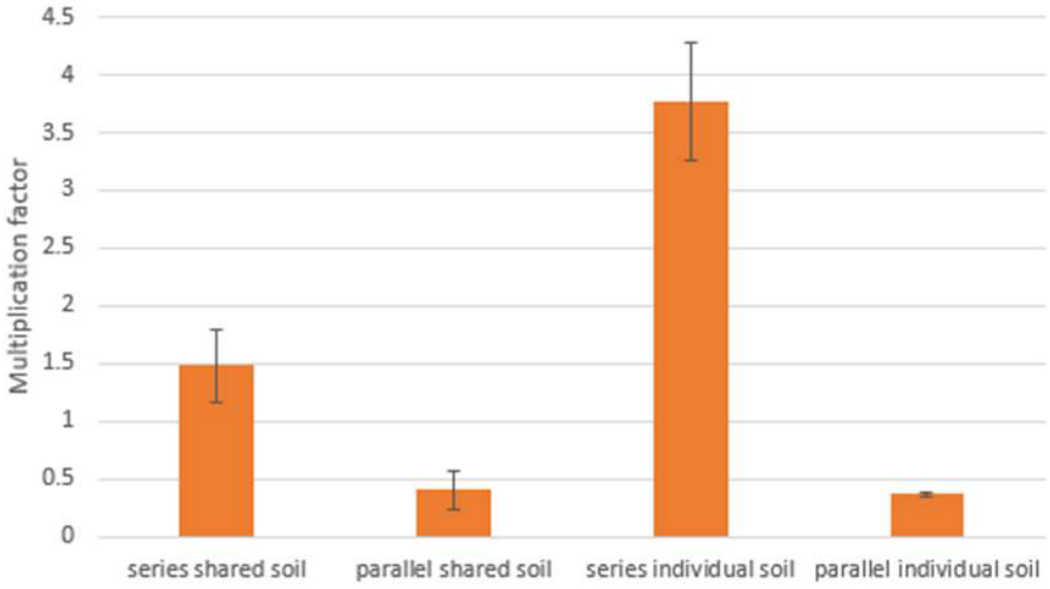
A 10 mm thickness carbon felt woven with stainless steel wire was used for both anode and cathode, and soil was a mix of compost and ground from pond banks (30%-70% weight, respectively).

Independent performances did not show any difference between individual and shared soil; appearance of biofilm on cathode catalyzing oxygen reduction reaction was detected with potential logging.

Stacking independent PMFC in series sums both open circuit potential (OCP) and internal resistance, while stacking in parallel sums current, keeping open circuit potential to the mean of the PMFC OCP (Figure 2).
Although series stacking seems to output best performances, this configuration may cause voltage reversal in one PMFC when current is strong, leading to biofilm damage, so stacking in parallel is recommended.



a) open circuit potential



b) internal resistance

Figure 2. Multiplication factor when stacking, compared to one PMFC, a) Open circuit potential and b) internal resistance.

Terrestrial microbial fuel cells: An effective tool for the remediation of contaminated soil and energy production

Gabriele Gagliardi, Carlotta Cosentini, Domenico Borello

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ABSTRACT

Terrestrial microbial fuel cells (TMFCs) are a class of bioelectrical systems operating by using soil as the electrolyte, i.e., acting as the proton exchange while electrodes are placed on a thin soil layer at the bottom of the cell (anode) and above a larger soil layer (cathode). This is a promising technology on the world scene because it can both generate electricity and mitigate greenhouse gas emissions and bioremediate soil from pollution. Moreover, TMFCs have a low cost and are able to work for long periods and have no impact on the environment.

Photos of the Terrestrial Microbial cells performed in different experiments.

At the laboratory of the Department of Mechanical and Aerospace Engineering of University of Roma, La Sapienza, in collaboration with CNR-IRSA (Montelibretti and Bari), two main research activities have been carried out: stimulation of the natural microbial community of the soil to promote degradation of pollutants and improvement of the microbial activity varying operating conditions to enhance the power generation. Different cells were set up to test their effectiveness on the degradation of different pollutants:

Dichlorodiphenyldichloroethylene (DDE) and Polychlorinated biphenyls (PCBs).

The overall results showed that MFCs promoted a substantial DDE removal in 2 months. However, 2 months were not a sufficient period to enhance the PCBs degradation. Two different conditions, soil and soil plus compost, were set up to compare the energetic performance in presence and in absence of organic matter. The compost addition stimulated microbial activity for a longer time allowing to achieve higher power generation, nearly 40 times higher in the cell with the presence of compost. Therefore, MFCs could provide an alternative power source for sensing devices where physical access to the device for battery replacement is difficult.

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PHOENIX

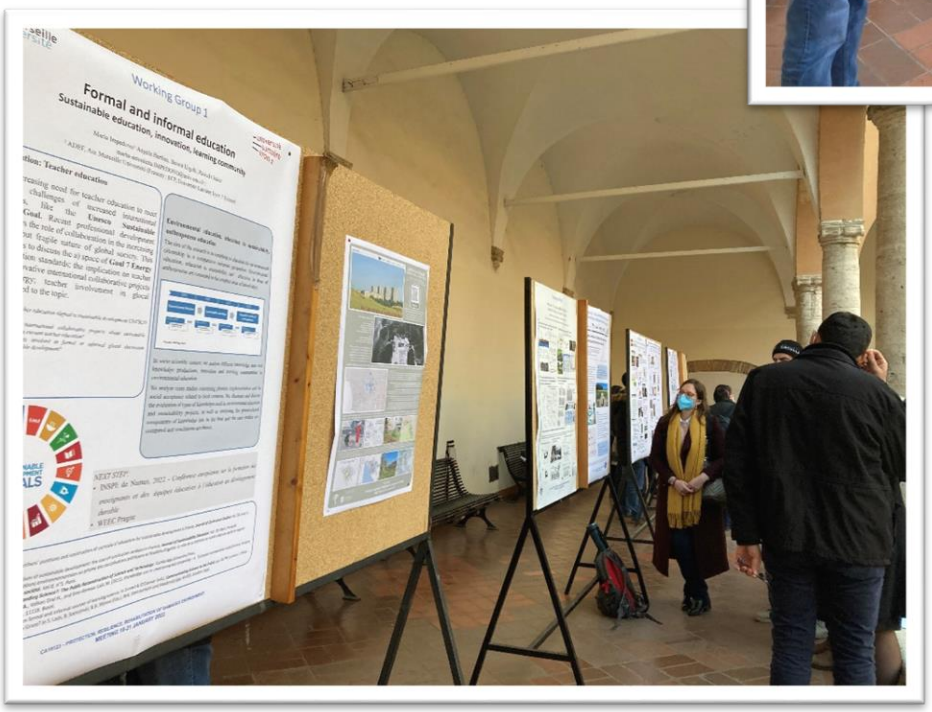
COST ACTION CA19123

PROTECTION, RESILIENCE, REHABILITATION OF DAMAGED ENVIRONMENT

Abstracts for Poster Presentations

Rome, 19-21 January 2022

Photos of the poster section at the cloister of the Faculty of Civil and Industrial Engineering, Sapienza University, Rome



WG1
Educational and socio-economics aspect of environmental science for sustainable city planning

Towards an Effective Framework for Environmental Education: A Literature Review to Point Key Results and Challenges

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ABSTRACT

This poster summarizes a literature review about environmental education to point key defining features of the field, existing results and current challenges. The focus of the paper is on environmental education in democracy, assuming it as a social ideal to pursue in order to orientate pedagogical action. Such a perspective leads to the necessity to address two main forms of linguistic and cognitive processes at the heart of democratic environmental education: argumentation and mediation. Only a performance of mediation makes it possible to relate diverging forms of knowledge across disciplines and epistemic status (theoretical-practical; daily-scientific) and the different actors elaborating them. Argumentation is then at the heart of any discussion on socio-ecological controversies to weigh such hybrid knowledge with the various, sometimes opposed interests and values guiding ethical and political choices in a context of uncertainty. Such socio-cognitive-emotional reasoning both requires individual literacy and appropriate settings for a democratic public debate to occur at the collective level, based on inclusive dialogue in search for common good. Last but not least, environmental education is at the crossroads of several research fields in education: education for specific applied purposes (sustainability, health, citizenship, etc.), active and dialogic pedagogy, learning-by-doing approach; ranging from social sciences and humanities to science education; both in formal and non-formal contexts.

A few key results deserve to be stressed out. First, social inequalities persist in public space, even in countries with democratic institutions, both at the level of participation to the discussion and to the decisions about social issues (Brunner et Maurin, 2021, Polo, 2019), which affects the quality and inclusiveness of environmental debate. Two of the sociodemographic categories who are under-represented in the public debate are specifically those with the higher sensitivity to ecological problems and tendency to undertake environmental action (women and young people) (Chen, Liu, Chen, 2015, De Waters & Powers, 2011, Akitsu et al., 2017, Lee et al., 2013).

Besides, educational policies and initiatives tend to be limited to targeting individual changes, on the basis of knowledge diffusion or explanation, without considering other factors that determine social behaviours, neither addressing institutional adaptation (Bader & Sauvé, 2011). At the end of the day, emotions also matter a lot, notably regarding climate change (Lombardi & Sinatra, 2013). Such state of the art points a few main challenges for today's environmental education. Regarding the target of inclusive learning, critical approaches to pedagogical settings (e.g. Mayberry & Lewis, 2015) can help unpack social inequalities of participation.

Taking the cultural dimension into account is also essential to grasp each student's relevant contribution to ecological reasoning and action. Paying attention to the social side of learning processes is also a way to experience at the micro level the controversial nature of socio-ecological issues and to get trained to decide democratically on adaptive strategies that supposed to take a critical stance at the current social values prevailing in mass media (Serpereau, 2015).

In addition to critical thinking, environmental education should develop caring and creative thinking (Lipman, 2003), notably involving sensible approaches (Danish et al., 2020, Lange, 2014) associated to concrete significant local action bringing sound hope instead of paralyzing eco-anxiety (Roussel & Cutter-Mackenzie-Knowles, 2020).

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See also the poster in the following page

Towards an Effective Framework for Environmental Education: A Literature Review to Point Key Results and Challenges

Claire POLO Lyon 2 University, ECP Laboratory, claire1.polo@univ-lyon2.fr

What does environmental education mean in democracy?

- **Technico-scientific opportunities and risks**
knowledge, instruments, economic models, uncertainty
- **Urgent socio-ecological controversies**
divergence of interests & opinions, intense emotions, dramatical impact on society & the environement
- **Ethical & political choices**
norms & values, power balance, decisions, governance

ARGUMENTATION & MEDIATION

Individual level: literacy
cognitivo-linguistic skills
theoretical & practical knowledge
thinking
communicating
disciplines
school, media
daily life

Collective level: public debate
inclusive, representative, pluralist dialogue
search for common good
consensus-building

social | cognitive | affective

Education for specific applied purposes
sustainability, health, international solidarity, citizenship, care, thinking

Active pedagogy
Socio-cognitive conflict (Doise & Mugny, 1981)
Dialogic teaching (Alexander, 2017)
Argumentation as a specific talk for cognitive 'exploration' (Mercer, 1996)

Transdisciplinary learning-as-doing perspective
Learning to argue (Von Aufschnaiter et al., 2008)
Caring, creative, critical thinking (Lipman, 2003)
Interactional skills (Fillettaz, Bronckart, 2005)

Environmental Education

Social science and humanities
Stylistic approache in rhetorics & eloquence
Argumentative written essays
Law conciliating style & search for truth
(Toulmin, 1958, Perelman, Olbrechts-Tyteca, 1958)

Science education
Science Technology Society > science classroom (Aikenhead, 1992)
Linguistic enculturation into science through argumentation
(Newton et al., 1999, Driver et al., 2000, Osborne et al., 2004)
Committed impartiality for teaching Socio-Scientific Issues (SSI) (Kelly, 1986)
Socio-scientific debates imbricate descriptive, prescriptive and affective logics (Polo, to come)

RESULTS

- **Social inequalities in public space**
Socio-economical status, gender, nationality, etho-cultural background
Participation to decisions (e. g. in France: Brunner et Maurin, 2021)
Participation to discussion (Polo, 2019)
- **Limitation to individual attitude**
Focus on habits with little social impact (*ecogestes*, Bader & Sauvé, 2011)
Knowledge only partially determining attitudes
(Simonneaux, 2006, Albe, 2009, Lewis & Leach, 2006)

- **Sensitivity and tendency to undertake action**
Upper-class, women and young people higher sensitivity to ecological concerns and tendency to undertake positive resilient action, accross diverging cultural contexts
(Chen, Liu, Chen, 2015, DeWaters & Powers, 2011, Akitsu et al., 2017, Lee et al., 2013)
- **Emotions in education to climate change**
Despair more trustworthy than anger (Lombardi & Sinatra, 2013)
Fear as a paralyzing form of awareness on climate change
Key role of experiential knowledge for behaviour change

CHALLENGES

- **Inclusive education**
Critical approaches to 'collaborative' learning settings (Mayberry & Lewis, 2015)
Overcoming cultural taboos to grasp the kairos in educational debates
(Polo, Lund, 2022)
- **Adressing the controversial and sociological nature of ecological issues**
Necessity to meet the urgent dramatical climate change (IPCC, 2018)
Need for democratically decide on social adaptative strategies
Need for a shift in prevailing social values through media critical analysis
(Serpereau, 2015)
- **Basing education for change on bottom-up dynamics**
Giving the floor to women and young people in an ecofeminist perspective
Developping sensible approaches based on embodied cognition
(Danish et al., 2020, Lange, 2014)

- **Building a critical but constructive attitude driven by sound hope**
Developpig the belief in our ability to undertake significant action
(Dwyer, 2011, Jorgenson, Stephens, White, 2019, Morizot 2019)
Need for concrete, participative, creative and affective educational actions
(Roussel & Cutter-Mackenzie-Knowles, 2020)

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Eco-citizenship education for Lebanese high school students. Analysis of the effects of the educational system, the associative movements and the social media networks

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A Doctoral Research Project in Education Sciences
Beirut, 2022

ABSTRACT

The concerns about the loss of environmental resources revert to the economic and social implications resulting of citizens' cumulative irresponsible acts (Rowe, 2020). Raising awareness toward the ecological problematic and the sustainable development has been challenging due to its interdisciplinary cognitive and practical approaches. The eco-citizenship education aims at building a pattern of ecological behaviors and skills. But also, it aims at creating environmental knowledge that makes the individual capable of taking responsible decisions interpreted in eco-durable acts (Corneloup, 2011). Nonetheless, the Lebanese context enlarges the challenges. Lebanon is a developing country where environmental laws and strategies are rarely followed, and the budgetary issues prevent the governmental support for local initiatives (Mekhael and Karameh, 2018), rather than its divergent demographic variety that alter the response for values' acquisition.

The present project aims at inquiring the applied strategies to educate to the environment to be able to answer the following questions: What are the ecological elements in the Lebanese curriculum? Are they linked to extra-curriculum activities? What are the effects of the demographic variables on students' perceptions, identities and acquisition for eco-responsible lifestyle? What are the marked impacts and challenges of the past implicated strategies? How do social dynamics' effect on eco-citizenship education differ

among the different Lebanese communities? What are the fundamental elements for an effective simulation via social media networks?
The conclusions will be based on a literature review of previous empirical research conducted in Lebanon under the environmental education thematic, comprising the actual achievements and the confronted challenges. It will be essential to review the interventions' aspects employed within the Lebanese educational institutions and within the undertaken environmental awareness campaigns as well. In other words, this position paper represents a departure point to deduce main assumptions, in order to apply state-of-the-art empirical research, action research and environmental awareness campaigns in Lebanon. In addition to the empirical research (Ghosn-Chelala, 2019; Kotob & Antippa, 2020; Chaya & Abou Ali, n.d.), we will use NGO reports (Greenpeace, 2014) and international reports (UNESCO, 2014; UNESCO, 2020; UNE, 2019).
The purpose of the present study is to help the stakeholders to design inclusive, state-of-the-art plans that avoid all the revealed gaps and to enable a high level of environmental values' acquisition, particularly in the Lebanese context, where initiatives and actions remain limited in this field despite the situation's gravity and the urgent need to act accordingly.

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See also the poster in the next page

Eco-Citizenship Education for Lebanese High School Students

Analysis for the Effects of the Educational System, the Associative Movements and the Social Media Networks

A Doctoral Research Project by Mona Khalifé, Master in Educational Technology, Lebanese University

The concerns about the loss of environmental resources revert to the economic and social implications resulting of citizens' cumulative irresponsible acts. Ecology and sustainable development have become challenging concepts to transfer to the young cohort, but also the future generation.

Aim

We aim at converting the environmental education into effectively useful asset, through providing cognitive skills, growing environmental values and helping adopt an eco-friendly lifestyle.

Rationale

Lebanon is a developing country where environmental laws are almost non-existent, and the budgetary issues prevent the governmental support for local initiatives, rather than its divergent demographic variety which alter the response for values' acquisition.

Questions of the Research

What are the ecological elements in the Lebanese curriculum? Are they linked to extra-curriculum activities?
What are the effects of demographic variables on students' perceptions, identities and acquisition for eco-responsible lifestyle?
What are the marked impacts and challenges of the past implicated strategies?
How do social dynamics' effect on eco-citizenship education differ among different Lebanese communities?
What are the fundamental elements for an effective simulation via social media networks?

Methodology

1 Literature Review

for previous environmental educational initiatives to detect the gaps and the challenges, and to understand the acquisition dynamics

2 Framework

To base the research on psychological and sociological criteria in order to reach high level of influence & agency

3 Questionnaires & Interviews

To identify the educators' perception and the students' understanding for the environmental problematic

4 Analysis

to examine the effects of each implicated strategy and the effects of the demographic variables on students' acquisition for eco-values

Main Objectives

We aim at helping the stakeholders to design inclusive, state-of-the-art plans that avoid all the revealed gaps and to enable a high level of environmental values' acquisition, particularly in the Lebanese context, where initiatives and actions remain shy in this field despite the situation's gravity and the urgent need to act accordingly

SveaSus: Sustainable World Heritage learning through a phenomenon-based approach

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ABSTRACT

Sustainable World Heritage Learning through a Phenomenon-based Approach (SveaSus) is a project that has been running in the Suomenlinna World Heritage site since 2017. The project team includes experienced committed lecturers, researchers and students at the Faculty of Educational Sciences at the University of Helsinki. They collaborate with World Heritage experts, artists, schools and other organisations. The aim of the project is to strengthen student teachers', in-service-teachers', educational administrators', and teacher educators' understanding of sustainability issues and encourage joint actions towards a more sustainable future. With sustainability as the focus, phenomenon-based learning as a method and World Heritage as both goal and environment, SveaSus is a unique teaching and learning experiment that relates to many of the Agenda 2030 goals.

Photo credit: Super Otus

Phenomenon-based learning is under-theorized and under-researched (Wolff, in press). There is also a request on more research on how to promote sustainability in teacher education (Wolff & al. 2017; Jónsson & al. 2021). Therefore, the SveaSus project develops theories through various interventions and empirical research. The theoretical basis draws from phenomenology-based approaches (Merleau-Ponty 2014), the work of educational philosophers like Vygotsky, Dewey, and Mezirow, Bildung theories and sustainability education approaches (Wolff & al., 2019; Wolff, in

press). The multiple dimensions that teacher educators bring in from history and social studies, multilingualism, biology, geography, mathematics, art and aesthetics broadens the overall perspective. Lecturers, students, artists and performers co-teach and co-learn. Through embodied learning and art-based narrative methods (Kaihovirta & Furu 2021), SveaSus introduces themes from the areas of global education, climate justice, and intersectionality (Vivitsou 2019a, 2019b), thus, promoting transformative reflection (e.g., Mezirow 1991).

The outcome of SveaSus is that authentic embodied learning in an historic and similarly active urban environment can lead further into existential issues that concern the community and the future of Helsinki, Finland and the world (Wolff & al. 2019). Digital and embodied learning in authentic learning contexts broaden the sustainability perspective. Hitherto the SveaSus pilot project has led to deep reflections and critical discussions among students and teachers on value-based issues that affect today's sustainability challenges (Wolff & al. 2019). Topics like identity, equality and sustainable use of natural resources emerge as central.

Keywords: Sustainability education, World Heritage, phenomenon-based learning, authentic learning, embodiment, art-based learning

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Lebanese Association for Educational Studies (LAES) scientific program

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In Lebanon, the fuel and electricity shortages have affected Lebanon's organizations activities (schools, hospitals, etc.). At the same time, public water supply and wastewater treatment systems that rely on fuel have cut back on their operations, leaving millions without access to water, and jeopardizing environmental and public health. Meanwhile, the country's chief electricity provider, Electricité du Liban (EDL), has halted main power service lines affecting roughly four million people across the country. While contributing to the educational development in Lebanon and in the Arab countries, LAES adopts Education 2030 and the whole institution approach implementation of Education for Sustainable Development (ESD). ESD equips learners at all levels to implement all SDGs through agency and action. In correspondence to PHOENIX aims, LAES program goals involve: 1) spreading awareness about ESD and BESs technologies and their implementations, and 2) encouraging national scientist to do more researches about BESs technologies and their implementation at the national level. The Targets of LAES program are:

a) performing training workshops/webinars for public and private school teachers and Principals about ESD,

b) performing training workshops/webinars of preservice and in-service teacher training institutions about ESD,

c) performing awareness webinars for middle and high school teachers concerning BESs technologies and implementations,

d) organizing national competitions for middle, secondary, and college science and technology students that motivate them to innovate in BES's technologies areas and its implementations,

e) signing Memorandum of Understanding with universities, schools of science and technologies, to reinforce research concerning BES's technologies and implementations,

f) Organizing conferences about BES's technologies and implementations research, and

g) sharing Knowledge about this program through publications, media, scientific events. The program will be implemented by a committee from LAES members.

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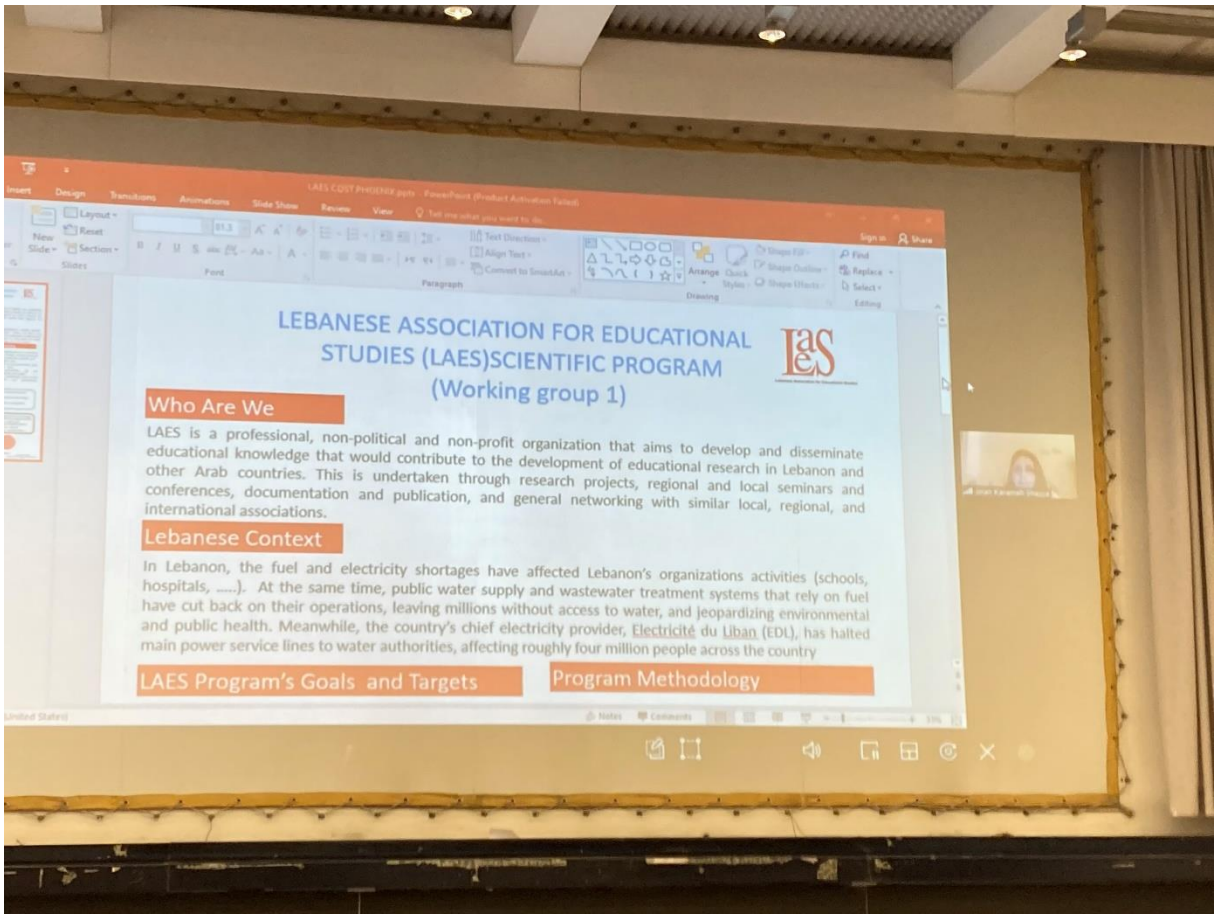

LABSU SAPIENZA
Thinking global, acting local

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ABSTRACT
The poster aims to present the activity of LABSU, Laboratorio di Studi Urbani "Territori dell'abitare" (urban studies workshop "Territories of dwelling"), an interdisciplinary working group of experienced scholars and young researchers based in Sapienza University of Rome.
In the last years, LABSU members have performed action-research in different contexts, mainly in the metropolitan area of Rome, sharing place-based methodologies to be adapted to specific themes and contexts.
Environmental issues are one of the research topics of LABSU, whose activities include action-research processes, scientific support to public institutions, individual and collective scientific research and publication, activities of doctoral school, workshops and seminaries, and so on.
The poster tries to summarize these experiences, giving some examples and collecting some general reflections of LABSU members.

Keywords: Action-research, Rome, Self-organization, Urban studies

See also the poster in the following page


Territori dell'Abitare
HOME
CHI SIAMO
IL LABORATORIO
ATTIVITA'
PUBBLICAZIONI
I LUOGHI
Un Laboratorio di studi ed analisi
LABSU SAPIENZA
THINKING GLOBAL, ACTING LOCAL
Luca Brignone[1], Carlo Cellamare[1], Marco Gissara[1], Francesco Montillo[1], Serena Olcuire[1], and Stefano Simoncini[1]
[1] Sapienza University of Rome, Dipartimento di Ingegneria Civile Edile e Ambientale)
official website of LABSU (only in Italian language, we apologize)
SCAN ME
https://sites.google.com/uniroma1.it/laboratorio-studi-urbani-dicea/
LABoratorio di Studi Urbani «Territori dell'Abitare»
URBAN STUDIES WORKSHOP «TERRITORIES OF DWELLING»
is an interdisciplinary working group of experienced scholars and young researchers based in Sapienza University of Rome (scientific coordinator of LABSU: Prof. Ing. CARLO CELLAMARE)
ABOVE
official website of LABSU Sapienza
RIGHT
Abitare Tor Bella Monaca (Living in Tor Bella Monaca) interdisciplinary urban studies workshop held in 2015 in a public housing neighborhood in Rome
BELOW
places in Rome of researches involving LABSU members and DICEA PhD program in urban studies
"there are no universal formulas that have value regardless of the contingencies of contexts and processes, while it is crucial recognize the transformative capacities of the local actors, and support of forms of self-organization that they put in place"
LABSU MEMBERS SHARE METHODOLOGIES FOR PLACE-BASED RESEARCH AND ACTION TO ADAPT TO SPECIFIC THEMES AND CONTEXTS
RESEARCH TOPICS
«Global Rome» / New urban centralities / Urban social movements / Social and spatial justice / Right to the city / Self-made urbanism / Self-refurbishment / Self-organization processes / City and migrations / Local development / Public and social housing complexes / Sustainability, environment, climate change / Collaborative platforms / and so on…
"rethink suburbs as 'pieces of the city' that must acquire adequate levels of urbanity [...]. To do this, it is necessary to develop 'policies for self-organization', that is, to enhance forms of self-organization and collaborative and mutualism networks"
"the presence of engaged research allows to beware of macro-processes, particularly neoliberal trends [...] e.g. pursuing competition between territories instead of welfare, or shifting public services and decision-making from democratic institutions to the private actors"
"the process perspective leads to drastically shifting the attention from the output to the input, that is, from the product, service, practice in itself taken, to the agency observed in its processual evolution, material and immaterial, and in the context to which it refers"
"because of the number of variables that determine the multilevel complexity of social and territorial systems, and because of the incidence of the time factor on processes, there are no possible formulas.It is always necessary to observe in depth and at length the contexts in their constant change as a result of the combined pressures of internal and external forces"
ENVIRONMENTAL ISSUES ARE A FIELD OF INTEREST OF LABSU, WHOSE ACTIVITIES INCLUDE ACTION-RESEARCH PROCESSES, SCIENTIFIC SUPPORT TO PUBLIC INSTITUTIONS, INDIVIDUAL AND COLLECTIVE SCIENTIFIC RESEARCH AND PUBLICATIONS, ACTIVITIES OF DOCTORAL SCHOOL, WORKSHOPS AND SEMINARIES, ETC.
1
2
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4
[1 - 3] MEMO – Memorie in movimento. Valorization of social memories in a public housing neighborhood (local consortium with public ins titutions, schools, NGOs and other actors, financed by Italian Government - MIBACT Ministero dei Beni Ambientali Culturali Territoriali)
[4] CRESCO – Cantieri di Rigenerazione Educativa Scuola Cultura Occupazione. Social, cultural and physical actions for the valorization of the educating community in a public housing neighborhood (local consortium with schools, NGOs and other actors, financed by Fondazione Paolo Bulgari)
[5 - 6] Advanced studies for strategic planning. Research about periurban agricolture, local development in peripheral urbani contexts, development of collaborative platforms, environmental sustainability and climate change, trends and patterns of urbanization (financed by Metropolitan City of Rome)
[7 - 8] MENTELOCALE. Collaborative mapping for the co-design of the ecological network of Eastern Rome (with local committees and associations, financed by Fondazione Paolo Bulgari)
5
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Dipartimento di Ingegneria Civile Edile e Ambientale
Sapienza Università di Roma
CA19123
Protection, Resilience, Rehabilitation of damaged environment
MEETING 19-21th January 2022

WG2
Bio-Electrochemical Systems to reduce the environmental impact of pollutants and bioresource valorisation

Biotechnology and genetic engineering of Gram-positive bacteria

Aleš Berlec

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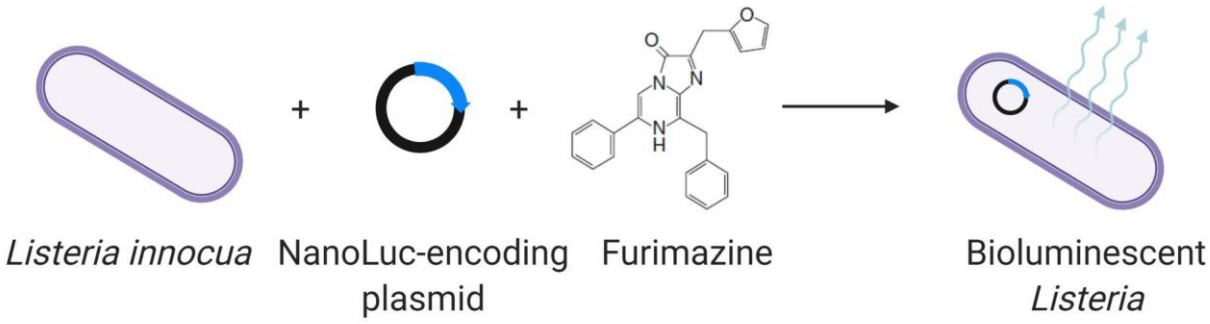
ABSTRACT

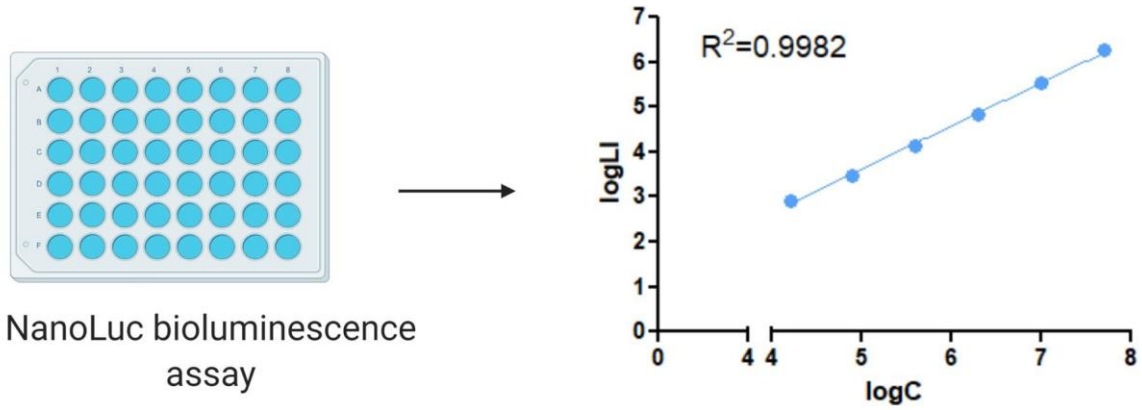
One of the interests of our research group is the development of novel tools for genetic engineering of Gram-positive bacteria. These tools enable studies of their properties, of their distribution and their quantification, as well as introduction of novel functionalities. For the latter, the bacteria are regarded as genetically modified organisms and have to be cultured in closed systems to prevent their spread into the environment. Genetic engineering approach involves the use of plasmids with compatible origin of replication, appropriate selection marker and species-specific electroporation for introduction of plasmid DNA. Below, four examples of genetic engineering are described:

a) We have developed CRISPRi plasmid for *Lactococcus lactis.* CRISPRi is a derivative of well-established CRISPR/Cas technology that enables targeting of catalytically inactive Cas9 to any region of the bacterial genome. Bound Cas9 prevents transcription and thereby enables silencing of the gene, which can be applied in the studies of gene functionality. Our proof-of-principle study targeted uracil phosphoribosyltransferase (1).
b) We have expressed NanoLuc luciferease in *Listeria innocua,* which is considered a non-pathogenic surrogate for *Listeria monocytogenes.* This enabled the development of a new bioluminescence biofilm assay for *L. innocua*. By measuring luminescence, the assay provided direct detection, absolute cell quantification, broad dynamic range, low time requirement, and high sensitivity (2).
c) We have developed a series of plasmids expressing fluorescent proteins and optimized electroporation conditions for vaginal lactobacilli *Lactobacillus crispatus, Lactobacillus gasseri* and *Lactobacillus jensenii.* A series of 16 species/fluorescent protein combinations was engineered. The fluorescence was used to observe the bacteria following their immobilization in nanofibers using confocal microscope, or their release using plate reader (3).

d) We have screened for novel surface anchors that enable surface display on lactic acid bacteria (4), as well as on other Gram-positive bacteria. The best candidates are tested for surface display of cellulases in the course of ERA.Net project Cell4Chem that deals with engineering of microbial communities for the conversion of lignocellulose into medium-chain carboxylates.

We are open for new collaborations and are particularly interested in developing and validating tools to control and measure extracellular electron transfer in model Gram-positive bacteria for biosensor and biocatalytical applications.





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Modified Polyvinylidene Fluoride Nanofiber Membranes in Microbial Fuel Cell

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ABSTRACT

Given the current trend of transitioning from fossil fuel supplies to more ecological energy sources, microbial fuel cells (MFCs) are gaining great importance due to their unparallel potential to transform wastewater into a valuable power source. However, their relatively low output compared to other fuel cells and high fabrication cost still limits their widespread utilization[1]. Therefore, improving MFCs efficiency is the top challenge in the field.

The latest advances indicate that the critical aspects for overcoming this challenge lie in the proper growth of microorganisms within the MFCs and the proton transfer efficiency between electrodes. At first glance, these two elements may seem quite independent, but both are closely related to a key MFCs component; the proton exchange membrane (PEM) between anode and cathode. On the one hand, even when it is desired that many microorganisms grow over the MFCs' anodes to produce vast quantities of electricity, their uncontrolled growth can also block the free proton flux in the system. On the other hand, a highly porous barrier would let the microorganisms cross to the cathode resulting in a proton conductivity decrement. Thus, an ideal PEM should avoid biofouling while efficiently transferring protons.

To date, various PEM commercial options partially offer a solution to such a dilemma. However, most of them still present implementation-related problems, such as limited proton conductivity, operational instability, or lack of mechanical strength[2,3]. To overcome these challenges, we propose modifying the existing PEM options by polyvinylidene fluoride (PVDF) nanofibrous membranes functionalized with a biosurfactant. These functional fibers reduce the excessive growth of microorganisms on the PEM

surface by providing a non-pleasant environment for their growth. Moreover, the hydrophilic oxygen-containing groups from the biosurfactant promote the nanofiber membrane's water retention ability, resulting in enhanced proton conduction[4].

Our results indicate that such a modification induces in the PEM a super hydrophilic behavior, which in turn leads to a 2-fold proton exchange rate enhancement in the MFC performance compared to one without modification. Besides, the structural integrity of the modifier membranes was assessed by surface tension tests and UV-Vis spectroscopy. Although the UV-Vis revealed a slight biosurfactant detachment, the surface tension tests confirmed that the modifier membranes are sufficiently robust to yield heavy water flow for over 24 hrs straight. Thus, since the current approach allows us to increase the proton flux in MFCs while ensuring operational stability effectively, these findings will be of great interest for further developments in improving MFCs.

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See also the poster in the following page

Working Group 2

TECHNICAL UNIVERSITY OF LIBEREC
Institute for Nanomaterials, Advanced Technologies and Innovation

Wrocław University of Science and Technology

Modified Polyvinylidene Fluoride Nanofiber Membranes in Microbial Fuel Cell

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Introduction

Given the current trend of transitioning from fossil fuel supplies to more ecological energy sources, microbial fuel cells (MFCs) are gaining great importance due to their unparallel potential to transform wastewater into a valuable power source. However, their relatively low output compared to other fuel cells and high fabrication cost still limits their widespread utilization[1]. Therefore, improving MFCs efficiency is the top challenge in the field.

Our research work focused on preparation of nanofiber incorporated PEM, which can reduce the excessive growth of microorganisms on membrane surfaces using biosurfactant (BS) surface modification. The main aim of the research is to reduce the biofouling formation on the nanofiber membrane surface. The membranes helped to control the microorganism growth and, thus, proton flux in the system. This approach allows us to increase the lifetime of the synthetic polymeric membranes.

Methods

Polyvinylidene fluoride nanofiber membrane were prepared in CXI-Technical university of Liberec. Prepared membrane surface was modified using rhamnolipid BS as shown in Fig. 1.

MFC set up was design as single chamber air–cathode MFC [1]. The maximum power density of the MFC was monitored by measuring linear sweep voltammetry using a potentiostat MultiPalmSens4 (Palmsens BV, Netherlands). Ohm's Law was used to calculate the power: P = I × V, where P – power (watt), I – current (amp), V – voltage (volt).

Washing test was used to determine stability of surfactant on the membrane surface. Membranes were washed with various intervals up to 1440 minutes. Surface tension and UV-Spectroscopy was used to control stability of biosurfactant attachment.

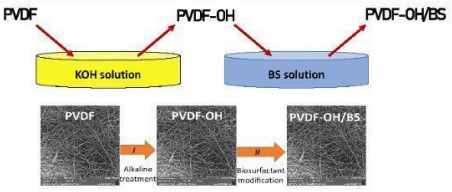

Fig. 1. Schematic diagram of surface modified PVDF PEM

Results

The maximum power density was monitored once a week, during the operational period of the study (50 days). Figure 2 shows the maximum power density of modified and unmodified membranes in the following weeks of operation. Modified membrane (Ceramic+PVDF-OH/BS) generated a higher level of power density in a long-term condition compared to unmodified PVDF membrane (Ceramic+PVDF).

The washing test was carried out to investigate the attachment of biosurfactant through surface tension and UV/vis measurements (Fig. 3). Surface tension results indicates no significant BS release was observed. In case of the surfactants released to the water, the surface tension would expect to drop drastically. The absorption spectrum of BS is characterized by peak at 200 nm. There was a large reduction observed in the peak absorbance during washing, which confirms the binding of biosurfactant with membrane surface.

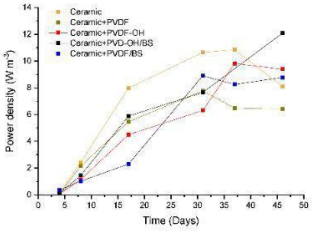

Fig. 2. Power density in time

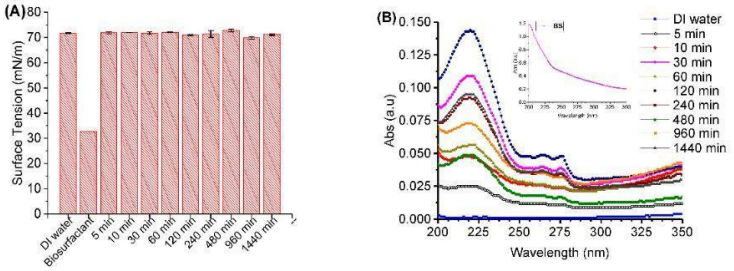

Fig. 3. (A) Surface tension and (B) UV-spectroscopy results of washing test

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We acknowledge the COST Action Horizon program and the COST Action PHOENIX: Protection, resilience, rehabilitation of damaged environment (CA19123), as well as the Polish National Agency for Academic Exchange – Polish Returns grant (PPN/PPO/2018/1/00038) and National Science Centre (Poland) OPUS grant (2019/33/B/NZ9/02774).

Controlling the emission of antibiotics into aquatic systems by hybrid bioelectrochemical constructed wetlands

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ABSTRACT

The occurrence of antibiotics, antimicrobial resistance together with the presence of microbial pathogens in aquatic ecosystems is raising the concerns of general public, stakeholders and scientific community. Water treatment technology capable of controlling the emission of antibiotics and resistance into water bodies is in high-demand. Yet, there is limited information and evidence about the capability of nature-based solutions (NBS) to reduce the impact of antibiotics from wastewaters.

Nature-based solutions to reduce antibiotics, pathogens and antimicrobial resistance in aquatic environments (NATURE) is a recently funded Aquatic Pollutants project with the aim of providing measures and technologies to mitigate the impact on water quality. NBS are defined as “living solutions” inspired by nature to address various societal challenges in a resource-efficient and adaptable manner, while delivering simultaneously economic, social, and environmental benefits. NATURE provides a holistic assessment of NBS as management option of antibiotics from inland to coastal areas. Among the different specific objectives of the NATURE we aim to evaluate and optimize the performance of secondary wastewater treatment by NBS.

Aarhus University and Kilian Water are working together to push forward the treatment of antibiotic residues by NBS. The work is currently focused on implementing the monitoring program for three treatment wetland designs: the most innovative hybrid bioelectrochemical wetland that will be benchmarked against an aerated constructed wetland and a vertical flow constructed wetland. We will study similar size (approx. 100 PE sized beds) systems treating domestic wastewater implemented in Denmark. Systems will be monitored for 1 year, by quantifying target model antibiotics and

respective transformation products together with classical water quality parameters. On the second year of the project, operational conditions will be manipulated and the effects in treatment performance studied. Antibiotic resistance and pathogens will be further studied by other project partners.

See also the poster in the following page

Working Group 2 - Bio-Electrochemical Systems to reduce the environmental impact of pollutants and bioresource valorisation

AARHUS UNIVERSITY
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Controlling the emission of antibiotics into aquatic systems by hybrid bioelectrochemical constructed wetlands

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Introduction

The occurrence of antibiotics, antimicrobial resistance together with the presence of microbial pathogens in aquatic ecosystems is raising the concerns of general public, stakeholders and scientific community

Water treatment technology capable of controlling the emission of antibiotics and resistance into water bodies is in high-demand. Yet, there is limited information and evidence about the capability of nature-based solutions (NBS) to reduce the impact of antibiotics from wastewaters..

Nature-based solutions to reduce antibiotics, pathogens and antimicrobial resistance in aquatic environments (NATURE) is a recently funded Aquatic Pollutants project with the aim of providing measures and technologies to mitigate the impact on water quality. NATURE provides a holistic assessment of NBS as management option of antibiotics from inland to coastal areas.

MONITORING OF NBS AT RIVER CATCHMENT

NATURE

CSIC climar ENJ-AU KIT

National Funders

Innovation Fund Denmark Sida FCT

Objective

Among the different specific objectives of the NATURE we aim to evaluate and optimize the performance of secondary wastewater treatment by NBS. Namely, a full-scale hybrid bioelectrochemical constructed wetland treating domestic wastewater from a small town.

Approach

- Partnership between Aarhus University and Kilian Water ApS (SME)
- Comparison of three constructed wetland designs: 1) hybrid bioelectrochemical constructed wetland, benchmarked against 2) a vertical flow system and an aerated system.
- All stsrems treat domestic wastewater, have similar sizes (approx. 100 PE sized beds) and are located in Denmark.
- Year 1: 12 months monitoring to assess performance baseline
- Year 2: manipulation of operational conditions to determine up- or down-regulation in treatment performance.
- Measurement of: target antibiotics and antimicrobial compounds; basic water quality parameters; antibiotic resistance and pathogens

Status

- Early screening and site selection ongoing
- Target compounds defined
- Harmonizing sampling plans, protocols and analytical methods across international partners

Acknowledgement
The authors would like to thank the European Commission and (AEI, IFD, BMBF, FCT, and Sida) for funding in the frame of the collaborative international consortium (Consortium acronym) financed under the 2020 AquaticPollutants Joint call of the AquaticPollutants ERA-NET Cofund (GA No 869178). This ERA-NET is an integral part of the activities developed by the Water, Oceans and AMR JPIs

Improved hydrogen production in MECs by introducing gel-entrapped anodes – plans and current status

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ABSTRACT

In the SIREN project ("Integrated system for SImultaneous Recovery of Energy, organics and Nutrients and generation of valuable products from municipal wastewater") we are developing and testing a microbial electrolysis cell (MEC) with gel-entrapped anodes to produce hydrogen gas from municipal wastewater and reject water after anaerobic digestion. It is hypothesised that the hydrogel entrapment of pure anode-respiring bacteria will improve the efficiency of the biological reactions occurring on the anode and prevent the development of methanogenic growth on the anode by providing a shielded environment. As the process may be limited by the diffusion rates of the available organic compounds in the feed stream, the gel thickness and polymer concentration are sought optimised according to the diffusion characteristics of selected compounds through the hydrogel depending on cell density and cell viability. The efficiency of the system will be compared to a similar system with carbon felt anodes.

See also the poster in the following page

Working Group 2 – Bioremediation in the 21st century

Improved hydrogen production in microbial electrolysis cells (MECs) by introducing gel-entrapped electrodes – plans and current status

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Abstract
In the SIREN project we are developing and testing a microbial electrolysis cell (MEC) with gel-entrapped bioanodes to produce hydrogen gas from municipal wastewater and reject water after anaerobic digestion. It is hypothesised that the hydrogel entrapment of pure anode-respiring bacteria will improve the efficiency of the biological reactions occurring on the anode. As the process may be limited by the diffusion rates of the available organic compounds in the feed stream, the gel thickness and polymer concentration are sought optimised according to the diffusion characteristics of selected compounds through the hydrogel depending on cell density and cell viability. The efficiency of the system will be compared to a similar system with carbon felt anodes. Similarly, if the membrane is removed (creating a one-cell MEC) to improve hydrogen production further and the cathode is entrapped in a hydrogel, it is further hypothesised that any development of methanogenic growth on the cathode would be prevent by providing a shielded environment.

Materials & methods

Reference MEC
We have built a **reference module two-cell MEC** similar to the ones built by Heidrich et al. (2013) and Baeza et al. (2017) using a 12 mm carbon felt (Zoltek PX35; 95% open porosity and an electric resistance of 6.3 Ω·mm) as solid support for the bioanode. The carbon felt was sandwiched between two acid-proof stainless-steel meshes and placed on each side of the cathode with an anionic exchange membrane separating the cathode and anodes. The catholyte (200 mM NaCl) is pumped in circulation to both provide good mixing internally in the cathode and to measure the pH development during hydrogen production. The MEC is placed inside a sealed anode chamber with the anolyte (wastewater) being pumped in circulation to provide good mixing and monitoring of pH, conductivity, DO and redox level. Se set-up is shown in more details in **Figure 1**.

Gel-entrapped bioanode MEC
Anode-respiring bacteria (ARB) will be isolated from the reference MEC and entrapped in a PVA-SbQ hydrogel. The photosensitive stilbazolium groups on the PVA backbone undergo a biocompatible photo-induced gelling process in fluorescent white light producing an irreversible and highly flexible hydrogel structure (Vogelsang et al. 2000). The gel-entrapped ARB will be molded on a fine-meshed acid-proof stainless-steel frame which then will replace the carbon felt bioanodes on the reference MEC.

Determining the appropriate PVA-SbQ concentration and gel thickness
Any substrates for the ARB need to diffuse through the gel. If the consumption is faster than the diffusion rate, then the consumption will be diffusion limited. Both the polymer network porosity (which is dependent on the fraction of SbQ units) and the concentration of ARB cells influence the diffusion rate. As long as the substrate is consumed, and the bulk concentration is stable, there will be a gradient through the fixed film and the hydrogel. At a certain gel thickness and accumulated consumption, there will be no available substrate left, as illustrated in **Figure 2**.

To determine the appropriate PVA-SbQ concentration and gel thickness to use in the gel-entrapped anode, a number of hydrogel diffusion tests are being conducted with relevant substrates (acetate, glucose, lactose, glycerol, butyrate and lactic acid) and different PVA-SbQ concentrations and inactive biomass (using kaolin as substitute). See **Figure 3**. The results will be linked with the specific consumption rates obtained with the reference MEC.

Working hypotheses

1. Since it is possible to entrap pure anode-respiring bacteria in the hydrogel, the biological reactions occurring on the anode will be significantly more efficient than on the carbon felt in the reference MEC if the gel thickness and PVA-SbQ concentration is optimised.
2. Once established, the process will be more stable due to the shielded environment provided by the hydrogel.
3. In a one-cell MEC, if the cathode is entrapped in pure hydrogel, it is postulated that any unwanted methanogenic growth would be prevented due to the shielding provided by the hydrogel.

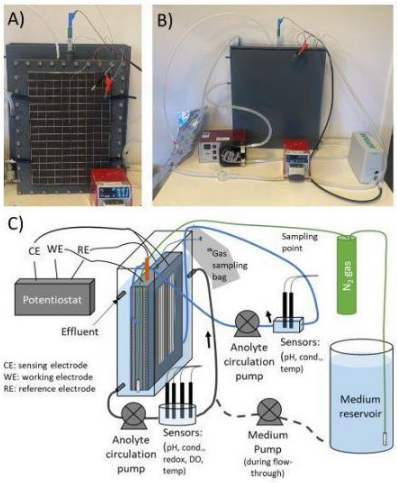

Figure 1. MEC set-up. **A)** The MEC outside the anode chamber showing one of the bioanodes. **B)** The basic part of the MEC system with the MEC in the anode chamber. **C)** Illustration of the MEC system with all components. Photos: Vogelsang.

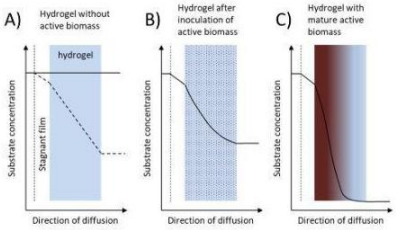

Figure 2. Diffusion in hydrogels without any active biomass (the stippled line indicating prior to steady state conditions) **A)**, after inoculation of active biomass **B)** and when the biomass have matured forming a gradient through the hydrogel **C)**.

Figure 3. Set-up for testing diffusion in hydrogels. Photo: Vogelsang.

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The SIREN Project.
Integrated system for SImultaneous Recovery of Energy, organics and Nutrients and generation of valuable products from municipal wastewater. The project is funded the EEA and Norway Grants. Read more about the project at https://siren.put.poznan.pl/

Application of carbon nanomaterials in CH_4-producing bioelectrochemical systems

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ABSTRACT

The improvement in global awareness and the demand for sustainable technologies and products strongly contributed to laid plans to combat climate change. CO_2 emission to the atmosphere is one of the major driver of global climate change, thus the development of alternative technologies for carbon capture, utilization and storage attracts more and more attention having positive impacts on economy, society and environment. Electrochemically assisted CH_4 production from carbon dioxide (CO_2) in a bioelectrochemical system (BES) using microorganisms as the catalyst, is a new and emerging technology in BESs. The bioelectrochemical production of CH_4 from CO_2 is an innovative approach that allows the storage of electrical renewable energy in the form of CH_4, that can, when needed, be reconverted. In addition, CO_2 is simultaneously captured contributing to mitigate the climate change and the global warming.

However, this technology has limitations mainly related to the transfer of electrons between the electrode and the biocatalysts, which limits its application at a large-scale. Previous results, obtained within the research group, demonstrated that improving the electrode surface area will improve the microbial attachment, thus increasing the efficiency of the process.

This work aimed to investigate the effect of the presence of carbon nanomaterials (carbon nanotubes (CNTs) at the cathode, on the CH_4 production via CO_2 reduction. It was hypothesized that the presence of carbon nanomaterials will improve the electrode surface area, thus increasing the electron transfer between the electrode and the biocatalysts.

The production of CH_4 was analyzed in two BESs, one working with a modified electrode (BES- CNT) and another one that works as a control with a non-modified electrode (BES-CTRL). The potential of CNTs to improve CH_4

production was investigated under different electrochemical control modes, potentiostatic and galvanostatic. The results demonstrated that for both electrochemical control modes, the production of CH_4 was higher in the presence of CNTs compared to the control assay.
In conclusion, this work contributed with preliminary insights on the effect of carbon nanomaterials, namely CNTs, to improve the biocathode performance on BESs for CH_4 production from CO_2.

WG3
Environmental monitoring and sensing

Methane degradation and sensor measurements necessity for biocovers

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ABSTRACT

Greenhouse gas emissions from waste sector are about 18 % of the global, therefore after landfill closure methane and other gasses remain trapped and degrades exponentially slower. Residual methane always remains and is still released nevertheless of earlier gas collection. Degradation of methane with aims of biologically constructed engineered biocover layer is possible. Biocovers novelty requires testing at operating landfill in pilot mode and extend in future opportunities for the use in remediation projects, column studies are preferable as screening option. Actions promoting EU climate policy and achieving two UN sustainable development goals: SDG13 reduction of greenhouse gases, and SDG12 recovery of materials are crucial. Important aspects are related to laboratory studies where column studies are necessary as well as field research. Therefore sensor applications are crucial for gasses measurements from covered waste masses.

Acknowledgements

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Environmental monitoring and sensing: Core Competences

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See the poster in the following page

PHOENIX COST Action

WG3 Environmental monitoring and sensing

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Core competences

Analitical methods



Different analytical instruments (UHPLC-MS/MS and UHPLC-Orbitrap HRMS with HESI, APPI, APCI, GC-MS with HS or SPME, GC-μECD) with complementary applications range enable wide range target and screening analysis of chemical contaminants in various environmental matrices; so far different pharmaceutically active compounds, perfluorinated compounds, pesticides, PCBs and PAHs have been analyzed in soil or water samples.

Additionally, hydrothermal biomass conversion has been studied as a means to convert wet biowaste to valuable solid (hydrochar as a multifunactional product) and liquid (source of important biochemicals) product, which characterization by available analytical methods provides information on their possible functional and safety aspects.


Colloids and Surfaces B: Biointerfaces

Characterization and application of biochar-immobilized crude horseradish peroxidase for removal of phenol from water


Science of the Total Environment

Seasonal occurrence and cancer risk assessment of polycyclic aromatic hydrocarbons in street dust from the Novi Sad city, Serbia

Water and wastewater treatment-heavy metal adsorption


Journal of Hazardous Materials

A new approach for modelling and optimization of Cu(II) biosorption from aqueous solutions using sugar beet shreds in a fixed-bed column

Nevena Blagojev, Dragana Kukić, Vesna Vasić, Marina Šćiban, Jelena Prodanović, Oskar Bera


Journal of Environmental Management

Modelling and efficiency evaluation of the continuous biosorption of Cu(II) and Cr(VI) from water by agricultural waste materials

Nevena Blagojev, Vesna Vasić, Dragana Kukić, Marina Šćiban, Jelena Prodanović, Oskar Bera

Our research group is interested in any kind of cooperation within the action: STSM, mobility, project applications etc.

"LEGO-microbes" - a new approach for building a microbial structures for successful remediation of the environment

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ABSTRACT

In the environment, multimicrobial structures such as flocs, mats or biofilms are extremely well spatially organized in terms of microenvironmental conditions and metabolite exchange that allow the establishment of different niches within. However, structures are formed by chance and it is extremely valuable to develop a synthetic approach since they are not only interesting for the basic research, but even more, the structures are acting as catalytic cores - i.e., they have exceptional useful value if they can be tailor assembled and maintained in biotechnological processes especially when applied in environmental technologies.

To assemble spatially oriented microbial cells within the consortium composed of different cells we need at least four simple components (4S):

(i) Stickiness, a special "glue" to attach one cell to another and then promote their mutual interaction must be used,

(ii) Spatial, cells should be spatially oriented according to the design to exchange metabolites,

(iii) Stable, structures should not disintegrate in the solution or solid matrix (e.g. soil) after the initiation of microbial growth and (iv) Scalable, a method must be upscaled for the use in the biotechnological systems.

To develop such synthetic structures we treated bacterial cells as colloidal particles to which we can approximate a zeta potential of about -40mV by the Smoluchowski equation. According to DLVO theory if we change the surface potential of one cell it will attach to the cell with opposite charge.

By careful manipulation using a top-down approach we were able to prepare special structures enabling the combining of different bacterial cells, including strict anaerobes, forming stable planar or 3D structures. Until now we have successfully applied the "LEGO" approach in the preparation of catalytic structures for organic wastewater processing, metal precipitation

from mine tailings, removal of micropollutants, prevention of biocorrosion and revalorisation of lignin wastes from the paper pulp industry.

See also the poster in the following page

Working Group 3

A new approach for building microbial structures for successful remediation of the environment

LEGO MICROBES

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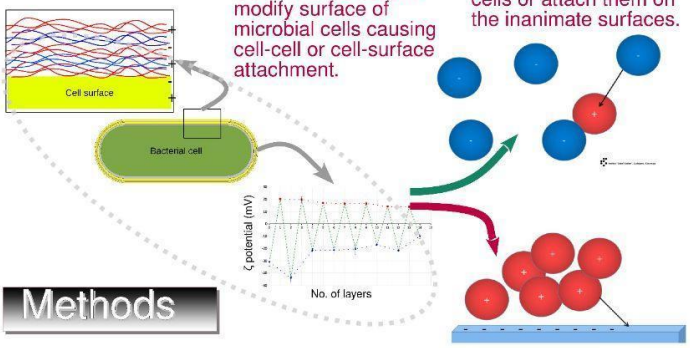
Introduction

Can we construct spatially oriented synthetic community like we put LEGO bricks together?

Yes, if we are able to modify surface of microbial cells causing cell-cell or cell-surface attachment.

Then we can aggregate cells or attach them on the inanimate surfaces.



Motivation

We are aiming to produce multicellular structures composed of multiple microbial species. By placing them in specific place, different microniches are formed, engaging cells to engage different metabolic pathways (Fig.1).

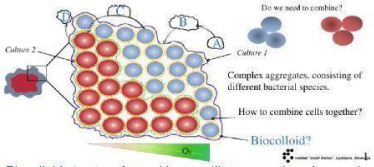
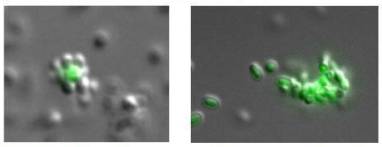


Fig.1. Biocolloid structure formed by specific aggregation of several different cells. This is spatially forming gradients of oxygen and nutrients. Besides, cells are also oriented in such a way that they can exchange metabolites and cross-feed each others according to the metabolic vectors.

Results



1. Specific or less specific aggregation is decreasing distance between cells and minimize competition.
(see van Tatenhove-Pel et al. 2021)

3. We forced different strains to form synthetic and stable biofilms on different surface such as steel, glass, cellulose etc. By this we were able to control community succession in open environmental systems.
(see Deev, et al., 2021 and Rijavec et al., 2019)

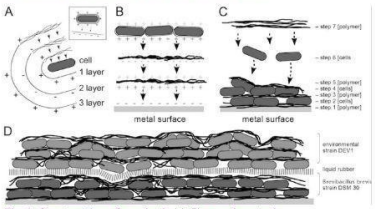


Fig.4. Construction of synthetic biofilm on the steel surface (Rijavec et al., 2019)

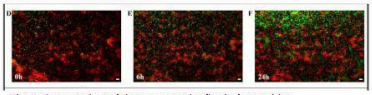


Fig.5. Succession of the community firstly formed by synthetic biofilm (red cells) and then invaded by the another type of cell (green coloured) (Deev et al., 2021).

Methods

We developed a set of methods based on tailor made capsules with nano-thickness that enable us to change surface potential of bacterial cells not causing any harm to them. Based on that we then developed different top-down approaches using different mixing or dipping approaches.

2. Aerobic cultivation of strict anaerobic strains by combination of aerobes and sulfate reducers. The constructs are precipitating inorganic pollutants within the anaerobic niches.

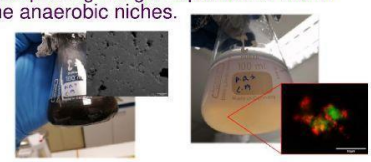


Fig.2. Artificial aggregates consist of *Desulfovibrio africanus* (SRB) and *Cobetia marina*, and were cultivated on a shaker in **aerobic conditions.** In 5 days black precipitate formed, indicating growth of

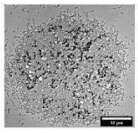


Fig.3. Synthetic aggregates of *Shewanella oneidensis* precipitated V^{4+}

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Acknowledgement

P1-0143
Cycling of substances in the environment, mass balances, modelling of environmental processes and risk assessment

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Project APPLAUSE

Photo of some on-site participants at the January Meeting in front of the Sapienza University.

General Information on COST Action CA19123 - Protection, Resilience, Rehabilitation of damaged environment (PHOENIX)

Humanity faces unprecedented challenges: global warming, overuse of fossil fuel energy and rapidly growing urbanisation. While the development, validation and cost-efficiency improvement of energy-aware and limited-complexity solutions are becoming increasingly time-consuming, microorganisms represent one realistic hope. For millennia microbes have tirelessly been shaping the Earth's ecosystems and with the right approach, they can help re-introduce environmental equilibrium. PHOENIX aims to demonstrate the effectiveness of Bio-electrochemical systems (BESs); BESs are low environmental impact systems that exploit the biological activity of live organisms for pollutant reduction, recycling of useful elements, synthesis of new products and production of electricity, in the case of microbial fuel cells (MFC). Recent advances in the field of low power electronics enable the exploitation of these sustainable and environmentally-friendly technologies. The activities of PHOENIX are related to the characterization of BESs technologies and their implementation as bio-remediator, bio-sensors, and bio-reactors connected to sustainable urban planning, educational and socio-economic aspects. The integration of bio-technologies in the urban context is a key priority for appropriate rational urban planning and minimum environmental impact.

Action keywords

bio-electrochemical system - microbial fuel cell - depollution - educational and socio-economics aspect of environmental science - low power

electronics - energy harvesting - wireless sensor network - sustainable city planning

Action Details:
MoU - 026/20
CSO Approval date - 24/03/2020
Start date - 21/09/2020
End date - 20/09/2024
https://www.cost-phoenix.eu

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WG1 Educational and socio-economics aspect of environmental science for sustainable city planning

Leader: Dr Rawad CHAKER

Co-coordinator: Dr Marco GISSARA

WG2 Bio-Electrochemical Systems to reduce the environmental impact of pollutants and bioresource valorisation

Leader: Dr Argyro TSIPA

Co-coordinator: Prof Claudio AVIGNONE ROSSA

WG3 Environmental monitoring and sensing

Leader: Prof Fabien MIEYEVILLE

Co-coordinator: Prof Giampiero DE CESARE

WG4 Point-of-load

Leader: Prof Domenico BORELLO

WG5 Dissemination

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COST near neighbour countries

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Universidad de La Sabana	PROF VASCO BARBOSA

WORKING GROUP DESCRIPTION AND MAIN ACTIVITIES IN THE FIRST YEAR OF PROJECT

WG1 – EDUCATIONAL AND SOCIO-ECONOMICS ASPECT OF ENVIRONMENTAL SCIENCE FOR SUSTAINABLE CITY PLANNING

Leader: Dr Rawad CHAKER

Co-coordinator: Dr Marco GISSARA

This WG supports the methodological and applicative aspects concerning the technology itself and the user's implications and impact qualification (in terms of costs vs gains) according to the deployment of technological devices, also focusing on the relationships between technological development, environment, urban planning and empowerment of local actors (groups of inhabitants, NGOs, etc.).

Deliverables will be reviews, reports or papers on the relationship between education, technology and environment, as well as sustainable city planning. Also, a related conference is planned on social aspects and integration of biotechnology for an ecologically coherent urban planning and city-making process and sustainable city planning for resilient cities and environment protection. Furthermore, a deliverable in connection with WP5 will be an educational easy-to-use handbook (D17) available on-line (supported by three STSMs). Specific polling activities are envisaged as general studies of the opinion of particular groups of people and actors.

Activities are related to:

- Implication of users in the technological implementation: qualification and quantification of level of acceptance, ecosystem improvement and empowerment (user-centred inquiries, participatory observation,

trainings); Social impact and acceptance by local communities;

- Increase social awareness of the opportunities for fractioned and widespread energy production, realised with eco-sustainable techniques;
- Introduction of the technologies into educational processes
- Action-research activities, e.g. hybrid participative design/public dissemination workshops, expert participation in local networks of people interested in sustainable urban regeneration policies and practises, development and use of tools for 'citizen science', etc.;
- Co-construction of socio-technical shared indicators, built on research bases and with the population in order to predict and evaluate how the objectives of protection, resilience, recovery of damaged environments is implemented;
- Integration of innovative technological means with well-established nature-based solutions and methodologies for ecological networks reparation (defragmentation) in urban contexts.

WG1 is organised in two tasks:

WT11 Relation between education, technology and environment; Deliverable 1 (D1) will be the production of a scientific report on educational teaching, knowledge mediation and moving, with support of 2 STSMs and the organisation of a dedicated conference on the relationship and links between technology, society, education, political decision-making and environment preservation.

WT12 Sustainable City Planning; accountable to produce a joint paper on sustainable city planning for resilient cities and environment protection (D11 – Month 48), supported by 2 STSMs joint with the organisation of a dedicated conference.

WG1 main activities and results from the first year of the project

Publications

Khalife M. & Chaker R. (2021) Eco-Citizenship Education in the Lebanese Educational Institutions Vis-à-vis the Actual Achievements and Challenges. *The challenges of citizenship education during the digital era facing todays' crises and globalization 2021. Lebanese Association for Educational and Cultural Renovation*. December 10-11, Beirut, Lebanon.

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Urgelli, B. (2022). Interpellations dans l'enseignement des sciences : des stratégies d'action liées aux représentations des enseignants et aux situations. In F. Lantheaume & S. Urbanski (dir.), *Laïcité, religions, racisme en milieu scolaire, Enquête sur les pratiques professionnelles en collèges et lycées* (2015-2020). Presses Universitaires de Lyon.

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WG2 - BIO-ELECTROCHEMICAL SYSTEMS TO REDUCE THE ENVIRONMENTAL IMPACT OF POLLUTANTS AND BIORESOURCE VALORISATION

Leader: Dr Argyro TSIPA

Co-coordinator: Prof Claudio AVIGNONE ROSSA

The WG2 program concerns aspects like bioremediation techniques and surface science related to BESs which can lead to environmental sustainability. Aspects that concern WG2 are electro remediation, bioremediation, bioprocesses, electromagnetic interactions on biofilm, BESs and electrodes materials, bioresource valorisation, electro-fermentation, biological interaction, water valorisation for coffee industry, drilling waste biodegradation, gene expression of microbial communities of MFCs, kinetic modelling of regulatory mechanisms of microbial communities involved in MFCs.

Some main scientific events will be organized by WG2 to spread the related knowledge and science progress and innovation among the consortium: a conference on Surface science in MFCs; a conference on microbial-functionalized electrodes interactions in BESs; a conference on BESs depollution capabilities; a conference on Hazardous contaminant treatment with BESs.

A Working Task organisation of WG2 comprehends:

WT21: Surface science related to BESs and sensors. This task includes a conference on surface science advancements for improving the performance and selectivity of microbial fuel cells for biosensor applications, and STSMs (e.g. short-term internships for PhD or MSc students) towards improved microbial metabolism in BESs. Knowledge exchange is planned with other

WGs and the implementation will be concluded with D2 as scientific report (Month 24).

WT22: Drilling waste biodegradation, biosurfactants and bioplastic production potential and Gene regulatory networks modelling for optimal bioprocesses of BESs: We will carry out activities on the production of biosurfactants and bioplastics, and to identify genes responsible for electrogenic activity, to build a gene regulatory network kinetic model built connecting the inter- and intra- regulatory mechanisms focused on added-value products formation, Knowledge exchange between partners will be supported by two STSMs dealing with environmental biotechnology. A dedicated conference will be organized among the dissemination activities. A scientific report (Month 24) on added-value compounds formation by MFCs using drilling waste will be written (D12).

WT23: Capacity of microbial communities to degrade hazardous contaminants: this WT will focus on different case studies which rely on the capacity of natural microbial communities to degrade contaminants (e.g. persistent organic pollutants and pharmaceuticals) with BESs. Exchange of knowledge between partners will be performed with 3 STSMs dealing with natural microbial communities able to degrade contaminants in BESs and training innovative methods for identifying electrochemically bacteria involved in xenobiotic degradation. Moreover, a conference on Hazardous contaminant treatment with BESs will be organized. A common review paper on the knowledge gaps and research needs for the implementation of BESs used for contaminant degradation will be written (D9 – Month 42).

WT24: Functionalized electrodes in BESs, Electro-fermentation, BESs for production of valuable compounds: this WT will focus on the study and consolidation of knowledge in the production of valuable compounds with

Electro-fermentation and functionalized electrodes in BES. Two scientific reports are expected to arise from these activities at Month 42 (D3). For Knowledge sharing between partners, two STSM will be promoted, one to train a young researcher in the preparation and characterization of functionalized electrodes and another in Electro-fermentation for wastes valorisation. The organisation of a conference on microbial-functionalized electrodes interactions in BESs is among the responsibilities of WT24. Besides, Practical Workshops on BES technologies will be organised with the goal to disseminate this technology among secondary students. 14

WT25: Wastewater depollution: WT25 will use BES inoculated with native or artificial microbial communities to depollute urban and agro-industrial wastewater with high organic loads, and will construct low-cost devices employing recycled or repurposed materials. Activities will involve STSMs for ECRs and PGRs training on BES construction using suitable alternative materials, and on applications of BES in wastewater depollution and re-use, either as self-standing systems or in combination with established technologies. WT26 includes the organisation of a conference on BESs depollution capabilities, with participation of world-leading scientists and technologists, and involving an experimental section directed to non-experts, where the advances and developments made in the STSMs will be put into practice. Deliverable: Scientific report in Month 24 (D6)

WG2 main activities and results from the first year of the project

Publications

Tsipa A., Varnava C. K., Grenni P., Ferrara V., & Pietrelli, A. (2021). Bio-Electrochemical System Depollution Capabilities and Monitoring Applications: Models, Applicability, Advanced Bio-Based Concept for Predicting Pollutant Degradation and Microbial Growth Kinetics via Gene

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Borello D, Gagliardi G, Barra Caracciolo A, Garbini GL, Visca A, Rolando L, Aimola G, Ancona V, Grenni P, 2021. Microbial activity and energy production of terrestrial MFCs in presence of compost and persistent organic pollutants. Archival paper in Digital Proceedings of 16th Conference on sustainable development of energy, water and environment systems - SDEWES, Dubrovnik, 10-15/10/2021, ISSN – 1847-7178, FP_165, pp 1-6.

Participation in the *16th Conference on Sustainable development of Energy, water and Environment System* (SDEWES), Dubrovnik, 10-15 October 2021 as chair in two special sessions:

1-Plant Assisted Bioremediation of Contaminated Areas: A Sustainable Technology for Recovering Soil Pollution and Energy Conversion in a Framework of Circularity (Chaired by Domenico Borello, Valeria Ancona, Anna Barra Caracciolo)

2- Bio-Electrochemical Systems as Sustainable Technologies for Implementing Innovative Remediation and Energy Harvesting Technologies (Chaired by Domenico Borello, Valeria Ancona, Paola Grenni Ioannis Ieropulus, Andrea Pietrelli)

In the same Conference the following oral presentations we performed:

- Ancona V, Aimola G, Garbini GL, Grenni P*, Losacco D, Rascio I, Nogues I, Terzano R, Pietrini F, Zacchini M, Porfido C, Uricchio VF, Barra Caracciolo A, 2021. Organic amendments of contaminated soil for improving phyto-assisted bioremediation

- Borello D, Barra Caracciolo A, Gagliardi G, Aimola G, Ancona V, Visca A, Rolando L, Garbini GL, Grenni P, 2021. Microbial activity and energy production of terrestrial MFCs in presence of compost and persistent organic pollutants

- Ancona V, Uricchio VF, Rascio I, Aimola G, Gatto A, Grenni P, Garbini GL, Barra Caracciolo A, Tumolo M, 2021. Microcosm experiment for assessing sunflower capability to grow on a PCB-contaminated soil

Participation to the *7th International Conference on Disaster Management and Human Health: Reducing Risk, Improving Outcomes.* On-line Conference, 10–12 November 2021. In that occasion, Prof. Ferrara presented the following work, just published:

Aimola G, Gagliardi G, Pietrelli A, Ancona V, Barra Caracciolo A, Borello D, Ferrara V, Grenni P, 2022. Environmental remediation and possible use of terrestrial microbial fuel cells, In: Disaster Management and Human Health Risk VII, Ed. G. Passerini, WIT Transactions on The Built Environment Series 207: 121-133, WIT Press. doi: 10.2495/DMAN210101, pp. 121 – 133, ISBN 978-1-78466-445-9https://www.witpress.com/elibrary/wit-transactions-on-the-built-environment/207/38187

Chapter (accepted, in press):

Ancona V., Borello D, Grenni P., Gagliardi G., Aimola G., Ferrara V., Pietrelli A, Barra Caracciolo A, 2022. Celle a combustibile microbiche terrestri: uno strumento efficace nel recupero di suoli contaminati e nella produzione di energia. Le bonifiche ambientali nell'ambito della transizione ecologica. Edizioni SIGEA, Collana: Monografie di Geologia Ambientale

WG3 - ENVIRONMENTAL MONITORING AND SENSING

Leader: Prof Fabien MIEYEVILLE

Co-coordinator: Prof Giampiero DE CESARE

WG3 focuses on the activities of monitoring and sensing, evaluating and exploring the different patches to exploit the energy converted from BESs and its sensing capabilities, in synergy with the other WGs. In the context of low power communications activities will be focused on the development and testing of autonomous efficient WSN. Also, activities will be performed for evaluation of sensing capabilities of BESs, optimization of hardware platforms, operating systems and MFCs configuration for several scenarios. Furthermore, WG3 takes part in the design of innovative sensors like system-on-glass for labon-chip that allow in-situ and real-time detection of small quantities of substances, like for acid rain evaluation.

The activities of this WG include the organization of a conference on environmental monitoring applications for energy harvesting techniques like MFCs and on sensors.

WT31: autonomous efficient WSN; A scientific report will be delivered (D4 – Month 36) on the following activities: monitoring of environments and sea (Benthic MFCs fabrication and testing); optimization of hardware platform, operating systems and MFC configuration for several scenarios; organization of a conference on environmental monitoring applications and a special session on BES (D16) attached to the existing JNRSE (days of energy harvesting and storage – 2021). Support of two STSMs) on autonomous WSN systems.

WT32: sensors for real-time detection: research and development of sensors for real-time control with innovative methods like lab-on-chip systems; the

activities will be supported by two STSMs; organization of a conference focused on Sensors; A scientific report (D10 – Month 48) will be delivered on development of environmental sensors integrated in lab-on-chip systems and powered by MFC cells and inserted in a detection network for pervasive and real time monitoring. Joint organization of in-field research activities and a practical seminar for kids (primary and secondary school) during training at natural lake/park school (D8) with WG4.

WG3 main activities and results from the first year of the project

Publications

Tsipa, A., Varnava, C. K., Grenni, P., **Ferrara,** V., & Pietrelli, A. (2021). Bio-Electrochemical System Depollution Capabilities and Monitoring Applications: Models, Applicability, Advanced Bio-Based Concept for Predicting Pollutant Degradation and Microbial Growth Kinetics via Gene Regulation Modelling. Processes, 9(6), 1038. https://www.mdpi.com/2227-9717/9/6/1038

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WG4 - POINT-OF-LOAD

Leader: Prof Domenico BORELLO

WG4 will focus on the electrical management aspect of energy harvesting techniques with MFCs. Assuming as primary objective the improvement of electrical outputs performance and energy storage systems: develop MFC systems with higher than state-of-the-art power outputs, considering miniaturisation of systems, increase in capacity and decrease in energy losses. Objectives of WP4 are the organisation of activities in-field with interactive training sessions or schools programmed in a Festival (D5) – in a Natural Lake/Park (D8) and a conference on Environmental Biotechnologies and energy harvesting from waste and workshops on BESs in connection with existing conferences (D14, D15).

Following the two working task descriptions:

WT41: electrical performance of BESs: this will cover all the electrical aspects of advancements on MFCs electrical efficiency and electrical management. It will be supported by a STSM and will be responsible for organising workshops in BES within Conferences such as ECS 2021 (D14) and EFCF 2022 (D15) as well as promoting the work through outreach activities available to the general public (such as science centres and festivals) and a training school in-lab.

WT42: environmental biotechnologies and energy harvesting from waste: this will focus on the relation between biological activities, waste degradation and electrical behaviour of BESs. Thus:

selective technological solutions for biological treatment of wastewater, using bacterial cultures, will be tested. Two STSMs will be considered for this purpose, with regard to identification of the new species of microorganisms

with valence in wastewater treatment, using a bacterial consortium as the source of microorganisms, with a high capacity to degrade different classes of chemical compounds from the hydrocarbons class;

selective technological solutions for quaternary treatment of wastewater, using specific plants (*Lemna* sp., algae etc), will be tested. One STSM will be considered for this purpose, with regard 15 to identification and exploitation of the ability of some plant species to remove antibiotics and heavy metals;

study of the potential impact of gaseous output from CO2 intensive industries such as sulphuric compounds on biocathode for methane production with BESs; Study of microbial-carbon material interactions in wastewater treatment processes. An STSM will be considered to support these activities;

waste water treatment using MFC with a focus on pure water formation on the cathode side via the oxygen reduction reaction, the support of an STSM will be considered; Moreover, this task manages possible activities related on COVID-19 emergency. A conference on environmental biotechnologies and energy harvesting from waste will be organized, as well as a scientific report on combined selective eco-technologies for water protection, conservation and treatment (D 7 – Month 48).

WT43: energy storage in MFCs: A scientific report will be delivered (Month 24) on energy storage systems for MFCs using super capacitors or capacitive electrodes to continuously supply small devices (D13). The recovered energy will be assessed for directly connecting to a microbial electrolysis cell to produce hydrogen; this is novel. The activities will be supported by STSMs in order to train two young researchers or PhD students in monitoring, characterisation and integration of the systems.

WG main activities and results from the first year of the project

Publications

Aimola, G., Gagliardi, G., Pietrelli, A., Ancona, V., Barra Caracciolo, A., **Borello, D.**, Ferrara, V. & Grenni, P. (2022). Environmental Remediation and Possible Use of Terrestrial Microbial Fuel Cells. WIT Transactions on The Built Environment, 207, 121-133. https://www.witpress.com/elibrary/wit-transactions-on-the-built-environment/207/38187

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WG5 - DISSEMINATION

Leader: Prof Rachel AMSTRONG

The WG5 are preparing yearly dissemination and exploitation plans with the purposes of:

- boosting engineering, industrial and scientific research on BESs by sharing knowledge with scientific research communities and programming shared research programs;
- promoting private investments, levering on the innovative outputs of the Action and appealing emerging market;
- increasing biotechnology acceptance and spreading, networking between citizens, communities, academics, governments, integrating biotechnology and energy harvesting techniques in the urban texture, evaluating correct city planning.

The production of materials and Open Educational Resources (OER) concern:

- production of different types of content (scientific articles, handbooks, panels for parks, brochures, videos and other dissemination materials on the specific themes of the project and their framing in sustainable urbanisation horizons);
- local dissemination, through specific appointments and projects (activities with schools, public debates, conferences, meetings, summer/winter PhD schools, etc.);
- synergy and organisation of shared events with pre-existing scientific conferences and symposia.

An easy-to-use handbook (D17) for educational programs available on-line, merging all the scientific and historical aspects related to the protection and

rehabilitation of environments and the correct city planning process as well as multimedia contents.

Publication of pamphlets on the project and implementation of a dedicated website (D19) and a YouTube channel. It will be established with updates on progress and with information about the project and its background. This website will attract wider attention and will be used to announce events and to disseminate results of high value to potential beneficiaries. This will include overall information about the project, the participants and their respective roles in the project, and specific information that requires regular updating, such as published scientific results, papers, conference presentations, as well as presentations to the general public in the form of public lectures, courses, seminars, radio and television appearances featuring the work, news clippings, film clips, etc.

MOOCs (Massive Open Online Courses) and social media strategy diffusion (Research Gate, LinkedIn, Twitter, YouTube…)

WG5 main activities and results from the first year of the project

Communication Plan

The communication objectives were identified, and the strategy described. The main target groups were outlined and the channels and means of communication were established and will continue to be updated throughout the action. The plan also outlines the PHOENIX collaborative action and exchanges aim to demonstrate the effectiveness of bio-electrochemical systems (BESs) as technological systems capable of building significant uptake communities leading to implementation. The technological portfolio currently comprises microbial fuel cells (MFCs) and the specifics of other examples of BES presently within the consortium such as bioelectrical systems in general, including biosensing and bioremediation,

will be sourced from the PHOENIX network. By exploiting the biological activity of living organisms, BES have potential applications in removing pollutants, recycling valuable substances, synthesising new products, and producing electricity. Advances in the field of low power electronics have opened up new ways to exploit BESs technologies and this action aims to demonstrate the benefits of powering wireless sensor networks (WSNs) with MFCs, which for example, enables autonomous self-monitoring networked systems for rehabilitation of ecosystems and for developing "smart" sewer systems. The action also aims at evaluating the socio-economical and educational aspects of this environmental technology for the development of sustainable-cities, monitoring environmental health, providing valuable resources (electricity, biomolecules) and creates a platform for the combined integration of bio- and smart- technologies via bio-digital interfaces in the urban context.

The specific objectives of the PHOENIX action are:

- To establish a common vision upheld by all consortium partners
- To appropriately valorise electroremediation, bioremediation, biosensing and biodegradation technologies. This includes developing narratives about why these technologies are valuable from an economic, ethical, environmental and social perspective;
- To enhance BESs based applications and identify their societal applications both in the immediate form and in their longer-term trajectories;
- To establish exploitable interactions between microbial biofilm, biocompatible substrates and electromagnetic fields;
- To increase MFC power density and stack efficiency;
- To advance surface science related to BESs;

- To catalyse research into gene regulatory networks kinetic modelling for the design of optimal bioprocesses in biological systems connecting the inter- and intra-regulatory mechanisms focused on added-value products formation;
- To optimize the hardware platform for autonomous WSN and sensing innovations;
- To integrate knowledge of biotechnological developments, as well as their risks and benefits in political decision-making process with respect to city planning for environmental conservation, brownfield site clean-up and waste recycling;
- To establish innovative economic models for the use and uptake of bioelectricity, with specific focus on the "bioelectrical commons";
- To identify the knowledge gap between BES science, politics and citizens;
- To establish bold inter/trans-disciplinary partnerships for the immediate and longer term;
- To generate stimulating, engaging big-picture narratives that simultaneously highlight the economic damage caused by COVID-19 as a direct consequence of environmental damage (urban expansion into wilderness, animal welfare abuses, international travel, urban density) alongside alternative value frameworks that will simultaneously position the emerging technologies in an alternative light as a healthier alternative than established frameworks.

Regarding the capacity building, the objectives are:

- To improve awareness and understanding of career opportunities and trajectories for students and researchers;
- To produce high-end open access publications and position papers;

- To enhance dissemination of knowledge between sciences, public institutions, citizens associations;
- To improve personnel skills, experience and competence, especially for PhD students and Early-Stage Researchers (ESRs); consortium members will host PhD students and ESRs for knowledge exchange;
- To promote collaboration and access to established worldwide research infrastructure networks;
- To set the scientific objectives for creating opportunities among different domains;
- To encourage the communication and dissemination of research results with various instruments;
- To bridge the gaps between research and productive sector, translation into business models;
- To foster the uptake of research results, especially by industry and small and medium-sized enterprises (SMEs).

This communication strategy produces accurate information about all aspects of the action in as clear and easily accessible form as possible to the widest possible audience. It is composed of internal and external-facing functions, which ensure the scientific and communication objectives can be achieved, while keeping stakeholders up-to-date on the activities and outcomes, and ensuring high visibility throughout the action. Internal communications structures and goals provide participants with up-to-date information and instructions to achieve the project actions, while external communications optimise the outreach to target audiences and stakeholders. This action works towards increasing the networking between stakeholders of private and public sectors so they establish a connection with BES solutions for the protection and rehabilitation of damaged environments, as

well as the development of cleaner cities. It also explores alternative value frameworks along which alternative accounts for the uptake of BES can be established and developed. PHOENIX connects researchers from 33 different countries that work in the field of BES technology and its applications in order to develop standards and approaches for the design, construction, deployment and monitoring of BESs. To achieve multi-disciplinary and interdisciplinary networking, researchers working in the fields of engineering and human and social sciences are brought into proximity in ways that enable cross- and inter- disciplinary collaboration between researchers in biotechnology, as well as policy makers, SMEs, investors, land/property developers, private associations (e.g. housing) and city councils. The overall picture presented is not just about "innovation" and "transdisciplinarity" in isolation but is also political, ethical, ecological and legal concerns. In this way, the introduction of the technology is prepared through strong, critical, narrative accounts that promote acceptance of change along with new ways of thinking. These narrative enable PHOENIX to compete with the existing metrics such as amount of power produced, numbers that are used to belittle the contribution of BES to energy provision. It is not about amounts but the relationship between life, environment and energy itself that are at stake. BES cannot be "just another" sustainable technology. It has to carry far more meaning with it that justifies the early stage development and the relatively low amounts of energy produced by the technology compared with fossil fuels and renewables.

Catalysing ongoing conversations between institutions and government representatives, and citizens and the PHOENIX Communication Plan also enables informed and nuance discussion about meeting the EU's New Green Targets with respect to environmental issues and economic benefits that

stem from the uptake and implementation of BES solutions. This action supports the co-construction of socio-technical shared indicators, built on research strengths while maintaining multi-stakeholder communication with social actors and the community. This enables the timely evaluation of the action's progress with respect to how the objectives of protection, resilience, and rehabilitation of damaged environments are implemented. In addition, the action identifies opportunities for increased social awareness of, and an understanding of the benefits of decentralized and widespread energy production, generated using BES eco-sustainable techniques. The benefits of involving uptake communities in the technological implementation of BESs will be explored, including the qualification and quantification of level of acceptance, ecosystem improvement (and/or disruption practices) and socio/technical empowerment (e.g. formation of commons, micro-economics).

Messages are targeted to their intended audiences. In addition to a range of activities and products (e.g. conferences, media coverage, multi-language materials, training courses for PhD students) organised in the action, further communication in PHOENIX-related conferences, symposia and dissemination activities will be ongoing to bring BES technologies into the proximity of key uptake audiences.

The objectives for the communication include:

- Establish a vision of possibility enabled by BES, from which new and existing conversations can be developed;
- Shared activities within the group;
- Find a common built project to work on together;
- Realise some funded projects together;
- writing a book together;

- group exchanges discussions on key ideas and approaches – world-building;
- Identify target uptake groups that can be reached using the proposed communication tools and distribution channels;
- Inform and engage relevant European stakeholders;
- Raise awareness of the PHOENIX action and its communication activities;
- Ensure effective communication to and among the partners;
- Ensure timely notices for actions and events;
- Evaluate the efficiency of the communication and revise in a timely and appropriate manner.

In the following pages, several actions were implemented in the first year of the project.

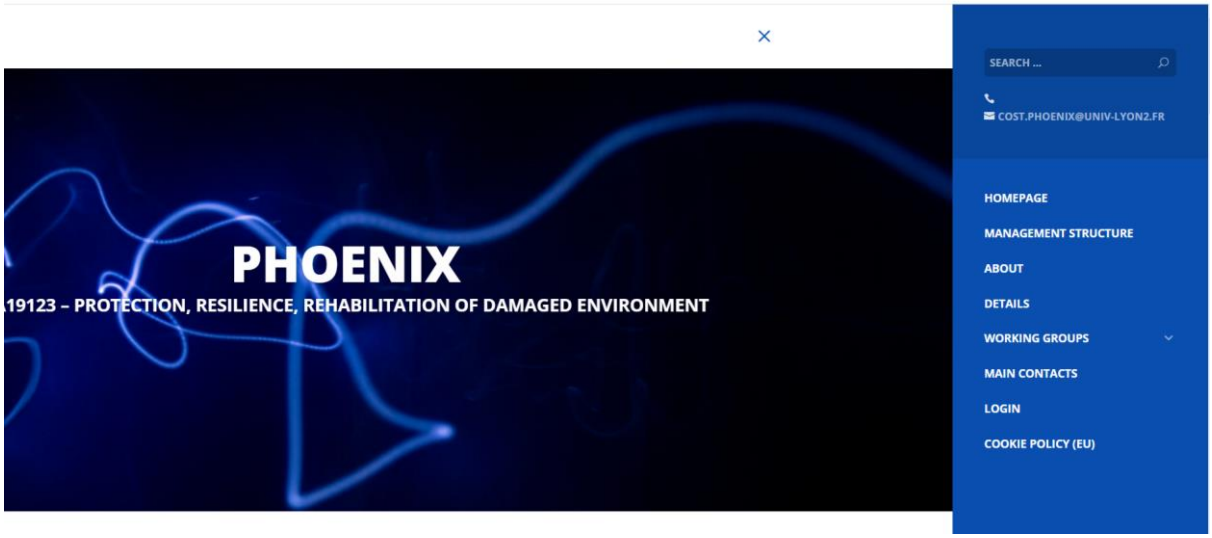
Logo

The PHOENIX logo was designed by Marco Gissara and it captures the multidisciplinary nature of the action. The logo is available in multiple colours and it will be widely used in the action dissemination.

Website

Thanks to the collaboration between Mira Sulonen and Paola Grenni (Science Communication of the project), the action website was launched in July 2021 and it is available at www.cost-phoenix.eu. The website has been created and implemented by Giorgia Ghergo (HEAP Design, https://www.heapdesign.it). The website was designed to demonstrate the activities and objectives of the action to a wide audience. The expansion of the functionalities of the website is currently ongoing and will include, e.g. update working group profiles and internal partners area, project main meetings etc.. Not only Phoenix participants, but all people interested in PHOENIX are welcomed to register and join our mailing list to receive news and updates from the action. In the following images, the main pages of the website are presented.

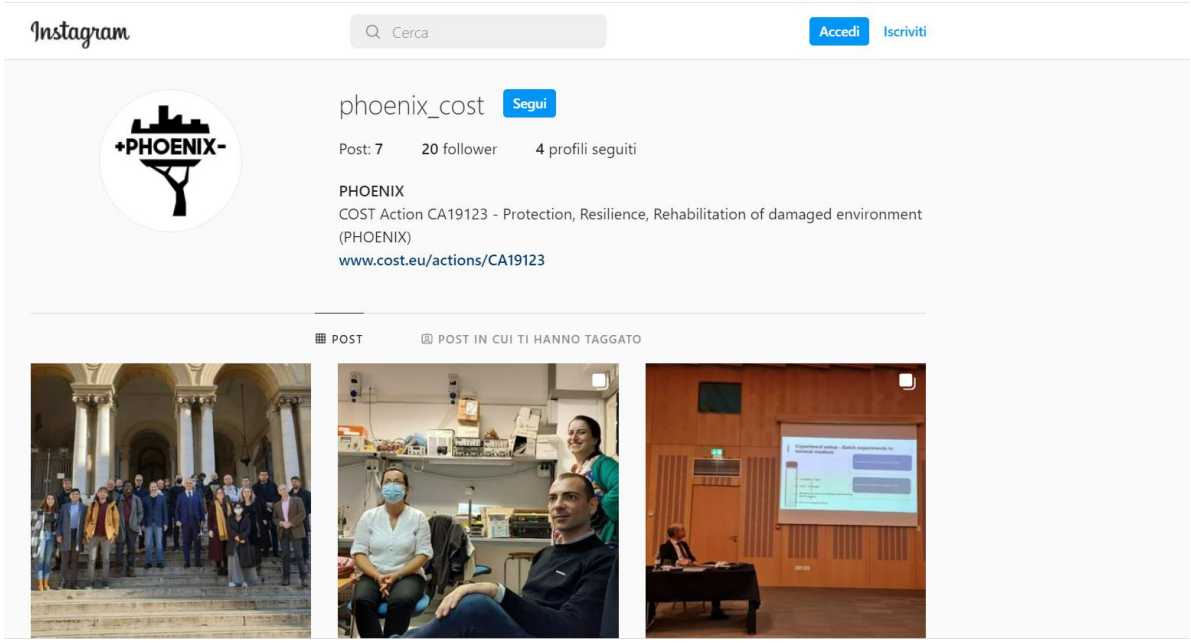
In specific pages, several details are included, as it possible to see in the next figure.



Social media

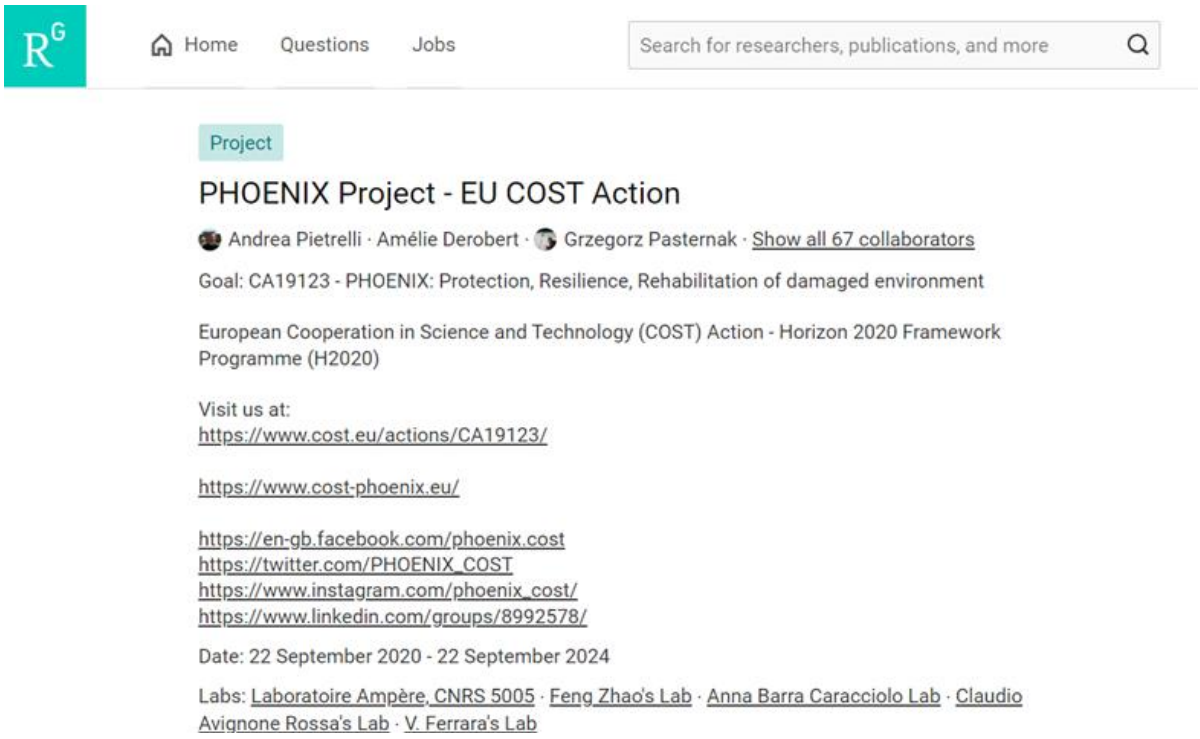
The actions social media accounts in **LinkedIn**, **Twitter** (@COST_PHOENIX), **Instagram** (@phoenix_cost) and **Facebook** (phoenix.cost) were launched in November 2020. The accounts will be used to share the actions activities and outcomes as well as other information and news related to the topics of interest of the action. People interested in the action are encouraged to follow the social media profiles.

In the following figure, images of Twitter and Instagram are displayed.



ResearchGate:

The actions participants have formed a group in ResearchGate providing a platform for easy interaction and sharing of ideas with the professionals taking part in the action. The group is currently open only to action participants.



Animation

Short animation highlighting the actions importance and goals is under preparation and will be released soon. The animation is designed to showcase the action to general public and will be utilised in disseminating the action to wide audiences.

Gender Balance Advisory Board and its aim

This Board was created with the aim of maintaining gender equalities and guaranteeing an inclusive working environment. It has been actively working performing gender statistics for each PHOENIX event and activity. This work has been performed, in collaboration with the Management Committee, in different ways, taking into account man/women balance.

For each PHOENIX event:

- analyzing the time used by each participant;
- counting the number of speeches and posters
- monitoring gender-related participation

For each activity:

- coordinating the delegates who were nominated for each of the WGs;
- monitoring the gender balance in each project action.

The final result is the preparation of a set of principles defining equality and diversity for improving gender balance in the project network and within its activities.

Main activities and results in the first year of the project

During the first year of the Action, Gender Balance Evaluation was carried out by a group (coordinator and three co-coordinators) in order to achieve the following projects objectives:

1. monitor gender-related participation and behavior (M/W presence and if a participant interrupt another one);
2. elaborate and disseminate a set of principles that define a woman-friendly environment.

The most part of the project meetings (organized by core-group, and by each working group (WG1, 2, 3, 4, 5) during the current year (2021) were

performed online, generally once a month. The recorded statistics were anonymous. Generally, relative representation of Female in Leadership roles was 116%, because more of the half of participants in the CORE GROUP are woman, as we desire. Male meeting attendants were predominant in all WGs the meetings excepted for WG2, were male/female composition was quite equal.