

# InteGRated systems for Effective ENvironmEntal Remediation



greener

NEWSLETTER

Issue 4, Jan. 2022

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The GREENER project has received funding from the European Union's Horizon 2020 research and innovation programme under the Grant Agreement No. 826312

# 1. INTRODUCTION



## A FEW WORDS FROM THE COORDINATION TEAM...



**Dr. Rocío Barros**

Head of ICCRAM-  
the Environment and  
Sustainability Research  
Group at University of  
Burgos

### Main innovations and benefits of the GREENER Project...

"The main innovation that we are dealing in this project is the combination of different bioremediation technologies in order to be able to get to eliminate and degrade different types of contaminant, like mixed contamination and also to be able to accelerate the remediation time. Some of the technologies that we are combining are more traditional bioremediation technologies, like bio-augmentation, bio-stimulation or phyto-remediation combined with bio-electrochemical systems, like microbial fuel cells, plant fuel cells, in order to be able to degrade different types of contaminants."

### Impacts expected from the GREENER project...

"In this project we are going to contribute to the different policies that are being developed under the European Commission framework, like the ones related with circular economy, the EU action plans towards word zero pollution for air, water and soil, being one of the aims of the European Green Deal. Our contribution will be achieved by remediating several types of contaminants, by developing different types of sustainable and energy efficient technologies. Moreover, we are going to contribute with the scaling up of these technologies; not only developing the technologies at laboratory scale, but aiming to scale up and test them so that they can be implemented in the future. Finally, we can target on creating as well different business models for different companies and adapting business strategies in order to exploit these technologies."



# 1. INTRODUCTION



## A FEW WORDS FROM THE COORDINATION TEAM...



**Prof. Carlos Rad,**  
Assistant Professor,  
University of Burgos

### How do you envision the future of bioremediation technologies in 10 years time?

"Bioremediation is not new in soil contamination, but it is always a promising technique, while this is the moment to change the vision. Bio-remediation technologies are generally slow and less aggressive, but the combination of them can have very promising results. For example, we tried to combine phytoremediation with microbial remediation and bio-electrical systems, which can optimize the process and in the next 10 years we can see more real applications. Phytoremediation is the most promising technology and while it is not a technique that offers solutions immediately, it is an environmental technology that can help to remediate any polluted soils in whole Europe and the rest of the world."

### Biggest challenge of the project...

"The biggest challenge relies on the achievement of efficient and successful rates of degradation while also achieving shorter times of degradation of the targeted contaminants, especially when scaling up the hybrid technologies that are being tested currently in the laboratory. Overall, the challenge will be to also achieve competitive results in comparison with the conventional remediation technologies that are currently applied."



**Dr. Blanca Velasco,**  
PostDoc Researcher,  
University of Burgos

### Why is the cooperation between Europe and China so important?

"This is a collaborative project between European Union and China, since the topic was a part of a specific flagship on biotechnology and environment. As China is currently leading the technological advancements, it is very interesting to collaborate firstly to acquire established knowledge concerning successfully implemented bio-remediation technologies for the pollutants that are under study. Moreover, in the framework of the project we will compare the very diverse scenarios that arise between contaminants that are emerging in China and in Europe and the degree of readiness of the technology in both places, as well as the promptness towards applying new bio-remediation technologies from a sustainable point of view."

# 2. GREENER PROGRESS



## WP3: Characterisation of selected contaminated sites and identification of best available bioremediation techniques (UBU)

Under WP3 the study, selection and sampling of contaminated soil/sediment and surface/ground water was finalised, along with their physico-chemical characterization, under the lead of UBU. Under this WP, the method for aggregation and cultivation of consortia in small volumes was developed by JSI, while new methods were also developed. MANO has worked on the isolation of 11 bacterial strains and resulted in the selection of 3 strains (Fe<sub>3</sub>, Zn<sub>1</sub>, Cu<sub>1</sub>) that will be used for remediation of water samples. UAM has isolated consortia by enrichment cultures from soil sites 1 (Noblejas) and 13 (Gudao). The microbial populations present in these consortia have been determined and metagenomic and metatranscriptomic analysis is ongoing. USUR is working on SITE 3 – Saale River Sediment, where metal-reducing/electroactive and contaminant-degrading bacteria are used, as well as on SITE 9 – Major non-ferrous Melter 2, where metal-reducing bacteria and metal-oxidizing bacteria are used.

## WP4: Remediation Technologies Development for Surface Water and Groundwater Technologies (LEITAT)

Related to phytoremediation of polluted water UBU is cultivating different species in water, mainly polluted with heavy metals from all contaminated sites, deriving from metallurgical activities. The contaminated samples present high content of sulfates, along with arsenic and other heavy metals.



# 2. GREENER PROGRESS



10 different aquatic species are adapted to the climate conditions, and through a floating system in which the plants are suspended, samples of water are periodically collected. Different consortia of bacterial were introduced to promote the growth of the plants and also adapted to these polluted conditions, with the ultimate goal to optimize the proper plant species, the proper media, and to use combined techniques with bio-electro chemical systems. Moreover, JSI is working on growing metal precipitating bacteria in aggregates forming anaerobic niches that increase toxic metal precipitation. MANO has worked on the use and combination of different bacterial strains into depolluting consortia for metal rich streams. This bioremediation technology is based on an upcycling strategy, allowing to lower the metal content by recovering it under particulate form. Two specific strains were successfully applied on water samples of SITE 8, having the particularity to be acidic and highly contaminated by iron and copper: the process allowed to lower the Ni, Fe, As and Cu content by 10-30% within 72h and to produce Cu and Fe particles. In order to develop hybrid technologies, these two strains were applied in BES by USUR and in aggregates by Mendel University. The overall idea is to scale up to wetlands in which this remediation techniques could be performed.

## **WP5: Remediation Technologies Development for Soil/sediment Technologies (BATH)**

Under the lead of University of Bath several strategies were developed for the removal of recalcitrant pollutants in soil, including bioaugmentation and biostimulation, ecopiles and bioelectrochemical systems. BATH's work is mainly focusing on bioremediation of soil that is being achieved via the use of soil microbial fuel cell technologies. The system takes advantage of microorganism that are naturally present in the soil to degrade pollutants. Through electrons that are transferred by an external wire to the system's cathode electricity is also generated; therefore this is a self-powered process. In particular, the focus was to develop innovative designs for the soil microbial cell technology, with the support of University of Calgary, providing mathematical simulations of the process that is guiding on the development of innovative designs, and also with the collaboration of LEITAT, that is providing cost effective electrode material. Finally, tests were performed in controlled conditions, i.e. control of temperature, radiation and irrigation conditions, in the presence of different types of pollutants. Investigation of degradation pathways occurring in the soil with or without the use of the soil microbial fuel cell technology was conducted, through advanced HPLC technology coupled with mass spectrometry. In parallel, ACCIONA is working on the improvement of biostimulation/bioaugmentation technologies for soil remediation, while soil phytoremediation trials have been completed by ITC, with Ecopile Microbiome analysis being 90% complete. Under this WP UBU is working on soils polluted with mineral oils and hydrocarbons from spills. Consortia of microorganism isolated from

# 2. GREENER PROGRESS



these soils, mainly bacteria, are used and nutrients are introduced, along with other elements like bio-surfactants or carriers (developed by JSI), like bio-char or hydrophobic alginates.

## WP6: Technology scale-up and field testing (ACCIONA)

Within WP6 ecotoxicity test on contaminated soil and water sites using selected model organisms has been performed by UBU and LEITAT. With the aim of scaling-up the technologies developed in the framework of WP4 (water remediation technologies) and WP5 (soil remediation technologies), the operational conditions and the operational parameters related with the Key Performance Indicators analysed in WP3 has been identified to ensure the efficiency and reproducibility of the technologies at pilot scale. For the scaling-up of water remediation technologies, TAUW has progressing in the treatability test for in-situ metal precipitation of As and heavy metals via biostimulation of sulphate reduction process. UBU has defined the phytoremediation pilot scheme with four plant species combined with rhizobacteria, that is able to treat around 800 L of polluted water, while MANO is currently operating a 2L bioreactor for effectively metal removing and producing nanoparticles in which the influence of stirring speed and oxygen in being investigated to maintain the removal efficiency. In the context of soil remediation technologies, ACCIONA has been focused on the scaling-up of biostimulation/bioaugmentation at mesocosm scale (7 kg) in which innovative methods to improve soil conditions are been defined by UBU. Additionally, preparatory actions related with the test of the selected optimum technologies at field scale have been started to be ready for the implementation of the techniques in Spring 2022.

## WP7: Impact Evaluations (MANO)

Vertech and Materia Nova have collaborated on the life cycle sustainability assessment (LCSA). LCSA encompasses different disciplines, related to an assessment along the whole life cycle of a product or service (from the extraction of raw materials to end of life). In particular, it includes life cycle assessment (LCA) which is a way to calculate the environmental impacts, life cycle costing (LCC) considering all the costs that will be incurred during the lifetime of the product, as well as the cost of externalities (such as greenhouse gas emissions) under specific conditions, and social LCA (SLCA), which assesses the social and sociological impacts.

The goal and scope of the preliminary and final assessment studies, as well as the choice of the functional unit and a list of technologies implemented at demonstration scale, have been detailed in Deliverable 7.2. Moreover, a first analysis of the coverage of the substances targeted by GREENER

# 2. GREENER PROGRESS



by common LCA methods have been made to support the selection of the method which will be used in the LCA. Deliverable D7.4 presents a screening of the scarce literature on SLCA applied to remediation technologies. The most relevant publications have been presented and discussed. An approach to follow for the SLCA in the project has been proposed in D7.4 including a preliminary work: qualitative screening of social impacts to support the choice of the indicators; final assessment: full SLCA of the demonstration site.

Moreover, the work under this WP is also focusing on the regulatory, legal and risk assessments. In D7.5, the regulatory and legal framework covering soil and groundwater remediation in Europe and China was presented. The deliverable provides limit values defined at EU level for contaminated soil and groundwater, and presents an overview of existing legislation or regulatory framework on pharmaceuticals and azo dyes present in soil and water. D7.5 also presents some elements regarding the conditions under which soil can be reused after decontamination, as well as the methodology which will be followed to conduct the risk assessment of the demonstration sites. The Technico-economic assessment (TEA) is ongoing and will be an important input for the choice of the best promising technologies to be implemented at a larger scale under GREENER.

## WP8: Promotion and Exploitation of Results (AXIA)

The purpose of WP8 is to support dissemination and communication activities aiming to reach targeted audiences, informing them on the developed technologies in the field of bio-remediation. Moreover, this WP aims at building business strategies towards innovations, aiming to set the ground for exploitation of the project results. The main achievements of this work package so far are:

- Set up D&C channels and tools, including website, social media platforms, printed materials, press releases and newsletters.
- Organise workshops and relative initiatives (including the GREENER talks) to train and familiarize students, scientists, interested stakeholders and the general public with the bio-remediation technologies developed under GREENER.
- Attend several events and publish the work in renowned journals.
- Identification and development of new business models.
- IPR management and roadmap to ensure that the innovation technology will be ready for further activities ensuring the freedom to operate.
- Description of business plans for each of the business models.
- Develop a system toolbox (stakeholders' platform) which will be used for the different organisations and external stakeholders to share information and create links among the different actors in the value chain, from technological companies to public authorities and citizens.

# 3. GREENER TALKS



## FIRST TALK WITH UNIVERSITY OF BURGOS

AXIA Innovation in collaboration with Universidad de Burgos organised the first set of interviews in order to present the GREENER concept, objectives, innovations, challenges and impacts!



The presenters were:

**Prof. Carlos Rad, PhD in Soil Biochemistry**, with an extensive experience in composting research in the framework of regional, national and international projects, participates along all the stages of the GREENER project.

**Dr. Rocío Barros, PhD in Environmental Sciences**, with 10 years of experience in managing and coordinating European projects in the field of environmental technologies and sustainability. Head of ICCRAM-Environment and Sustainability Research Group at the University of Burgos and Project Coordinator of GREENER project.

**Dr. Blanca Velasco, PhD in Plant Biotechnology**, working on bioremediation technologies in soils and phytoremediation solutions in water, also collaborating in coordination and management of the GREENER project.

Take a look at the video : <https://lnkd.in/dVYvdyx>



# 3. GREENER TALKS



## GREENER TALK WITH UNIVERSITY OF BATH

Our second GREENER talk was organised by AXIA Innovations and University of Bath, where the work of the Bath team was presented related with the use of bio-electrochemical system technologies for soil bioremediation.

The presenter was:

**Dr Mirella Di Lorenzo, Reader in the Department of Chemical Engineering of University of Bath,** focusing her research on bio-electrochemical systems.

The video can be found here:

[https://www.youtube.com/watch?v=F\\_BuL3UgduM](https://www.youtube.com/watch?v=F_BuL3UgduM)



GREENER talk on the "Use of BES technologies for soil bioremediation" by University of Bath



# 4. GREENER MEETINGS



## CONSORTIUM MEETING

On November 15 and 17 and December 10<sup>th</sup> the GREENER project consortium met online! This was the 30M meeting summarising the work performed under different WPs. The Project Managers and the coordination team gathered online to present the team's achievements and collaborative work along the WPs., depicting their progress and discussing on the future steps and plans.



# 5. STAKEHOLDERS' PLATFORM

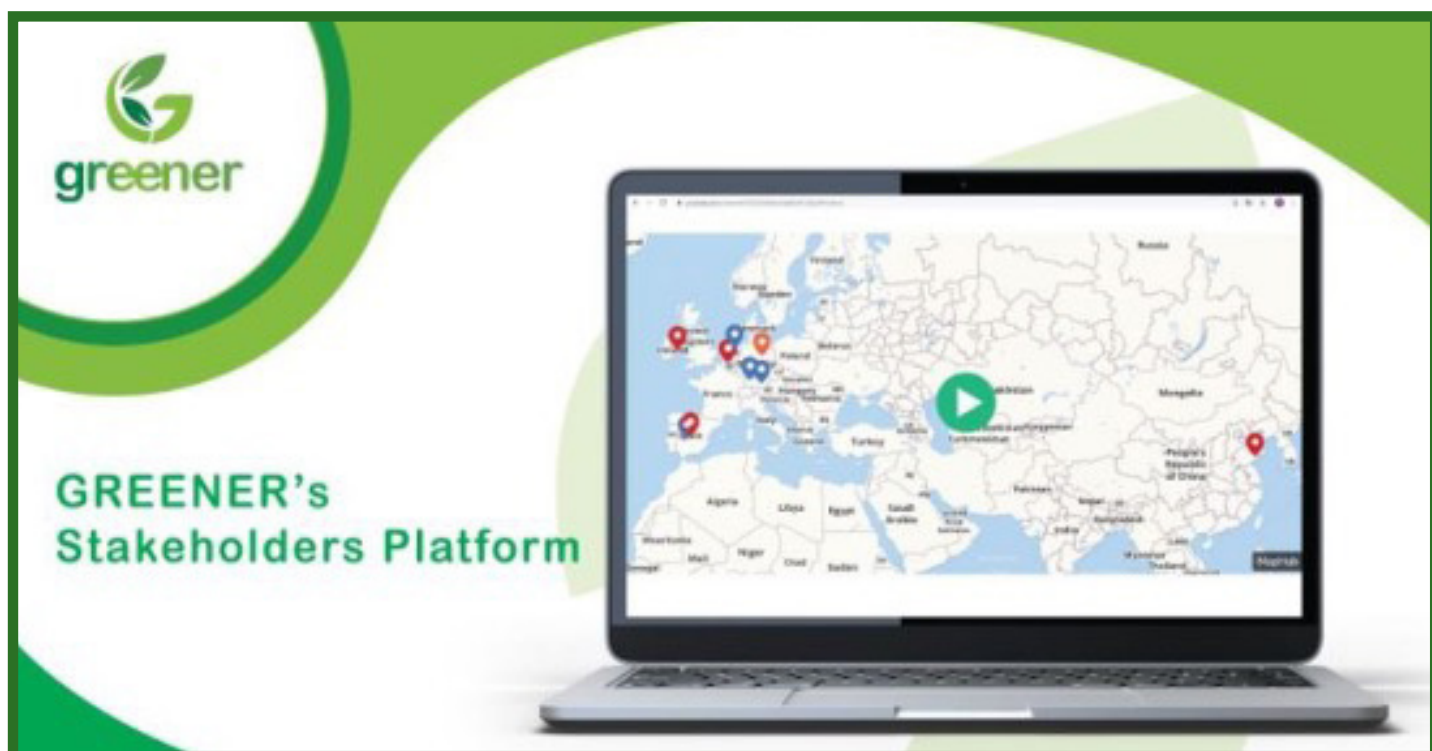


We are glad to announce that the GREENER project Stakeholder Platform is already available for consultation on our website:

[https://www.greener-h2020.eu/en/static/stakeholders-platform.](https://www.greener-h2020.eu/en/static/stakeholders-platform)

The platform, designed by Sustainable Innovations, will bring together a wide variety of actors leading the way for the upscaling of bioremediation innovations within the industry. An ecosystem for discussing ideas, and connect with potential partners all around Europe.

To kick-off this initiative, we've carried out research on European and Chinese contaminated systems and identified best suitable bioremediation technologies for them. This interactive map is filled with new opportunities to link your project or technology with potential partners, with the possibility of joining the map and increase your visibility. Don't miss out, contact us!



# 6. STAKEHOLDERS' SURVEY



AXIA Innovation has developed a survey aiming to monitor the social acceptance of the Project outcomes. The survey is addressed to the GREENER stakeholders aiming to monitor their opinion on the technologies developed under GREENER and the impact this project can make.

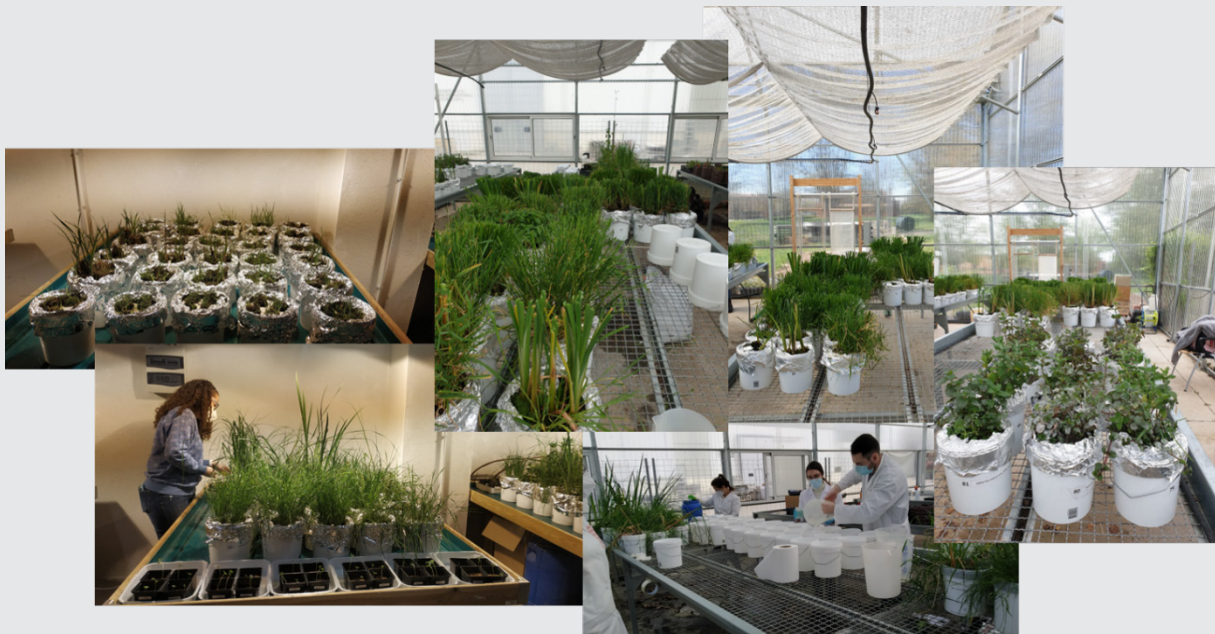
Please take a few minutes to take this survey.

*Your data will be treated anonymously and confidentially.*

**START  
SERVEY!**



**WITH THIS SURVEY, WE AIM TO MONITOR STAKEHOLDERS'  
OPINION ON THE CHALLENGES ADDRESSED BY THE  
GREENER PROJECT!**



# 7. INCUBATOR FOR LEADERS IN SUSTAINABILITY



As part of the Capacity Building services, Sustainable Innovations has launched its first Incubator for Sustainable Leaders, which aims at educating and training students in areas of sustainability, innovation, and business. As part of this Programme, for up to 6 months, students can be part of an intensive programme which will help them to improve their career preparation, gain and develop new skills, broaden and applying their knowledge, at the same time that they are certificated in up to three different courses: Sustainability, Micro-MBA and Innovation. Following the learning-by-doing methodology, students take action in online or on-site internships with different companies working in H2020 projects as GREENER.

A photograph of a classroom or meeting room. A man in a suit is standing at the front, presenting to a group of students seated at tables. A large screen displays a presentation slide. The text 'Incubator for Leaders in Sustainability' is overlaid in white on the image.

Incubator for Leaders in  
Sustainability

# 8. PUBLISHED WORK



## ACCEPTED

Casula, E, Kim, B, Chesson, H, Di Lorenzo, M, Mascia M. Modelling the influence of soil properties on performance and bioremediation ability of a pile of soil microbial fuel cells. 2021. *Electrochimica Acta*. 368: 137568.

DOI: 10.1016/j.electacta.2020.137568, BATH

<https://researchportal.bath.ac.uk>

## UPCOMING

Assessing the effect of electrode orientation on the performance of soil microbial fuel cells,

European Fuel Cells and Hydrogen Conference 2021, University of Bath

Towards cost-effective soil microbial fuel cell designs,

European Fuel Cells and Hydrogen Conference 2021, University of Bath

Minimalistic soil microbial fuel cells for bioremediation of recalcitrant pollutants,

European Fuel Cells and Hydrogen Conference 2021, University of Bath



# 9. DISSEMINATION EVENTS

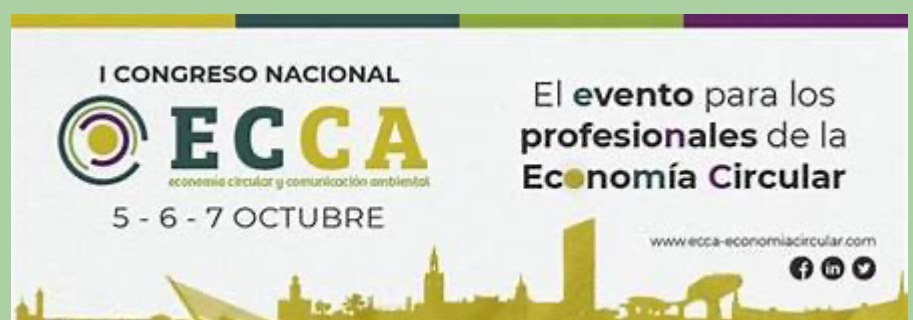


UBU participated on 23-27 August 2021 at the EuroSoil Congress that took place online. For more information on the event please visit: <https://eurosoil-congress.com>

Today, University of Burgos's researchers Juan José González Plaza and Blanca Velasco Arroyo have shared an entertaining talk entitled "Ask a scientist!", with 7-8 years old students from CEIP Fuentecillas, in Burgos. Interesting questions have been posed to the two scientists, who have promoted curiosity of children, by answering their queries in diverse fields of research, also including GREENER Project H2020 targets.



ACCIONA participated in the first national congress on Economía Circular y Comunicación Ambiental, ECCA (=Circular Economy and Environmental Communication). The overall objective of the congress is to implement the Circular Economy within sustainable consumption and production processes. ECCA is the first national congress on circular economy and environmental communication, where business and government leaders meet to develop circular ideas, circulate business models and get in touch with all agents in the sector. ACCIONA presented, "Aplicaciones circulares innovadoras en infraestructuras de obra civil: casos de éxito de ACCIONA", a presentation of applications and projects, among them GREENER, that promote the transition towards the circular economy.



# 9. DISSEMINATION EVENTS



University of Surrey, LEITAT Technological Center and University of Bath participated at the AP ISMET conference that took place in China, on July 2021. They gave an invited talk in the special session on “Electro-bioremediation”, organised by the ELECTRA cluster project consortium.

The consortium participated in roundtable discussion in the 5<sup>th</sup> EU ISMET conference that took place in Spain, on September 2021. The talk was about the future of BES technologies in bioremediation. For more information visit the link: <https://www.euismet2021.eu>



GREENER Project coordinator University of Burgos participated in the Researcher's Night Activities, organising a workshop called “Understanding our environment”.

The event included experiments to shed light on soil properties, including observation of cells of different living beings, isolation of DNA from fruits, highlight as well the different types of pollutant removal in soil and water. Activities were aimed at pre-school and primary school children and 24 students, while a game to discover our carbon footprint was also included.





# 9. DISSEMINATION EVENTS



Our project coordinator University of Burgos presented on 25<sup>th</sup> of May the work titled: "Sistemas Integrados para una efectiva remediación ambiental" on CONDEGRESS 2021 conference. Check out the programme here: <https://lnkd.in/dh-aQZR>

UBU participated in the CISDS2021 event with an oral presentation given by Prof Carlos Rad, on "Biorrecuperación de suelos contaminados con hidrocarburos mediante la utilización de consorcios microbianos edáficos". Check out for more info: <https://es.cisds2020.com>



University of Burgos participated in the AquaConSoil Conference, that took place on 14-17 June 2021! Take a look at the topics covered by the conference here: [https://lnkd.in/dJp\\_B2t](https://lnkd.in/dJp_B2t)

# 7. UPCOMING EVENTS



## EFC21 conference 2021

GREENER Project H2020 will be presented in the EFC2021! Our project partners University of Bath, Leitat Technological Center, Università degli Studi di Cagliari, and University of Surrey will participate at the European Fuel Cells and Hydrogen Conference (EFC2021) that will be held on 15<sup>th</sup>-17<sup>th</sup> December 2021 online. The presentations will also result in proceeding papers! You can visit the event's link here: [https://lnkd.in/d6\\_aswi4](https://lnkd.in/d6_aswi4)



## 22<sup>nd</sup> World Congress of Soil Science 2022

UBU will participate at the 22nd Congress that will be organised by the British Society of Soil Science on behalf of the International Union of Soil Sciences on 31 JULY - 5 AUGUST 2022. The Congress theme, 'Soil Science – crossing boundaries, changing society' focuses on the link between soil and society, with sessions covering soil systems, soil processes, soil management and how we interact with and use soils around the world. (<https://22wcsc.org>)





From the  
GREENER consortium,  
we wish you  
a Happy New Year!



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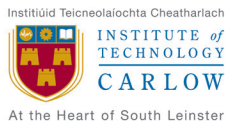
## The GREENER team Project Coordination team: University of Burgos -ICCRAM



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