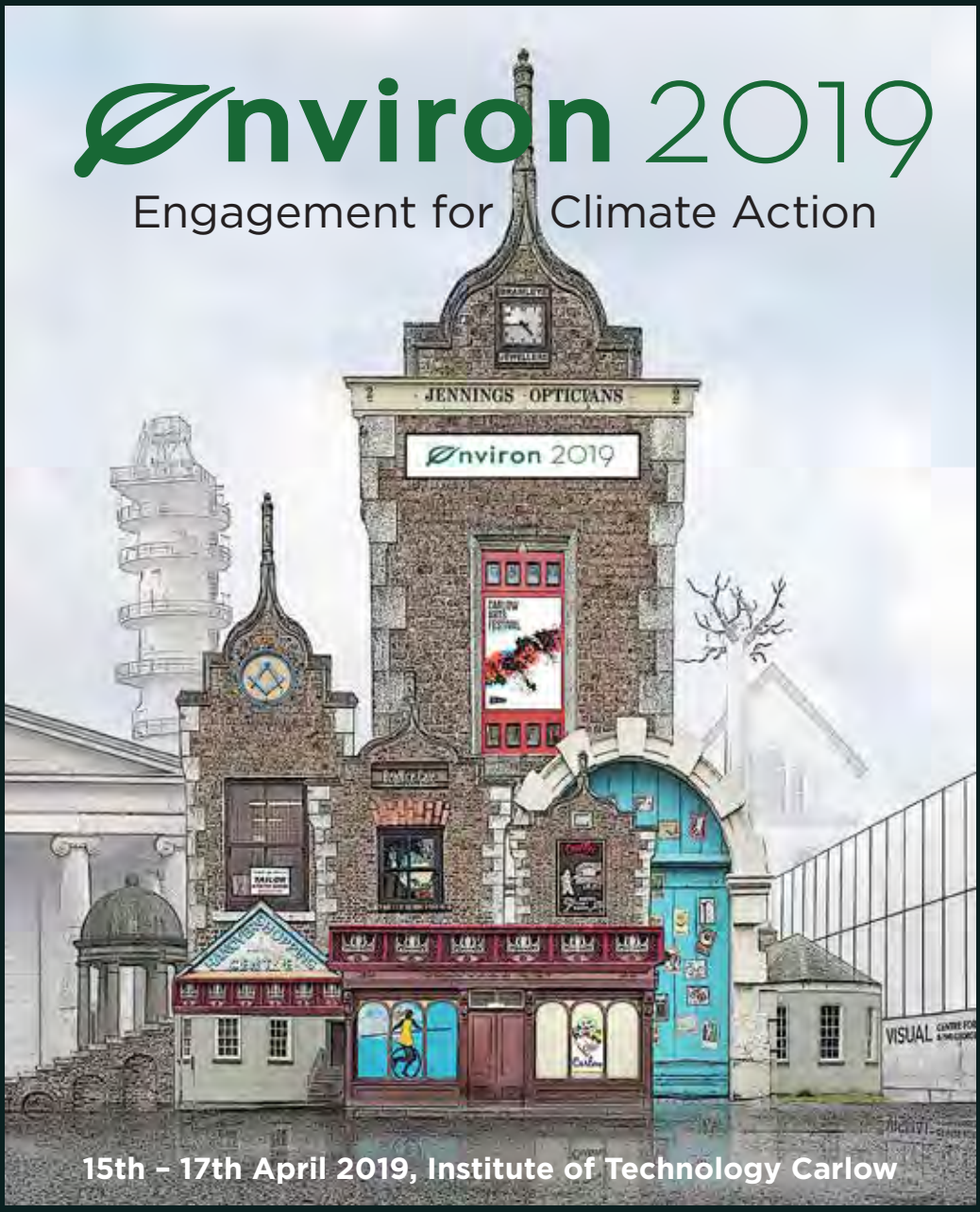
# Environ 2019

## Engagement for Climate Action




**15th – 17th April 2019, Institute of Technology Carlow**

29th Irish Environmental Researchers Colloquium

INSTITUTE of TECHNOLOGY CARLOW
Institiúid Teicneolaíochta Cheatharlach

esai
Environmental Sciences Association of Ireland


KILKENNY ROAD
N
SLIP ROAD
SLIP ROAD
HAUGHTON BUILDING (LSB)
DARGAN BUILDING (K)
KILLESHIN CENTRE (E)
BURRIN BUILDING (D)
CSB
NORE BUILDING (C)
BARROW CENTRE (F)
GAA STAND (G)
LEARNING RESOURCE CENTRE (A)
RUGBY STAND
VISITOR CARPARK
GREEN ROAD
GREEN ROAD

## Contents

## IT Carlow Convenor's Welcome to ENVIRON 2019

Dear Delegate,

The ENVIRON 2019 Organising Committee welcomes you to the 29th Irish Environmental Researchers' Colloquium (ENVIRON 2019) at Institute of Technology Carlow. The ENVIRON colloquium is the largest gathering of environmental researchers in Ireland with over 250 delegates attending this year. This event is a wonderful opportunity for environmental researchers both new and experienced to share their research with an audience drawn from academia, government bodies, industries and perhaps most importantly, the community and general public.

The world in 2019 is at a critical juncture regarding issues such as global food security, pollution, waste at an unprecedented scale, access to clean water, biodiversity loss, soil degradation, loss of natural resources and, associated to all the above, socioeconomic and geopolitical issues. The recent alarming report by the United Nations Intergovernmental Panel on Climate Change states the urgency for climate action now to reduce risks of extreme heat, drought and poverty that will affect hundreds of millions of people in the coming decades. This year's colloquium overarching theme of **"Engagement for Climate Action"** should stimulate lively discussions, as ultimately, and at this point in the planet's history all environmental research we do will help, directly and indirectly, to alleviate and face climate change. This unprecedented, real and concrete challenge for humanity was never as close and now is the time to practice 'Engagement for Climate Action'

The conference will begin on Monday 15th of April with a morning field trip by the River Barrow, Ireland's second longest river, guided by Ms Mary White (ex-deputy leader of the Green Party), followed by an afternoon workshop on microbial bioinformatics (Dr Andrew Lloyd, IT Carlow) and an afternoon workshop/fringe festival at Carlow's Delta Sensory Gardens (Dr David Ryan, IT Carlow) on sustainable living. The morning field trip and the fringe festival will be open to the public, but the community can continue availing of the colloquium on Monday 15th April with a questions and answers style evening public engagement event entitled "Engagement for Climate Action". This topic is of both local and global interest. This discussion will be moderated by Ms Sue Nunn from KCLR 96 FM, and the speakers is the Green Party Kilkenny Councillor Mr Malcolm Noonan, followed by the Q&A session panellists Dr John Macnamara from Bord Na Móna, Ms Mindy O'Brien from Voice Ireland, Mr Eddie Punch from the Irish Cattle and Sheep Farmers' Association, Mr Thomas Ryan from the Irish Farmers' Association, Dr Jannette Davies from the Wexford Campus of IT Carlow an expert on human behaviour and the environment, as well as Ms Martina Moyne from designCORE in IT Carlow bringing insights in humanising innovation for environmental protection.

The scientific proceedings of the colloquium will be formally opened on Tuesday 16th April by Dr Patricia Mulcahy (President, Institute of Technology Carlow), Dr Thomaé Kakouli-Duarte (Conference Convenor, IT Carlow), and Dr Frances Lucy (ESAI Chairperson). Three or four concurrent sessions will follow over the course of the next day and a half, at which over seventy papers and 45 posters will be presented under the following 20 thematic areas: Water Quality and Resources, Waste Management, Energy, Climate Change, Invasive Species, Environmental Policy and Communication, Human Health, Ecotoxicology, Environmental Management, Air Quality and Urban Development, Marine and Coastal, Sustainable Transport, The Human Built Environment, Sustainable Infrastructure, Sustainable Land Use and Agriculture, Biodiversity and Ecosystems, Nanotechnology and the Environment, Smart Technology for the Environment, Sustainable Crop Science, Nature Based Solutions for Resilient Communities

Unique feature of this year's ENVIRON is the extensive community engagement in the colloquium proceedings via the public event and the two workshops open to the public. Indeed, we envisaged and developed an accessible to all workshop on sustainable day to day living, which took a life of its own and evolved to the sustainability Carlow fringe festival. Another special feature of ENVIRON 2019 is the exhibition of a spider plant, whose mother plant was on board the Rainbow Warrior, the Greenpeace vessel, handed to us by Brad Farmer via the BA (Hons) IT Carlow student on the Wexford Campus Mr Ciaran O'Brien, under the module of "Narrative and identity", and under the supervision of Mr Brain Garvey. The title of the exhibit is "Historical environmental concerns in a contemporary context"

We hope that you will find ENVIRON 2019 stimulating for your own research and interests and that you also enjoy the various social activities at our beautiful IT Carlow campus and Carlow town.

Fáilte roimh go léir go dtí Institiúid Teicneolaíochta Cheatharlach agus tá súil againn go mbeigh comhdháil an-taitneamhach agaibh go léir.

Dr Thomaé Kakouli-Duarte

ENVIRON 2019 Convenor

On behalf of the ENVIRON 2019 Organising Committee

## ESAI Welcome to ENVIRON 2019 Delegates

On behalf of the Environmental Sciences Association of Ireland (ESAI), the ESAI Council extends to you a warm welcome to the 29th Irish Environmental Researchers Colloquium (ENVIRON) at Institute of Technology Carlow (ITC).

We are delighted that the ENVIRON Colloquium is held in IT Carlow this year, which is an organisation with long tradition in environmental research. This year's theme in Environ is "Engagement for Climate Action".

ENVIRON provides an annual platform for researchers to present on the environment to a wide audience and it also gives an opportunity to engage with the general public. Environmental news is extremely topical with reports on climate change, biodiversity, single-use plastics, water supplies and waste management regularly featuring on both social media and on traditional platforms. For the last number of years, the colloquium has been freely open to the public on the first evening of the event. On the evening of Monday April 15th, there will be a Public Presentation and Q&A on the urgency now needed to stimulate action on climate change. This important event will be held at 8pm in the Haughton Building, Lecture Theatre L117. In addition, there is a public workshop at 2pm that afternoon on 'Day to Day Sustainability–what can I do'.

I would like to highlight some other initiatives that we have developed in ESAI for the benefit of our members. We now have an ESAI Liaison in each college in Ireland to encourage undergraduate and postgraduate researchers to avail of our network, information and events. We are also offering free membership to all undergraduates in relevant courses in each college. On the back page of this book, please read details of the ESAI Postgraduate Researcher of the Year competition and the ESAI/EPA Grassroots Workshop Support Scheme.

The ESAI wishes to sincerely thank Environ Convenor 2019 Dr Thomaé Kakouli-Duarte and the IT Carlow committee for hosting ENVIRON and for assembling a very comprehensive programme. We also wish to thank Ms Sinead Macken for providing excellent administrative support to the event as always.

We look forward to meeting you over the course of the colloquium and hope you enjoy your visit to Carlow.

Dr Frances Lucy
ESAI Chairperson

## Environ 2019 Organising Committee

**Conference Convenor**

Dr Thomaé Kakouli-Duarte

**Institute of Technology Carlow Planning & Scientific Committee**

Ms Marta Mroczkowska
Dr David Ryan
Dr Adriana Cunha Neves
Dr Guiomar Garcia – Cabellos
Dr Carloalberto Petti
Dr Andrew Lloyd
Dr Gary Cahill
Dr John Carroll
Dr Thomas Confrey
Dr David Dowling
Dr Kieran Germaine
Ms Mary Bates
Dr Rosemary O'Hara
Dr John Cleary
Dr David Phelan
Dr Stephen Whelan
Dr Ann-Marie Enright
Ms Maura Bolger

**Environmental Sciences Association of Ireland (ESAI)**

Ms. Sinead Macken — ESAI Administrator
Dr. Frances Lucy — ESAI Chairperson
ESAI Council

**On the ground assistance at Institute of Technology Carlow**

A special thank you to:
ITC Postgraduate Research Students and Undergraduate Students, Building and Estates Dept, Caretakers, IT and Audio-Visual Services and the ITC Communications Dept.

The Organising Committee wishes to acknowledge the kind support of Nuala Grogan, Carlow Photographic Society, who offered the artwork for the event poster and the front cover of this book.

## Thanks to the ENVIRON 2019 Sponsors and Exhibitors

Thanks to the ENVIRON 2019
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Identifying pressures • Informing policy • Developing solutions

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engineers without borders ireland

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CIWM

CIEEM Chartered Institute of Ecology and Environmental Management

CIWEM Chartered Institution of Water and Environmental Management
Republic of Ireland Branch

AQUATT
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INSTITUTE of TECHNOLOGY CARLOW
Institiúid Teicneolaíochta Cheatharlach

# Environ 2019

Institute of Technology Carlow

April 15th – 17th 2019

Engagement for Climate Action
29th Irish Environmental Researchers Colloquium

**DELEGATE INFORMATION**

**Registration**

The ENVIRON 2019 Registration Desk will be open at the following times:

| | | |
|---|---|---|
| Monday April 15th | 09:00 - 20:00 | Haughton Building |
| Tuesday April 16th | 08:15 - 18:00 | Haughton Building |
| Wednesday April 17th | 09:00 - 11:00 | Haughton Building |

**Delegate Badges**

Delegates are asked to wear their badges at all times during the colloquium.

**Locations**

| | |
|---|---|
| Registration | Ground Floor Haughton Building |
| Eco Trail Workshop | Departure from bus bay IT Carlow |
| Day-to-Day Sustainability Festival | Delta Sensory Gardens Centre Departure as above |
| Bioinformatics workshop | L216 Haughton Building |
| Public Event and Q&A: | L117 Haughton Building |
| Reception | Ground floor Haughton Building |
| Plenary sessions | L117 Haughton Building |
| Conference Sessions | L114, L115 (Haughton Building), K103, K104 (Dargan Centre) |
| Poster sessions | Ground Floor Central Services Building (CSB) |
| Exhibitors | Ground Floor Central Services Building |
| Tea/Coffee | Ground Floor Central Services Building |
| Lunch | First Floor Central Services Building |
| Conference Dinner | The Woodford Dolmen Hotel, Carlow |
| ESAI AGM | L117 Haughton Building |
| ESAI College Liaisons Meeting | Chamber Room Second Floor Haughton Building |

**Delegates giving oral presentations**

After registering for the colloquium, delegates giving oral presentations should upload their presentation at the content management desk (located beside the Registration desk). All presentations for oral sessions should be uploaded well in advance of the session in which the presentation is being given (no later than 2 hours before the session begins). Presentation titles should include the submitting author's surname for easy identification. Presenters are asked to introduce themselves to the session chairs in the assigned session room at least 5-10 minutes before the session begins

**Delegates presenting posters**

The poster presentation area is located in the Central Services Building. When you arrive at the Registration desk please indicate that you have a poster for presentation and we will guide you to the poster area.

Posters can be erected on Monday April 15th (09:30 - 17:00) or on Tuesday morning April 16th (8:15 -10:30). All posters should be in place by 10:30am on Tuesday April 16th. Please do not remove your poster until the end of the poster session on Wednesday morning. There will be 3 poster sessions throughout the colloquium. To ensure the colloquium delegates can meet poster presenters we would strongly encourage poster presenters to be by their posters for these sessions to answer any questions. Each presenter is assigned a unique poster ID number (check your poster ID number in poster abstract section). Your poster must be mounted on the poster board assigned to your ID.

**WIFI**

The Institute of Technology Carlow has Eduroam for those from other colleges. There will also be a temporary log in (Guest WiFi) available during Environ. Attendees not using Eduroam will be able to connect to the Guest Wifi using the password environ2019. This will also be provided on signs in the conference zones.

**Social Media Posts**

Please use #environ2019, #itcarlow and @esai_environ2019 for your social media posts during and after the event if you post event material.

**Tea/ Coffee/ Lunch**

Tea/Coffee will be available in the Central Services Building (CSB). A hot lunch will be served in the Central Services Building (first floor) on Tuesday and Wednesday.

**ATM**

There is an ATM located in the Central Services Building (opposite the AIB bank).

**Parking**

Free parking is available in the main campus car parks.

**Carpooling**

We will aim to operate a carpooling practice in the colloquium. If you wish to participate please come to the registration desk.

**Local Transport**

Carlow town centre is a 10 minute walk from the campus.

**Taxi services**

| | |
|---|---|
| Ace Brooklawns | +353 59 9141823 / +353 59 9133366 |
| Brooklawn Taxi Service | +353 59 9141687 |
| Carlow Cabs | +353 59 9140000 |
| Castle Cabs | +353 59 9130660 |
| Fast Cabs | +353 59 9143088 / +353 86 8038553 |

## ENVIRON 2019 Conference Programme

| | Conference Programme Monday April 15th 2019 |
|---|---|
| **09.00 -20.00** | **Registration: Haughton Building** |
| **9:30 - 13.00** | **Workshop A: Field Trip: Eco Trails**<br>Facilitator: Ms Mary White |
| **14.00 - 17.00** | **Workshop B: Sustainability Fringe Festival @ Environ**<br>Facilitator: Dr David Ryan (IT Carlow) |
| **14.00 - 17.00** | **Workshop C: Bioinformatics: Gene Discovery in Microbiomes**<br>Facilitator: Dr Andrew Lloyd (IT Carlow) |
| **19.15 - 20.00** | **Drinks Reception: IT Carlow** |
| **20.00 - 21.30** | **Public Engagement Event:**<br>**L117 Haughton Building "Engagement for Climate Action"**<br>**Followed by Q&A Session**<br>Panel: Mr Malcolm Noonan (Green Party), Dr John Macnamara (Bord Na Móna), Ms Mindy O'Brien (Voice Ireland), Mr Eddie Punch (ICSA), Mr Thomas Ryan (IFA), Dr Janette Davies (IT Carlow), Ms Martina Moyne (IT Carlow)<br><br>Chairperson: Ms Sue Nunn, KCLR 96FM |

## ENVIRON 2019 Conference Programme

| | Conference Programme Tuesday April 16th 2019 | | | |
|---|---|---|---|---|
| **08.15 - 18.00** | **Registration: Ground Floor, Haughton Building** | | | |
| **9.15 - 9.30** | **Opening of Environ 2019: Lecture Theatre L117**<br>Opening Address: Dr Patricia Mulcahy, President of Institute of Technology Carlow<br>Environ 2019 Conference Convenor: Dr Thomaé Kakouli-Duarte<br><br>Dr. Frances Lucy, ESAI Chairperson | | | |
| **09.45 -10.45** | **Plenary Session**<br>Lecture Theatre L117, Haughton Building<br>**Prof. Victoria Thoresen, Inland Univesity, Norway and UNESCO** – Title: Finding the Balance – Why dealing with climate change requires large scale, fundamental change at all levels.<br>**Dr Frank McGovern, EPA** – Title: Climate change: science, policy, action. | | | |
| **10.45 - 11.30** | **Coffee, Poster Session 1 & Meet the Exhibitors, CSB** | | | |
| **11:30 - 13:00** | Water Quality & Resources 1<br>**Room L114** | Energy 1<br>**Room K103** | Biodiversity & Ecosystems<br>**Room L115** | |
| **13.00 - 14.00** | **Lunch: 1st floor Central Services Building, CSB** | | | |
| **14.00 - 15.30** | Water Quality & Resources 2<br>**Room L114** | Energy 2<br>**Room K103** | Climate Change<br>**Room L115** | Sustainable Transport, Infrastructure, Land Use & Agriculture<br>**Room K104** |
| **15.30 - 16.15** | **ESAI College Liaisons Meeting, Chamber Room, Second Floor, Haughton Building** | | | |
| **15.30 - 16.15** | **Coffee, Poster Session 2 & Meet the Exhibitors CSB** | | | |
| **16.15 - 17.15** | Water Quality & Resources 3<br>**Room L114** | The Human Built Environment and Nature Based Solutions for Resilient Communities<br>**Room L115** | Smart Technology and Nanotechnology for the Environment<br>**Room K103** | Ecotoxicology<br>**Room K104** |
| **17.30 - 18.00** | **ESAI AGM & Presentation by Postgraduate Researcher of Year Award Winner: Room L114** | | | |
| **19.00 - 20.00** | **Drinks Reception & Live Music, Woodford Dolmen Hotel Carlow** | | | |
| **20.00** | **Conference Dinner & Entertainment, Woodford Dolmen Hotel Carlow** | | | |

## ENVIRON 2019 Conference Programme

| | Conference Programme Wednesday April 17th 2019 | | | |
|---|---|---|---|---|
| **09.00 - 11.00** | **Registration Ground Floor, Haughton Building** | | | |
| **09.30 - 10.00** | **Plenary Session**<br>Lecture L117, Haughton Building<br><br>**"Nutrients recovered from waste (water) streams for production of mineral fertilisers"**<br>Prof. Erik Meers, Ghent University, Belgium | | | |
| **10.00 -11.00** | Waste Management 1<br><br>**Room L114** | Environmental Policy and Communication<br>**Room K103** | Marine & Coastal 1<br><br>**Room L115** | Sustainable Crop Science<br><br>**Room K104** |
| **11.00 - 11.45** | **Coffee, Poster Session 3 & Meet the Exhibitors, CSB** | | | |
| **11.45 - 12.45** | | Environmental Management<br>**Room K103** | Marine & Coastal 2<br><br>**Room L115** | |
| **12.45 - 13.30** | **Lunch: 1st Floor, Central Services Building, CSB** | | | |
| **13.30 - 14-15** | **Prize Giving & Close of Environ 2019 Room L117** | | | |

# Carlow Sustainability Festival

*'Learn how you can make a real difference to our environment'*

**2-5pm**

**15th April 2019**

**Delta Sensory Gardens, Carlow**

***Book on Eventbrite –Carlow Sustainability Festival***


Institute of Technology Carlow · esai · Environ 2019 · delta centre · Carlow County Council

**DAY-TO-DAY SUSTAINABILITY – WHAT CAN I DO?**
**Carlow Sustainability Festival**
**Fringe Festival @ Environ**

The Day-to-Day Sustainability Festival forms part of Environ 2019 and will provide a unique opportunity for families, scientists, communities and the country's leading sustainability practitioners and organisations to get together, share ideas and learn from each other. We all want to live more sustainably but can feel unsure and even disempowered as to what we can do at an individual level to have a positive impact on our shared environment. This event will highlight the relatively small but tangible actions that we can all take immediately in order to effect positive environmental change. From decisions around recycling, composting and water harvesting to practical steps on successful tree and wild garden planting to bee-keeping and wild life conservation, energy reduction, transport alternatives, eating seasonally and growing your own, and avoiding the use of plastics, this event will cover it all. The Day-to-Day Sustainability Festival takes place at Delta Sensory Gardens in Carlow town from 2-5pm on Monday April 15th. Delta is a wonderful space consisting of 16 interconnecting themed gardens, accessible for people of all abilities. Visitors will work their way through the gardens visiting the various displays, stands and how-to events and get a real and practical insight in to how they can immediately begin living more sustainably and will include: the stop food waste programme, home composting, recycling ambassadors, VOICE Ireland, conscious cup and sick of plastic campaigns, community gardens, Teagasc arable margins, Crann million trees project, grow your own, bee keepers and bird boxes, sustainable energy and transport systems, cyclist.ie, refill.ie, the public participation network, local authorities water and communities, citizen scientists and a children's environmental awareness play area. Come along and learn how you can make a real difference.



# Environ 2019

Institute of Technology Carlow

April 15th – 17th 2019

Engagement for Climate Action
29th Irish Environmental Researchers Colloquium

**BIOGRAPHIES**

## Field Trip and Workshop Sessions

**WORKSHOP A: EcoTrails – A Walk on the Wild Side – River Barrow Field Trip**

**Mary White**

Ms Mary White is a former Green Party Member of the Irish Parliament for Carlow/Kilkenny and former Minister of State for Equality, Human Rights and Integration. She is a linguist, walking guide, forager, and flora and fauna specialist. She speaks to a wide public on Deep Ecology, Eco Tourism, Climate Change, Sustainability and other green issues.

Mary runs Blackstairs Ecotrails, an award winning ecotourism business in the Blackstairs Mountains and the Barrow valley, with her husband Robert and daughter Dorothy Ellen. She works with schools and other organisations running wild life and foraging workshops and talks and fun trails for children and adults.

**WORKSHOP B: Day-To-Day Sustainability – What Can I Do? Fringe Festival @ Environ**

**Dr. David Ryan**

Dr. David Ryan is a graduate of the National University of Ireland in Galway where he completed his undergraduate studies in biotechnology in the department of biochemistry and his PhD in the environmental research unit at NUIG, under the supervision of Professor Emer Colleran. He has been based at the Institute of Technology in Carlow since 2000, initially as a postdoc in enviroCORE before taking on the role of lecturer in Department of Science and Health. He was Head of the Department from 2003-2015 before taking on the role of Assistant Registrar and he is currently the Director of the Office of Institute Planning and Research.

## Bringing Research to the Next Level Workshop

**WORKSHOP C: Bioinformatics: Gene Discovery in Microbiomes Workshop**

**Dr Andrew Lloyd**

Dr Andrew Lloyd has spent the last 30 years trying to make sense of protein and DNA sequences. In the early 90s, he was looking at evolutionary constraint in codon choice which turned out later to be important in getting GMOs to express incoming genes. From 1993 to 2000 he was the Director of the Irish National Centre for Bioinformatics (INCBI) where he developed, with Aoife McLysaght, and rolled out, ABC Aoife's Bioinformatics Coursea useful training course in sequence analysis which introduced several hundred Irish biologists to the value of molecular evolution, sequence alignment and phylogenetic trees. That course was also brought to Norway, Finland, South Africa and Turkey at the end of the last century. In the 00s, he split his time on gene discovery (TLR15 the first avian specific toll-like receptor) and whole genome analysis in Cliona O'Farrelly's Comparative Immunology Lab in UCD and Ken Wolfe's Comparative Genomics Lab, TCD. He is now a Lecturer in the Institute of Technology Carlow, where he has mined the sequence of several bacterial genomes to reveal their metabolic capabilities.

## Public Event

### Chairperson Sue Nunn

Sue Nunn has been a broadcaster for almost thirty years, presenting and producing flagship news and current affairs programmes continuously over that period, on local, national, European and international issues. She has lectured on media and delivered courses in journalism. She is the station editor at KCLR96FM which broadcasts to counties Kilkenny and Carlow and presents "The Way It Is With Sue Nunn", weekdays on the station. Sue lives in rural Kilkenny.

### Malcolm Noonan

Malcolm Noonan is a Green Party Councillor on Kilkenny County Council and the Party's Spokesperson on Local Government, Community and Rural Affairs. He works and campaigns on a range of issues; urban mobility, urban regeneration, rural transport, built and natural heritage, social inclusion, cultural diversity and climate action. Malcolm led Kilkenny's participation in an EU URBACT Programme to future proof heritage town centres with eight other municipalities. He is currently studying towards an MA in International Development at NUIM.

## Public Event

**John MacNamara**

Dr John MacNamara heads up Bord na Móna's Regulatory Affairs team. This team actively engages with policy makers, regulators, trade associations and legislators at local, national and international levels, to ensure Bord na Móna's strategic direction is aligned with forthcoming legislation, policy decisions and regulatory rule sets. John is company secretary for the Electricity Association of Ireland, a director of the IWMA, he is also chair of the IWEA's Market's Committee, vice-chair of IBEC's Energy Provides Group (EPC) and a member of the Brussels based Eurelectric 's Wholesale Markets Design Working Group. John has previously worked with the EPA as a senior scientist as well as in the private environmental sector, and he holds a PhD in Combustion Chemistry and an LLB in Irish Law.

**Mindy O'Brien**

Ms Mindy O'Brien is the Coordinator of VOICE of Irish Concern for the Environment. She is an environmental attorney and has been actively involved in environmental issues for over 25 years. Mindy worked on Capitol Hill in Washington DC for 6 years for several Members of Congress and Congressional Subcommittees.

She has been involved with VOICE for over 20 years and has campaigned for proactive actions to reduce waste and promote sustainable consumption.

Mindy organised the Feeding the 5,000 food waste public awareness event in 2012. She developed and managed the 'Towards Zero Waste, Cashel' pilot programme which was the first towards zero waste community in Ireland. She conceived, developed and oversaw the implementation of the Recycling Ambassadors Programme which educated attendees on the new recycling list in Ireland, running 700 workshops and reaching nearly 25,000 people face to face. She was also one of the original founders of the Conscious Cup Campaign, which is now run as a VOICE initiative, and the Sick of Plastic campaign, which VOICE runs jointly with Friends of the Earth Ireland.

She sits on the Environmental Pillar Steering Committee, on the National Waste Prevention Advisory Council and on the board of the Sustainable Water Network (SWAN).

## Public Event

**Eddie Punch**

Mr Eddie Punch is the General Secretary of the Irish Cattle & Sheep Farmers' Association, which represents the interests of Irish farmers in the beef and sheep sectors at local, national and EU level. He is currently a member of several Department of Agriculture committees including the Farmers' Charter, Brexit Consultative Committee and the Rural Development Programme Monitoring Committee. He has previously served as a representative on the National Economic and Social Council (NESC) and he represents the association at senior level negotiations with Government, EU Commission and European Parliament.

He has worked as a consultant to Farmer Organisations in Botswana in 2015 and is a director of Sixmilebridge Co-operative Livestock Mart. He previously worked with Laois LEADER and West Limerick Resources in the implementation of rural development, enterprise and community development programmes as well as in social inclusion. He is a frequent contributor to debates on agri-food issues on local and national media and he has a particular interest in the potential of renewable energy to contribute to the agri-food sector.

He is an honours graduate of the University of Limerick in European Studies (Economics & Public Affairs).

**Thomas Ryan**

Thomas Ryan is the Environment and Infrastructure Executive with the Irish Farmers' Association. He is a graduate of University College Dublin, Dublin Institute of Technology and the Irish Management Institute. He holds degrees in Agricultural Science and Property Studies and a diploma in Business Management. He previously worked with Kerry Group plc and currently represents IFA on two recycling organisations IFFPG and Farm Plastic Recycling Ltd. He is an associate member of the Society of Chartered Surveyors of Ireland and a member of the Agricultural Science Association and Irish Environmental Law Association. He is also the Programme Manager of the on-farm voluntary cost saving initiative, Smart Farming.

## Public Event

**Janette Davies**

Dr. Janette Davies joined the Institute of Technology as Deputy Head of the Wexford Campus in January 2013. She holds a B.Sc. in Management from Trinity College, Dublin, a Masters in Marketing from the University of the West of England, Bristol and a Ph.D. from Keel University, where her research focused on environmental behavioural change strategies. She has over 30 years lecturing, research and industry experience. In additional to lecturing and research experience, Janette has held senior marketing positions in global companies such as Reckitt & Colman and Allied Domeq where she managed product portfolio strategies in key European markets. In 1991 she joined the University of the West of England as a senior lecturer, lecturing in consumer behaviour, business research and marketing management. In 2003, Janette established WoodsDavies Consultancy, which specialised in environmental behaviour research for Public and Private sector organisations in the UK and Ireland. National awards included An Post's Direct Marketing award, and Repak's Waste Minimisation award for environmental campaigns developed for Wexford County Council. Janette's research focuses on a better understanding of social –psychological models of altruistic behaviour to determine if they predict and explain observed consumer behaviour. Current research involves identifying opportunities for leveraging pro-environmental behavioural change in third level institutes. She is a chair of the Institute of Technology's, Wexford Campus, Green Campus committee and an advocate of educating for sustainable development.

**Martina Moyne**

Martina Moyne is a Lecturer in Product Design and Innovation in IT Carlow, Research Fellow in Harvard School of Engineering and Applied Science and Visiting Lecturer in Design and Innovation in University College Dublin. She is passionate about sustainable design and is collaborating with enviroCORE on a SFI funded research into bioplastic development using concurrent design engineering processes. In a past life, Martina has worked extensively in the medical device and plastics industry and is published in engineering design processes and paedagogy. She is completing her PhD in Engineering Design Processes.

## Opening Event

**Dr.Patricia Mulcahy**

Dr. Patricia Mulcahy is the President of Institute of Technology Carlow. She was first appointed to the post in January 2012. She is a graduate of the National University of Ireland in Galway where she completed her undergraduate studies in Biochemistry in 1986 and her PhD 1989. Following postdoctoral research positions with BioResearch Ireland in NUI Galway and Dublin City University, she has held lecturing, research, Head of Department and Vice President roles in Institute of Technology Carlow. She has acted as an advisor, evaluator and board member to various bodies and is currently the Chairperson of the South East Regional Skills Forum and others.

**Professor Frances Lucy**

Professor Frances Lucy is Head of Department of Environmental Science at the Institute of Technology, Sligo. As a researcher, she is Director of CERIS, the Centre for Environmental Research Innovation and Sustainability at IT Sligo. Her main research interests are aquatic invasive species, fisheries science and human waterborne pathogens. She is involved in a range of international invasive species forums in both Europe and North America. Frances is a Board member of Inland Fisheries Ireland.

## Opening Event

**Dr Thomaé Kakouli-Duarte**

Dr. Thomaé Kakouli-Duarte is the Director of enviroCORE in IT Carlow with her research focus on agricultural and environmental sustainability. She has experience in the area of agri-environmental science, specifically, biological control of insect pests using entomopathogenic nematodes, the development of molecular diagnostics for quarantine insect pests, bumblebee molecular ecology and conservation, and the application of nematodes and their assemblages as indicators or environmental change. She commenced her career at undergraduate level obtaining a BSc in Technology of Crop Production from the Technological Education Institute of Western Macedonia, Greece, and then qualified at MSc level in the Technology of Crop Protection at the University of Reading, UK. In Reading, she also obtained a PhD on the biological control of Otiorhynchus sulcatus using entomopathogenic nematodes. She then completed two postdoctoral fellowships in Maynooth University, on the molecular genetics of entomopathogenic nematodes and on the development of molecular probes for the identification of tephritid fruit flies. Subsequent to these, she was appointed Assistant Lecturer at the Institute of Technology Carlow, and she is currently a Lecturer in the Department of Science Health. Her research interests encompass the areas mentioned above and have expanded in the areas of sustainable plant parasitic nematode management and vermitechnology. Thomaé has also a keen interest in science communication, community engagement and outreach.

## Plenary Sessions

**Prof Victoria Thoresen**

Victoria W. Thoresen holds the UNESCO Chair for Education about Sustainable Lifestyles at The Collaborative Learning Centre for Sustainable Development at Inland Norway University. The Centre promotes the development and use of research and learning methods that assist people to contribute to constructive change through the way they choose to live. Thoresen has specialized in curriculum development, global education, peace education, value-based education and consumer education. In addition to many years of experience as a teacher and teacher trainer, Thoresen has written articles and textbooks for teacher training and has functioned as an international educational consultant. As leader of PERL, The Partnership for Education and Research about Responsible Living, she has worked closely with UNEP, UNESCO and other international agencies concerned with sustainable development particularly in connection with the 10-Year Framework of Programmes about Sustainable Consumption and Production's program on Sustainable Lifestyles and Education as well as with the U.N. Decade on Education for Sustainable Development and the present Global Action Plan for Education for Sustainable Development. Thoresen has been an invited speaker at many conferences on sustainable human development, education and behaviour.

## Plenary Sessions

**Frank McGovern**

Chief climate scientist with the EPA, and Chair of JPI Climate which coordinates and supports pan-European research on climate change. Leading on communication of climate change issues and informing actions to address the causes and consequences of climate change as well as broader atmospheric protection issues. National representative to Intergovernmental Panel on Climate Change (IPCC) and regular member of the national delegation to the UN Framework Convention on Climate Change (UNFCCC). PHD atmospheric physics from NUI Galway, MSc, TCD.

**Prof Erik Meers**

Erik Meers is a Professor in the Department of Green Chemistry & Technology of Ghent University, Belgium. His main interests are in resource recovery in the biobasedeconomy. His research topics focus on removal and recovery of nutrients from waste streams and wastewaters and their application as mineral biofertilizers in agriculture. He is currently involved in more than 10 international research projects within these topics (of which several as the lead partner), including RENU2FARM. He is the coordinator of Biorefine Cluster Europe, in which RENU2FARM is also a member-project. Find out more about Erik and his research by visiting: https://www.ugent.be/bw/gct/en/research/ecochem/overviewresearch/researchmeershttps://www.linkedin.com/in/erik-meers-a9298217https://www.researchgate.net/profile/Erik_Meers

## ESAI AGM Guest Speaker - Postgraduate Researcher of the Year 2018

**B.Conall Holohan**

Conall is a PhD. student completing his PhD degree (2019) in NUI Galway. He has a BSc. in Biochemistry from NUIG and along with extensive commercial and applied experience from his Irish Research Council Employment Based Scholarship with a start-up wastewater technology company NVP Energy Ltd., providing 21st Century technology to treat industrial food, beverage, and municipal wastewater through low-temperature anaerobic digestion.

Studying in the field of environmental microbiology and anaerobic digestion (biogas production) throughout his PhD, Conall has focused on the treatment of wastewater with high fat content. He has investigated the process from a microbiological point of view, studying the microbial communities in lab-scale reactors through to the molecular level. Utilising the state-of-the-art microbial and engineering techniques and research, Conall strives to drive efficient biodegradation employing microbiology to drive the sustainable treatment of wastewater.

Furthermore, Conall has organised the global collaboration of scientists and companies to solve the problem of fat-rich wastewater treatment through the ADLipids Network. He is also the winner of the NUI Galway's Ryan Award for Innovation 2018 for the development of his innovation Fat-through-Anaerobic Digestion to Energy (FADE) Biotechnology - a novel high-rate solution to treat fat-rich wastewater.

Continually teaching, learning and working with environmental microbiology - Conall is currently working with NVP Energy Ltd. and NUI Galway.

www.linkedin.com/in/bconallholohan

# Environ 2019

AN APPROVED EVENT FOR CONTINOUS PROFESSIONAL DEVELOPMENT

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## ESAI Student Competition 2019

**The ESAI will be judging all student oral and poster presentations for consideration in this years student competition.** Winners will be invited to submit an article on their research project to the ESAI Website and the ESAI E-Zine 'Environews and will receive a 12 month subscription to the Royal Irish Academy journal 'Biology and Environment'. Results will be announced at the prize giving ceremony at the close of conference at lunch time on Wednesday 17th April at 13:30pm. Best of luck to everyone!

**The prizes and categories this year are:**

- ESAI Best Oral Presentation (€500) sponsored by Environmental Sciences Association of Ireland (ESAI)
- ESAI Best Poster Presentation (€250) sponsored by Environmental Sciences Association of Ireland (ESAI)
- Best Soils Presentation (€250) sponsored by Soil Sciences Society of Ireland (SSSI)
- Best Water Related Presentation (€250) sponsored by the Chartered Institution for Water and Environmental Management (CIWEM)
- Best Waste and Resources Management Presentation (€250) and 12 months student membership to CIWM sponsored by the Chartered Institution of Wastes Management (CIWM)
- Best Biodiversity Presentation (€250) sponsored by the Chartered Institute for Ecology and Environmental Management (CIWEM)
- Richard Fitzgerald Poster Prize for Best Aquatic Environment Presentation (€250) sponsored by AquaTT

## Dr. Richard D. Fitzgerald

Richard was an exemplary fisheries zoologist. He was an excellent researcher and a gifted and inspiring lecturer. A UCC graduate [BSc and PhD], Richard was involved research and development in Aquaculture for almost 30 years in a variety of roles and posts in UCC, AquaTT and NUIG. He was also extremely interested in natural freshwater and marine fish populations, with a rare and extensive knowledge in both aquatic environments developed over the span of his career. He published over thirty peer reviewed publications, which are widely cited. Until the end of 2015, he was Research Co-ordinator and manager of the NUIG aquaculture research lab at Carna.

Richard was blessed with an insatiable curiosity about all research, particularly in the aquatic environment and the highlight of his annual visit to Environ was the poster sessions. His rule of thumb for all his students and employees was that they could go to any relevant conference as long as they produced a poster! Richard sadly passed away on December 5th 2016. Thank you to AquaTT for sponsoring the Richard Fitzgerald prize for best poster in Aquatic Environment

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INSTITUTE of TECHNOLOGY CARLOW
Institiúid Teicneolaíochta Cheatharlach

# Environ 2019

Institute of Technology Carlow

April 15th – 17th 2019

Engagement for Climate Action
29th Irish Environmental Researchers Colloquium

**ORAL AND POSTER PRESENTATION SCHEDULE**

## ENVIRON 2019 CONFERENCE PROGRAMME

| | **ORAL PRESENTATIONS SESSIONS**<br>**Tuesday April 16th 11.30 – 1.00** | | |
|---|---|---|---|
| | **Water Quality & Resources 1**<br>**Room L114** | **Energy 1**<br>**Room K103** | **Biodiversity & Ecosystems**<br>**Room L115** |
| **11:30 - 11.45** | Chair:<br>**Mark Bowkett**<br>Managing Director, TE Laboratories<br><br>**Keynote presentation** | Chair:<br>**Lucy Corcoran**<br>SEAI Research, Development & Demonstration Programme, SEAI<br><br>**Keynote presentation** | Chair:<br>**Adriana Cunha Neves**<br>Genetic evaluation of a *Dactylorhiza maculata* urban population by RAPD analysis: implication for an evolutionary dynamic<br><br>**Stephanie Coakley**<br>IT Carlow |
| **11:45 - 12.00** | Nutrient dynamics in Lough Feeagh to understand the drivers of ecosystem productivity<br><br>**Maria Caldero Pascual** DkIT | A decision support tool for energy use on dairy farms<br><br>**P. Shine** CIT | Two-way engagement with stakeholders to improve biosecurity around invasive alien species in the workplace<br><br>**Eithne Davis** IT Sligo |
| **12.00 - 12.15** | Seawater as a potential transmission route for clinically significant antimicrobial resistant bacteria<br><br>**Brigid Hooban** NUIG | Greenhouse gas calculation tool for community-based biomass renewable energy projects<br><br>**Chi-Thang Phan-Tan** CIT | Young commercial forests as a habitat for the hen harrier *(Circus cyaneus)*; selection of a suboptimal habitat?<br><br>**Alan McCarthy** UCC |
| **12.15 - 12.30** | *Asellus* aquaticus as a potential biomonitor of trace metal pollution in freshwaters<br><br>**Irene O'Callaghan** UCC | Energy service demands projections in transport sector for SSPs<br><br>**Siddharth Joshi** UCC | The diet of a predatory stonefly *Diura bicaudata* in Ireland<br><br>**Tara Joseph** UCD |
| **12.30 - 12.45** | Association of potential human pathogens on microplastics in natural water systems<br><br>**Loriane Murphy** ITC | Developing a regional energy balance; Case study from the Dingle peninsula<br><br>**Connor McGookin** UCC | The role of motorway attenuation ponds as new habitats for mobile aquatic insects<br><br>**Roisin Normanly** UCD |

## ENVIRON 2019 CONFERENCE PROGRAMME

| | **ORAL PRESENTATIONS SESSIONS**<br>**Tuesday April 16th 11.30 – 1.00 *Cont.*** | | |
|---|---|---|---|
| | **Water Quality & Resources 1**<br>**Room L114** | **Energy 1**<br>**Room K103** | **Biodiversity & Ecosystems**<br>**Room L115** |
| **12:45 - 13.00** | Drinking water treatment and challenges in developing countries<br><br>**Josephine Treacy** LIT | Effect of trace element supplementation on anaerobic digestion of chicken litter with enzyme treatment<br><br>**Navodita Bhatnagar** IT Carlow | Eco-hydrogeology in Irish Calcareous Fens<br><br>**Ella Bijkerk** TCD |
| **13:00 - 13.15** | | | Poster 1 Minute Oral Presentations<br>BE1 Plant diversity effect on intensively managed grassland productivity and sustainability<br><br>**Guylain Grange** Teagasc<br><br>BE 64 Lough Arrow - Conservation status assessment and collaborative actions for the Natura Network<br><br>**Darren Garland** IT Sligo<br><br>BE 105 Managing the small stream network for improved water quality, biodiversity and ecosystem services protection (SSNet)<br><br>**Edward Cox** UCD |

## ENVIRON 2019 CONFERENCE PROGRAMME

| | **ORAL PRESENTATIONS SESSIONS**<br>**Tuesday April 16th 14.00 – 15.30** | | | |
|---|---|---|---|---|
| | **Water Quality & Resources 2**<br><br>**Room L114** | **Energy 2**<br><br>**Room K103** | **Climate Change**<br><br>**Room L115** | **Sustainable Transport, Infrastructure, Land Use & Agriculture**<br>**Room K104** |
| **14:00 - 14:15** | Chair:<br>**Thomas Confrey**<br>Antimicrobial resistant bacteria in the subsurface environment: a global systematic review<br><br>**Luisa Andrade** UCC | Chair:<br>**Anne-Marie Enright**<br>An investigation and comparative study of the levels of particulate matter 2.5 (PM2.5) produced by different solid fuel burners and fuel in indoor ambient air at different stages of combustion<br><br>**Damian Smyth** DIT | Chair:<br>**David Dowling**<br>The role of nitrogen in climate change and agriculture<br><br>**Vivien Pohl** DIT | Chair:<br>**John Carroll**<br>Closing the nutrient cycle: what are the properties required by farmers, to encourage the use of recycling-derived fertilisers in North West Europe<br><br>**Niamh Power** CIT |
| **14:15 - 14:30** | Science of the future? – Does citizen science provide a means of monitoring water quality for the Sustainable Development Goals (SDGs)?<br><br>**Lauren Quinlivan** UCC | Engaging communities on future re-use options for decommissioned wind turbine blades<br><br>**Thomas Fergal Gough** UCC | Soil management, carbon sequestration and climate change mitigation: The solution under foot<br><br>**Brian Murphy** Enrich Environmental Ltd. | Characterisation of residual soil P indices using recovered P fertiliser as a comparison to TSP<br><br>**Ciaran O'Donnell** CIT |
| **14:30 - 14:45** | Assessment of the potential environmental impacts arising from mercury-free dental restorative materials<br><br>**Hannah Binner** UCC | An appraisal of *Miscanthus x giganteus* (Greef et Deu.) as a Negative Emissions Technology in Ireland<br><br>**Paul Rice** TCD | An analysis of drought during the Irish summer in 2018<br><br>**Simone Falzoi** Univ. of Torino, Italy | Suitability of selected natural fibres for improving concrete performance<br><br>**Ana Caroline da Costa Santos** AIT |

## ENVIRON 2019 CONFERENCE PROGRAMME

| | **ORAL PRESENTATIONS SESSIONS**<br>**Tuesday April 16th 14.00 – 15.30 *Cont.*** | | | |
|---|---|---|---|---|
| | **Water Quality & Resources 2**<br><br>**Room L114** | **Energy 2**<br><br>**Room K103** | **Climate Change**<br><br>**Room L115** | **Sustainable Transport, Infrastructure, Land Use & Agriculture**<br>**Room K104** |
| **14:45 - 15.00** | Sulphate detection using Raman spectroscopy from Dublin rivers<br><br>**Patricia Loren** CIT | Preliminary evaluation of functional coatings for marine based renewable energy applications<br><br>**M. Hedge** IT Carlow | Assessing Ireland's energy CO2 emissions under the first (draft) National Energy and Climate Plan (NECP)<br><br>**Barry McMullin** DCU | Fin embedded composite phase change material (PCM) thermal management system for li-ion battery packs<br><br>**FS Hwang** IT Carlow |
| **15:00 - 15.15** | Arsenic detection in water using microfluidic detection systems<br><br>**Annija Lace**<br>IT Carlow | | Observing the impacts of extreme precipitation events on wastewater systems<br><br>**Sukanya D Saikia**<br>NUIG<br><br>Poster 1 Minute Oral Presentations<br><br>CC21 Climate change attribution: extreme weather events and their impacts from the perspective of the stakeholder (EUPHEME)<br><br>**Jevon Keane-Brennan** Met Office | Poster 1 Minute Oral Presentations<br>S 85 Recycling-derived fertilisers as alternative to triple super phosphate in Irish grassland<br><br>**Lea Johanna Deinert** UL<br><br>S99 Analysis of local pollutant dispersion through full scale three-dimensional modelling of wind flows in Dublin City Centre<br><br>**N Kut** IT Carlow |

## ENVIRON 2019 CONFERENCE PROGRAMME

| | **ORAL PRESENTATIONS SESSIONS TUESDAY APRIL 16TH 16.15 – 17.30** | | | |
|---|---|---|---|---|
| | **Water Quality & Resources 3**<br><br>**Room L114** | **The Human Built Environment and Nature Based Solutions for Resilient Communities**<br>**Room L115** | **Smart Technology and Nanotechnology for the environment**<br><br>**Room K103** | **Ecotoxicology**<br><br>**Room K104** |
| **16.15 - 16.30** | Chair:<br>**Rosemary O'Hara**<br>New and traditional methods to determine the impacts of river fragmentation on salmonids<br><br>**Siobhán Atkinson** UCD | Chair:<br>**Brian Gilmore**<br>Sustainability Manager, Cement Manufacturers Ireland<br><br>**Keynote presentation** | Chair:<br>**Jean O'Dwyer**<br>Development of a lab-on-chip electrochemical immunosensor for detection of Polycyclic Aromatic Hydrocarbons (PAH) in environmental water<br><br>**Shifa Felemban** Tyndall | Chair:<br>**Stephen Whelan**<br>Microplastics bound to the duckweed Lemna minor are ingested by the amphipod Gammarus pulex: an unexplored microplastic trophic transfer route in freshwater systems<br><br>**Mateos-Cárdenas Alicia** UCC |
| **16.30 - 16.45** | Microfluidic analysis of chemical oxygen demand<br><br>**Jaime Edwards** IT Carlow | A wetland efficiency index was developed using constructed wetland sampled data, combining Principal Component Analysis and Fuzzy indices to realise the wetlands efficiency<br><br>**John L. Byrne** IT Carlow | An event-triggered fault detection for non-residential water distribution system: a case-study<br><br>**Hafiz M. Hashim** NUIG | Nematode identification using artificial neural networks<br><br>**Jason Uhlemann** IT Carlow |
| **16.45 - 17.00** | Fat-anaerobic digestion to energy: unlocking the forgotten resource<br><br>**B. Conall Holohan** NUIG | BioPack Project: The use of concurrent design in the generation of bioplastics with high environmental impact<br><br>**Colin Eyer** IT Carlow | Introducing GRAppLE: Groundwater Risk Application for Local Evaluation<br><br>**Jean O'Dwyer** UCC | Molecular and behavioural characterisation of neonicotinoid exposure on bumblebees reveals trends between chemical effect and their mode of action<br><br>**Felipe Guapo** MU |

## ENVIRON 2019 CONFERENCE PROGRAMME

| | **ORAL PRESENTATIONS SESSIONS**<br>**TUESDAY APRIL 16TH 16.15 – 17.30 *Cont.*** | | |
|---|---|---|---|
| | **Water Quality & Resources 3**<br><br>**Room L114** | **The Human Built Environment and Nature Based Solutions for Resilient Communities**<br><br>**Room L115** | **Smart Technology and Nanotechnology for the environment**<br><br>**Room K103** |
| **17.00 - 17.15** | Developing historic and predictive groundwater flood maps for Ireland<br><br>**Owen Naughton**<br>IT Carlow | Achieving resilient cities and communities - Science or science fiction?<br><br>**Liam McCarton** DIT | Cost effective sensing platform for the detection of phosphate in fresh and marine waters<br><br>**Andrew Donohoe** DCU<br><br>Poster 1 Minute Oral Presentation<br>ST 30 Effect of praseodymium (Pr) for high temperature anatase stability of titania and its visible light photocatalytic activity<br><br>**Snehamol Mathew**<br>IT Sligo |
| **17.15 - 17.30** | Poster 1 Minute Oral Presentation<br>WR 84 Raman probe on chip<br><br>**Madhumidha Murugan**<br>CIT | Poster 1 Minute Oral Presentation<br>NB 61 A strategic look at natural water retention measures in Ireland<br><br>**Mary Bourke**<br>TCD<br><br>NB 74 Effects of different gelatin sources on characteristics of starch and gelatin blend bioplastic<br><br>**Marta Mroczkowska**<br>IT Carlow<br><br>NB 127 Development of natural bioplastics with applicability in the packaging industry<br><br>**Hui Ming Tew**<br>IT Carlow | |

## ENVIRON 2019 CONFERENCE PROGRAMME

| | ORAL PRESENTATIONS SESSIONS<br>WEDNESDAY APRIL 17TH 10.00 – 11.00 | | | |
|---|---|---|---|---|
| | **Waste Management 1**<br><br>**Room L114** | **Environmental Policy and Communication**<br>**Room K103** | **Marine and Coastal 1**<br><br>**Room L115** | **Sustainable Crop science**<br><br>**Room K104** |
| **10.00 - 10.15** | Chair:<br>**Kieran Germaine**<br><br>Dairy processing wastewater as a potential feedstock for microbial bioplastic production<br><br>**Arno Fricke** UCC | Chair:<br>**Dan McInerney,** Carlow County Council<br><br>Irish Climate Policy Evaluation: The value of social and environmental impacts in policy uptake<br><br>**Sabrina Dekker** DCU | Chair:<br>**Niall McDonough,** Director of Policy, Innovation & Research Support Services, Marine Institute<br><br>**Keynote presentation** | Chair:<br>**David Ryan**<br><br>Role of Alltech crop science formulations in biological control of root-knot nematodes.<br><br>**Anusha Pulavarty** IT Carlow |
| **10.15 - 10.30** | Influence of density and light on the capacity of Lemna minor to treat dairy processing wastewater<br><br>**Éamonn Walsh** UCC | Towards knowledge transfer and stakeholder alignment in development of private well risk communication interventions: A qualitative interview study of national and international experts<br><br>**Simon Mooney** DIT | Impact of processing on total and inorganic arsenic content in edible seaweeds<br><br>**Jenny Smith** The Marine Institute | Exploring the demand for recycling-derived nutrients and organic matter in Northwest Europe<br><br>**Imke Harms** NMI-Agro, The Netherlands |
| **10.30 - 10.45** | VALOR - Valorisation alternatives to landfill for organic residues<br><br>**Jessica Graça** DCU | Circular economy framework on recycling-derived fertilisers<br><br>**Laura van Schöll** NMI-Agro, The Netherlands | Microplastics in Galway Bay: preliminary results from the benthos<br><br>**Elena Pagter** GMIT | Plant growth promoting bacteria biocontrol of the plant parasitic nematode Meloidogyne javanica<br><br>**Aoife Egan** IT Carlow |

## ENVIRON 2019 CONFERENCE PROGRAMME

| | **ORAL PRESENTATIONS SESSIONS<br>WEDNESDAY APRIL 17TH 10.00 – 11.00 *Cont.*** | | | |
|---|---|---|---|---|
| | **Waste Management 1<br><br>Room L114** | **Environmental Policy and communication<br>Room K103** | **Marine and Coastal 1<br><br>Room L115** | **Sustainable Crop science<br><br>Room K104** |
| **10.45 - 11.00** | Low-cost physicochemical treatment for removal of ammonia, phosphate and nitrate contaminants from landfill leachate<br><br>**Sinead Morris**<br>IT Carlow | Poster 1 Minute Oral Presentation<br><br>EP 73 Environmental compliance requirements: awareness in Irish SMEs<br><br>**Margaret Savage**<br>IT Sligo<br><br>EP 126 Irish shortfall in achieving the SDGs: business responsibility and opportunity<br><br>**Angela Nagle**<br>UCC | Development and testing of "ecologically friendly" concrete for use in marine artificial structures<br><br>**Bryan J. Thompson**<br>UCD | |

## ENVIRON 2019 CONFERENCE PROGRAMME

| | **ORAL PRESENTATIONS SESSIONS<br>WEDNESDAY APRIL 17TH 11.45 – 12.45** | |
|---|---|---|
| | **Environmental Management<br>Room K103** | **Marine and<br>Coastal 2<br>Room L115** |
| **11.45 - 12.00** | Chair:<br>**Prof. Tasman Crowe**<br>UCD Earth Institute<br><br>Peat-based biochar as an additive in the control of greenhouse gas emissions in manure management systems<br><br>**Josephine Getz** DIT | Chair:<br>**Niall McDonough**<br>Marine Institute<br><br>The development of a biomarker to monitor fish health in aquaculture<br><br>**Sandra Bohan**<br>IT Carlow |
| **12.00 - 12.15** | The AREST Project - Antimicrobial Resistance and the Environment – Sources, Persistence, Transmission and Risk Management<br><br>**B. Hooban** NUIG | Poster 1 Minute Oral Presentation<br><br>MC 32 A baseline study of the variability of pCO2 in Irish coastal and shelf waters – preliminary results<br><br>**Aedín McAleer** NUIG<br><br>MC 113 Rays and Skates in the Irish Sea<br><br>**Danielle Crowley** UCD |
| **12.15 - 12.30** | Remote sensing for mapping groundwater floods in the Republic of Ireland<br><br>**Joan Campanyà** GSI | |
| **12.30 - 12.45** | Poster 1 Minute Oral Presentation<br><br>EM 43 Environmental change in Ireland's small marl lakes<br><br>**Raymond Wilson**<br>Univ. of Ulster | |

# Environ 2019

Institute of Technology Carlow

April 15th – 17th 2019

Engagement for Climate Action
29th Irish Environmental Researchers Colloquium

**ORAL PRESENTATION ABSTRACTS**

## Water Quality & Resources 1 (L114)



**Nutrient dynamics in Lough Feeagh to understand the drivers of ecosystem productivity**

Maria Caldero Pascual 1, Eleanor Jennings 1, Elvira deEyto 2, Mary Dillane 2, Mikkel Andersen 1, 2, Valerie McCarthy 1

[1]Centre for Freshwater and Environmental Science, Dundalk Institute of Technology, Dundalk, Co. Louth, Ireland.

[2]Marine Institute, Furnace, Co. Mayo, Ireland.

Corresponding Author Email Address: maria.calderopascual@dkit.ie

The Burrishoole catchment is situated on the northwest Atlantic coast of Ireland in Country Mayo and consists of approximately 90 Km2 of mainly blanket bog. The Burrishoole catchment has a network of in-situ sensors which measure a range of variables in near real time. The focus of this work is on Lough Feeagh, which is an oligotrophic, humic lake with a maximum depth of 48 meters (mean depth 14m) and residence time of 0.47 years with an area of 4 Km2. The principal aim is to address the gap in the current monitoring programme for Lough Feeagh by quantifying macro-nutrient concentrations through the monitoring of major nutrient fractions (carbon (C), nitrogen (N), and phosphorus, (P)), in order to gain a better understanding of the drivers of productivity. The current high frequency monitoring (HFM) system in Lough Feeagh has been augmented by the addition of a new dissolved nitrogen sensor at one of the inflows. In addition, fortnightly grab samples from three Inflow Rivers to Lough Feeagh, two outflows and the lake have been carried out to monitor seasonal nutrient dynamics. The sampling campaign takes into account water and particulate nutrient fractions as well as phytoplankton and zooplankton quantification and identification. In addition to informing on the nutrient loading and cycling, the next stage of this work aims to establish the relative importance of seasonal allochthonous versus autochthonous contributions to ecosystem production. Humic systems such as Burrishoole tend to be characterised by high allochthonous (terrestrial) C sources, leading to low light conditions and the promotion of high bacterial production at the expense of phytoplankton production. This has potential implications for food quality for higher trophic levels.

**Keywords:** ecological stoichiometry, nutrient dynamics, food quality for primary consumers, allochthonous versus autochthonous organic matter contributions

## Water Quality & Resources 1 (L114)



**Seawater as a potential transmission route for clinically significant antimicrobial resistant bacteria**

Brigid Hooban 1, 2, Benjamin Wong Ngie Xiong 1, Bláthnaid Mahon 1, 2, Niamh Cahill 1, 2, Louise O' Connor 1, 2, Paul Hickey 3, Shane Keane 3 , Dearbháile Morris 1, 2.

[1]Antimicrobial Resistance and Microbial Ecology Group, School of Medicine, National University of Ireland, Galway.

[2]Centre for Health from Environment, Ryan Institute, National University of Ireland, Galway.

[3]Environmental Health Service, HSE West, Galway, Ireland.

Correspondence Author Email Address: b.hooban1@nuigalway.ie

Antimicrobial resistance (AMR) is a major public health problem globally. There is increasing recognition of the important role the environment plays in the transmission and persistence of AMR. Bathing waters may represent a reservoir for the transmission of AMR to humans. The aim of this research was to examine seawaters for the presence of clinically significant antimicrobial resistant Enterobacterales. A total of fifteen samples (30 litres each) of seawater were collected from three beaches in Ireland between June and September 2018. All samples were filtered using the CapE method, and filters were enriched overnight. Enrichments were cultured on mSuper CARBA and Brilliance CRE agars to screen for the presence of carbapenemase-producing Enterobacterales (CPE). Enrichment broths were also cultured on CHROMID ESBL and MacConkey agar with a ciprofloxacin (5µg) disc to screen for extended-spectrum beta-lactamase-producing Enterobacterales (ESBL-PE) and fluoroquinolone-resistant Enterobacterales (FQR-E) respectively. Colonies of interest were identified by MALDI-TOF and antimicrobial susceptibility testing was performed in accordance with EUCAST criteria. Selected isolates were examined for the presence of the following beta-lactamase encoding genes, blaCTX-M, blaVIM, blaIMP, blaOXA-48, blaNDM-1, and blaKPC using real time PCR. Double disc diffusion testing using cefpodoxime and cefpodoxime/clavulanic acid, coupled with real time PCR revealed that of the 87 Enterobacterales isolated, 46 (53%) were ESBL producers. A total of 43 (93%) of the ESBL producers harboured blaCTX-M-1 while 3 (7%) isolates harboured blaCTX-M-9. Antibiotic susceptibility testing demonstrated that fluoroquinolone resistance was detected in all seawater samples collected. Overall 10 (11%) isolates were resistant to ertapenem. A blaOXA-48 positive Klebsiella pneumoniae was detected on one sampling occasion. These findings highlight that seawaters are an important source and potential transmission route for clinically significant antimicrobial resistant bacteria. The number of confirmed cases of CPE in Ireland are increasing with OXA-48, KPC and NDM being the most commonly reported. The detection of an OXA-48 producing Klebsiella pneumoniae in seawaters that are consistently classified as good/excellent under EU bathing water quality criteria is concerning. These findings highlight the need for increased surveillance of AMR in the environment.

**Keywords:** seawater, antimicrobial resistance, carbapenemase-producing Enterobacterales.

## Water Quality & Resources 1 (L114)



### *Asellus aquaticus* as a potential biomonitor of trace metal pollution in freshwaters

Irene O'Callaghan 1, 2, Timothy Sullivan 1
[1]School of Biological, Earth & Environmental Sciences, University College Cork, Distillery Fields, Cork, Ireland.
[2]School of Chemistry, University College Cork, Western Road, Cork, Ireland.

Corresponding Author Email Address: irene.ocallaghan@ucc.ie

In Ireland, trace metal pollution of freshwater systems is an ongoing concern. While trace metal monitoring programmes exist, their widespread implementation is limited by the cost of sensitive analytical instrumentation, and the need for an initial estimation and mapping of potential pollutant sources to inform an effective sampling regime. The use of biomonitors for trace metal pollution could potentially inform this sampling regime. In particular, the use of a species that is tolerant to metal pollution in freshwaters, but also bioaccumulates selected metals could be used as a cost-effective warning of metal pollution. Asellus aquaticus is a benthic macroinvertebrate and has been suggested as one such potential biomonitor. The species is abundant, widespread and tolerant to a range of pollutants, including heavy metals. A. aquaticus also spends a considerable time in contact with the sediment, which is known to be a sink for trace metals, thereby increasing the exposure of the organism to the metal pollutants. In this work, we examine the potential use of Asellus aquaticus as a biomonitor of various trace metals in Irish freshwater systems. We present work on the initial culture conditions necessary for examining trace metal bioaccumulation in A. aquaticus, and on preliminary uptake and sequestration of selected trace metals in this species. We envision that this work will aid in reducing the cost and increasing the sampling efficiency of traditional freshwater metal monitoring programmes.

**Keywords**: metals, macroinvertebrates, biomonitoring, Asellus, freshwaters

## Water Quality & Resources 1 (L114)



**Association of potential human pathogens on microplastics in natural water systems**

Loriane Murphy, Kieran Germaine ,Thomais Kakouli-Duarte and John Cleary enviroCORE, Department of Science and Health, Institute of Technology Carlow, Kilkenny Road, Carlow, Ireland.

Corresponding Author Email Address: loriane.murphy@itcarlow.ie

Microplastics (MPs) are a global concern in aquatic ecology and are readily colonised by environmental microorganisms. Due to their low biodegradability, MPs persist in the environment and serve as potential vectors for spreading bacterial pathogens of humans. Plastic polymers play significant roles in pathogen transfer. In pelagic and benthic environment, surfaces are always colonised by microorganisms, forming biofilms. Despite recent findings on microorganisms associated with MPs in marine environment, there is a lack of information on microbial colonisation of microplastics in freshwater ecosystems. Due to their small size, MPs in river offer a solid surface on which dense biofilms can form, just like on natural particles. Therefore, we employed a 14-day experiment to investigate bacterial colonisation on polyethylene (PE) MPs within river Barrow (upstream of a municipal wastewater discharge point), Carlow, Ireland. MP beads were placed in-situ in the river as well as in river water samples in the laboratory and left for 14 days. High throughput 16S ribosomal DNA (rDNA) gene sequencing was used to profile bacterial communities on the surfaces of microplastic particles. Different bacterial communities and lower microbial diversity were observed in the laboratory samples compared to the environment samples. Results revealed the presence of potentially pathogenic species, such as Enterobacter spp, Campylobacter spp, Enterococcus spp, Helicobacter spp, Clostridium perfringens spp and Escherichia coli spp. This is a clear evidence for the potential of MPs to carry potential harmful bacteria into the food chain.

**Keywords:** microplastics, bacterial community, microbial biofilms, pathogens, 16S rDNA

## Water Quality & Resources 1 (L114)



**Drinking water treatment and challenges in developing countries**

Josephine Treacy
Department of Applied Science, Limerick Institute of Technology, Ireland.

Corresponding Author Email Address: Josephine.Treacy@lit.ie

Safe drinking water remains inaccessible to many humans in developing countries. Access to drinking water is monitored by the World Health Organisation (WHO), the United Nations International Childrens's Emergency Fund (UNICEF) and the Joint Monitoring Programme for water supply and sanitation (JMP). Research continuously innovates to develop efficient and cheap methods to sustain clean water for developing countries. Developing nations are a broad term that includes countries that are less industrialised and have a lower per capita income levels than developing countries. This presentation will discuss a review chapter titled Drinking Water Treatment and Challenges in Developing Countries. The importance of categorising pollution concerns of water in developing countries in terms of physical, chemical and biological pollution will be discussed. The Literature review findings on the Natural and anthropogenic pollution concerns linking with seasonal factors and climate change will be outlined. The debate on the multi-barrier approach to drinking water treatment in developing countries will be discussed. Research findings on the types of abstraction points utilised will be highlighted. Water treatment systems medium to small scale approaches researched will be discussed. Research findings concerning the use of conventional methods as well as solar disinfection, hydrid filtration methods and arsenic removal technologies in developing countries will be outlined. Global precipitation climatology data supplied by NASA for the years 1979 to 2017 highlighting the under resourced rainwater harvesting systems will be presented. Review data on rain water harvesting technologies utilised by developing countries will be presented. Challenges of water treatment in rural and urban areas linking with climate change will be highlighted. This review chapter is part of a larger book project namely, 'The relevance of hygiene to Health in Developing Countries'.

**Keywords:** drinking water treatment, abstraction, pollution, developing countries

## Energy 1 (K103)

Oral Presentations Session
Tuesday April 16th 11.30 – 1.00

### A decision support tool for energy use on dairy farms

P. Shine 1, M. Breen 1, 2, J. Upton 2, A. O'Donovan 1, M. D. Murphy 1,
[1] Department of Process, Energy and Transport Engineering, Cork Institute of Technology, Cork, Ireland.
[2] Animal and Grassland Research and Innovation Centre, Teagasc Moorepark Fermoy, Co. Cork, Ireland.

Corresponding Author Email Address: philip.shine@cit.ie

This body of work pertained to the development and application of the Decision Support System for Energy use in Dairy Production (DSSED). DSSED is an online portal offering decision support to dairy farmers wishing to invest in new farm infrastructure or upgrade their existing farm infrastructure. Increasing the utilization of energy efficient and renewable energy technologies on dairy farms may increase the probability of Ireland achieving its strict EU targets by: 1) reducing electricity related CO2 emissions on dairy farms, 2) reducing the required load from the electrical grid, and 3) increasing the proportion of renewable energy contributing to national electricity demand. However, the installation of these technologies may lead to greater long-term costs for dairy farmers if not managed and sized correctly. In order to provide useful advice, information related to infrastructural equipment, management practices, available grant aid and electricity tariffs are required, as the impact of installing a particular technology may interact with existing on-farm technologies. Thus, the DSSED was developed to allow dairy farmers calculate how a potential investment in a renewable or energy efficient technology will affect their economic and environmental sustainability, using input details specific to their current farm setup. The technologies which may be assessed include: plate coolers, variable speed drives, heat recovery systems, solar thermal water heating systems, solar photovoltaic systems and wind turbines. It is anticipated that the DSSED will be used extensively in the future to assist farmers, farm managers and policy makers with decisions pertaining to dairy farm energy, costs and CO2 emissions.

**Keywords:** decision support, dairy energy, renewable energy, agricultural sustainability

## Energy 1 (K103)



**Greenhouse gas calculation tool for community-based biomass renewable energy projects**

Chi-Thang Phan-Tan, Ger Kelly, Martin Hill
Cork Institute of Technology, Cork, Ireland.

Corresponding Author Email Address: chi.phan-tan@mycit.ie

Renewable energy generation is possible at small to medium scale over a geographically distributed area and this opens the opportunity for community-owned energy projects to help transform the energy system. Communities all over Europe are creating projects where they own and are actively involved in running an energy resource. EU policy supports this development and many projects are underway to support communities to become engaged in the process. The EU Interreg ECCO project is working to capture the best practice in existing community energy schemes. One difficulty identified for community groups has been the difficulty in determining the greenhouse gas (GHG) reduction associated with proposed systems. Existing calculation tools are either simple or very complicated giving inaccurate results or requiring excessive input data to be useful for communities. A GHG calculation tool that can overcome this difficulty by adopting a layered interface is presented here. Users can initially input a minimum data set to the tool to generate indicative GHG reduction estimates and then progressively input additional data to refine the estimated values. The interface is designed to be user-friendly and the data required progresses from more generally available data to detailed site-specific parameters. By applying this tool, the community project promoters can generate an initial estimated value of the GHG reduction without a significant investment of effort and thereafter refine their estimate as the project progresses. This paper will focus on the tool applied to biomass combined-heat-and-power (CHP) methods with the three main sources of wood chips, wood pellets, and manure.

**Keywords:** greenhouse-gas, biomass, community co-operative

## Energy 1 (K103)



**Energy service demands projections in transport sector for SSPs**

Siddharth Joshi, James Glynn, Brian O Gallachoir
MaREI Centre, Environmental Research Institute, University College Cork, Ireland.

Corresponding Author E-mail Address: Siddharth.joshi@ucc.ie

In the transport sector, the share of low-emission final energy would rise from less than 5% in 2020 to about 35–65% in 2050 compared to 25–45% for 2°C of global warming (medium confidence)"-IPCC. Energy Service Demand estimation was undertaken for global Aviation and Rail sector. Each Sector was broken down into sub-categories of Cargo and Passenger. Historical data pertaining to Tonne-Kilometres (TKM) and Passenger-Kilometres (PKM) metrics was procured for 128 countries for Aviation and 100 countries for railways with country wise disaggregation for years 1990-2015. The data was collected from UN and World Bank databases. The metrics were correlated with GDP/Capita and Urbanisation Percentage for four flavours of regression – Linear, Log-Linear, Log-Log, and Linear Log. Best flavour was chosen to design 'Projection equations' for each sub-categories. Future Projections were performed using SSPs (Shared Socioeconomic Pathways) databases for all five SSPs scenarios. It was observed from the results that rich island nations have the highest per capita air travel. For air travel highest correlation is observed for PKM/Capita, GDP/Capita and Urbanisation Percentage using Log-Log regression. For rail transport, linear relationship was observed between TKM, GDP and Urbanisation percentage. These initial projections are part of the CHIMERA project developing a new Global TIMES model in partnership between University College Cork (IRELAND) and Tsinghua University (CHINA). The method outlined in the abstract is calculating actual Energy Service Demands in physical units which can be used in conjunction with future changes in efficiencies and/or usage and holds an advantage over current established methods that calculate only final energy demand in Peta Joules

**Keywords:** global energy modelling, regression analysis, transport sector energy demand

## Energy 1 (K103)



**Developing a regional energy balance; Case study from the Dingle peninsula**

Connor McGookin 1, 3, Brian O'Gallachóir 1, 3, Edmond Byrne 2, 3
[1]School of Engineering – Energy Engineering, University College Cork, Ireland.
[2]School of Engineering – Process & Chemical Engineering, University College Cork, Ireland.
[3]MaREI Centre, Environmental Research Institute, University College Cork, Ireland.

Corresponding Author Email Address: connor.mcgookin@ucc.ie

The energy system's transformation to a low carbon future has been increasingly focused on action at a local level, seeking pilot or flagship projects to showcase the transition process. In Ireland, this has lead to the formation of the sustainable energy communities (SECs) network, through which SEAI mentor groups undertaking energy initiatives. An important step in the formation of these groups is the development of an energy master plan, exploring the current energy demand and outlining a roadmap for the transition of the area to a low carbon future. In support of the development of an energy master plan for the Dingle SEC, this paper produces a regional energy balance including residential, agriculture, industry, services and transport sectors. This is derived from a combination of national statistics and local energy usage indicators. Prior to performing this calculation, existing "sustainable energy action plans" and "energy and emissions baseline" reports from across Ireland were reviewed to see if there was any consensus on the suitability of different energy usage indicators. It was found that there was a lack of consistency across the reports with a variety of different indicators being used. To address this gap a number of energy usage indicators are compared and contrasted across each sector, in doing so outlining a practical guide for estimating a regional energy balance. Focusing on the current energy demand or baseline energy usage in this manner provides a valuable insight into the local context that defines the energy system.

**Keywords:** local energy planning, energy balance, sustainable energy communities

## Waste Management 2 (L114)



**Effect of trace element supplementation on anaerobic digestion of chicken litter with enzyme treatment**

Navodita Bhatnagar 1, David Ryan 1, Richard Murphy 2, Anne-Marie Enright 1
[1] enviroCORE, Institute of Technology Carlow, Kilkenny road, Ireland.
[2] Alltech, Dunboyne, Co. Meath, Ireland.

Corresponding Author Email Address: navodita.bhatnagar@itcarlow.com

Animal manure, composed of digested organic matter, represents a rich source of minerals including nitrogen, phosphorus, calcium, potassium and magnesium. However, due to the presence of inorganic minerals improper disposal of this waste stream can result in contamination of ground and surface water. The poultry industry is one of the largest producers of organic waste within the agriculture sector. Specifically, Irish chicken production and consumption is higher compared to other poultry animals, thus generating large volumes of chicken litter (CL). Anaerobic digestion (AD) is an ecofriendly technology which not only stabilizes this waste by converting it to biogas (CH4, CO2 and N2) but also reduces the volume. However, mono-digestion of CL results in low methane yields. The current study examined the effect of enzyme and trace element supplementation in small scale batch biomethane potential (BMP) assays in 150 ml serum bottle. The experiment included ten different enzyme and trace element combination assays including negative controls containing CL alone and a positive control containing cellulose. All batch assays were carried out in triplicate at 37 □C. Results indicate that both enzyme treatment and trace element supplementation enhanced the biogas yield (10% to 60% increase) and methane yield (35% to 100% increase) of AD of CL. The CL treated with1% enzyme and the CL that received a 1% enzyme pretreatment plus a trace element supplementation effected the highest specific biogas and methane yields.

**Keywords:** co-digestion, biogas, biomethane potential, organic matter

## Biodiversity & Ecosystems (L115)



**Genetic evaluation of a *Dactylorhiza maculata* urban population by RAPD analysis: implication for an evolutionary dynamic**

Stephanie Coakley, Carloalberto Petti
enviroCORE, Institute of Technology Carlow, Kilkenny Road, Carlow, Ireland.

Corresponding Author Email Address: Stephanie.Coakley@itcarlow.ie

The Orchidaceae family is the second largest family in the plant kingdom with a staggering conservative estimate of 26000 species. Their evolutionary radiation, co-evolution with pollinators, ability to adapt and evolve and to hybridise and establish niches makes them one of the most extensively researched plant species. Dactylorhiza maculata, the spotted marsh orchid, has been recommended for conservation due to the large number of hybrids it produces, including D. dinylensis- a hybrid with the Irish endemic D. occidentalis. Dactylorhiza maculata flowers vary in shade from white to purple with striking purple markings. A rarer pure white morph, devoid of the typical floral markings, was observed in a mixed population in Limerick. Orchids are considered to be evolutionary labile, capable of altering their physical appearance (colour and markings) through minute changes in their expression of pigments. Switching dominant pigments in orchids is often a rapid response to environmental stimuli. Populations of orchids with higher frequencies of white morphs were found to possess enhanced fitness and rates of pollination. RAPD PCR was utilised to investigate the purple/pink and white morphs of D. maculata to identify polymorphisms relating to their pigmentation. This low complexity method is simple, fast and can be quite sensitive in detecting polymorphic differences on an allele level. Though RAPD PCR is not as powerful as other methods for molecular analysis, it can be informative for initial typings. For example, analysis revealed that the white morph had lower levels of polymorphic loci (78.6 % versus 96.4 %), which one would expect as visibly the purple/pink morph is much more dynamic in its colouring and markings. Significant diversity was observed in the expression of alleles, seemingly supporting the hypothesis that orchids can alter their phenotypic appearance through subtle changes in the expression of their genes.

**Keywords:** Dactylorhiza maculata, RAPD PCR, colour morphs

## Biodiversity & Ecosystems (L115)



**Two-way engagement with stakeholders to improve biosecurity around invasive alien species in the workplace**

Eithne Davis 1, Sonia Vanderhoeven 2, Emily Smith 3, Caitriona Shannon 4, Stephanie Bradbeer 4, Joseph M. Caffrey 5, Julien Carlier 1, Neil Coughlan 6, Jaimie Dick 6, Sara Meehan 1, Frances E Lucy 1
[1]Centre for Environmental Research, Innovation and Sustainability, Institute of Technology, Sligo, Ireland.
[2]Belgian Biodiversity Platform, Brussels, Belgium.
[3]University College, London, UK.
[4]School of Biology, Miall Building, University of Leeds, Leeds, LS2 9JT, UK.
[5]INVAS Biosecurity, Dublin, Ireland.
[6]Queens University, Belfast, Northern Ireland, UK.

Corresponding Author Email Address: Eithne.Davis@mail.itsligo.ie

Being an island means that Irelands biodiversity is particularly vulnerable to the threat of invasive alien species (IAS). However, islands also offer greater opportunities for protection from IAS than individual states in a continental land mass. Promoting good biosecurity and a strong sense of biosecure citizenship must become a priority among the broad range of stakeholder groups who engage in risky behaviour for the spread of IAS. In April 2017, a daylong workshop, part-funded by the ESAI Grassroots Workshop Support Scheme, took place at the Institute of Technology, Sligo. This workshop drew together a broad range of stakeholders, from state-sponsored competent authorities, to consultants, members of community groups and recreational water-users. The measureable outcomes from the workshop were a repeated survey, plus the collated outputs from an elicitation session. Rather than identifying any specific species, the emphasis for the workshop was on practicing good generic biosecurity. With a small amount of guidance towards reliable sources of information, participants reported an increased confidence in identification skills. The most significant change after the workshop was in participants' confidence in designing good biosecurity plans and carrying out effective biosecurity measures in the field. Of those who attended, 93.8% reported that their behaviour would change as a result of the workshop. The facilitated elicitation process identified some of the existing obstacles to practicing good biosecurity in the workplace, drawn from participants' experience on the ground. During the elicitation process, extensive information was gathered in the form of a prioritised range of obstacles affecting participants' ability to engage in effective biosecurity, and a list of opportunities that these stakeholders perceived as open to promoting good biosecurity. This information is now available to managers and policy-makers to inform future biosecurity measures on the island of Ireland, and is potentially transferrable to other jurisdictions.

**Keywords**: invasive species, biosecurity, stakeholder engagement

## Biodiversity & Ecosystems (L115)



**Young commercial forests as a habitat for the hen harrier (Circus cyaneus); selection of a suboptimal habitat?**

Alan McCarthy 1, Sandra Irwin 1, Anthony Caravaggi 1, 2, Darío Fernández-Bellon 1, John O'Halloran 1.
[1]School of Biological, Earth and Environmental Sciences, University College Cork.
[2]University of South Wales, Glyntaff Upper Campus, 9 Graig Fach, Pontypridd, UK, CF37 4BB.

Corresponding Author Email Address: alanmccarthy@ucc.ie

Increases in afforestation of upland breeding habitats of the Hen Harrier (Circus cyaneus) may be creating suboptimal habitat for this vulnerable bird of prey. As vast areas of their traditional open breeding habitats are lost to forest expansion, Hen Harriers in Ireland use young commercial forest habitats for nesting and foraging. However, recent evidence suggests that while these habitats may provide cues for Hen Harriers looking for suitable nesting habitat, these cues may not be indicative of the presence of the appropriate resources to support successful breeding of Hen Harrier populations. This study set out to investigate the mechanism underlying the poor breeding performance of Hen Harriers in young commercial forests. The suboptimal conditions may present in two ways: (i) through decreased prey abundance, and/or (ii) through increased rates of nest predation. We conducted two studies during the summer of 2018 to investigate these aspects of young commercial forests. The first examined prey abundance within young commercial forests and open upland habitats using point count surveys of avian prey, and small mammal trapping to survey mammalian prey of Hen Harriers. The second study examined the predator communities in young commercial forests using a combination of camera traps, scent lures and bait. Our results showed a lower abundance of Hen Harrier prey in young commercial forests compared to open moorland, and a varied predator community in young commercial forests. This suggests that increases in afforestation of upland breeding habitats of the Hen Harrier may therefore be creating a suboptimal habitat for this species. This has important conservation and management implications. The findings from these studies will help to inform forest policy and management practices and Hen Harrier conservation strategies throughout Ireland and across their range.

**Keywords**: hen harrier, suboptimal habitat, uplands, afforestation

## Biodiversity & Ecosystems (L115)



**The diet of a predatory stonefly *Diura bicaudata* in Ireland**

Tara Joseph, Jan-Robert Baars
School of Biology and Environmental Science, University College Dublin, Belfield, Dublin.

Corresponding Author Email Address: tara.joseph@ucdconnect.ie

Freshwater systems are deteriorating in quality, and a better understanding of the system and its components are required to manage our aquatic habitats effectively. Although aquatic invertebrates are used as bio-indicators there is still much we don't know about their ecology. Stoneflies are considered a pollution sensitive group, but the reasons why they cannot tolerate pollution is unclear. This study determined the dietary requirements of Diura bicaudata, to assess the breadth of prey consumed and temporal and spatial changes in its diet. Surber samples were taken in April and October 2018 in a tributary of the Glencree catchment to collect D. bicaudata nymphs and determine the density of nymphs and their prey. Kick sampling was used to determine the community present and collect additional nymphs for the diet assessment. Spatial changes were assessed by collecting the same samples in two tributaries. The results show that the nymphs are exclusively predatory and feed on aquatic insects including mayflies, other stoneflies, caddisflies and simulid larvae. Temporal and spatial differences in the diet were recorded but in each season the nymphs fed on a range of functional feeding groups suggesting they accept a broad prey complex. The nymphs seemed to be selective, feeding on certain taxa irrespective of their density. This first account of the diet of D. bicaudata in Ireland contradicts previous results in Europe showing that nymphs do feed on ephemeropteran nymphs including both Baetis and Ecdynurus species. This study provides an insight into the dietary requirements of D. bicaudata fulfilling a knowledge gap in the ecology of Irish stonefly species.

**Keywords:** Diura bicaudata, stoneflies, indicator species, diet analysis, Ireland

## Biodiversity & Ecosystems (L115)



**The role of motorway attenuation ponds as new habitats for mobile aquatic insects**

Roisin Normanly, Jan-Robert Baars
School of Biology and Environmental Science, University College Dublin, Belfield, Dublin.

Corresponding Author Email Address: roisin.normanly@ucdconnect.ie

Ponds are biodiversity hot spots and support a greater diversity than rivers or streams relative to their size. However, many of Irelands natural ponds have been lost or impacted by agriculture and land-use change. During the construction of Ireland's motorways, stormwater run-off ponds were built every few kilometres to meet EU regulations. These ponds are providing a new man-made habitat in the landscape but despite being an EU requirement, minimal research has been done on the biodiversity supported by these ponds. This study investigates the overall biodiversity of the coleopteran communities using horizontal activity traps in five motorway run-off ponds. Temporal changes were investigated by sampling three times over a year in March, June and September. Results show that these ponds support a large number of species, some of which are red-listed. Most of the ponds supported statistically unique communities, even ones in relatively close proximity to each other. The ponds varied significantly in the vegetation cover and macrophyte species present which affected the insect diversity. The results show that these ponds support a high diversity of mobile aquatic insect groups and highlights how important these new habitats are in the conservation of these insects and maintaining aquatic diversity in a landscape dominated by agriculture.

**Keywords:** Coleoptera, biodiversity, macroinvertebrates, anthropogenic, community structure

## Biodiversity & Ecosystems (L115)



**Eco-hydrogeology in Irish Calcareous Fens**

Ella Bijkerk 1, Shane Regan 1, 4, Stephen Waldren 2, Catherine Coxon 3, Paul Johnston 1, Laurence Gill 1
[1]Department of Civil Structural & Environmental Engineering, Trinity College Dublin, College Green, Dublin 2, Ireland.
[2]Department of Botany and Centre for the Environment, Trinity College, Dublin 2, Ireland.
[3]Department of Geology and Centre for the Environment, Trinity College Dublin, Dublin 2, Ireland.
[4]National Parks & Wildlife Service, 90 North King Street, Dublin 7.

Corresponding Author Email Address: bijkerke@tcd.ie

Alkaline and Cladium fens are protected under the European Union (EU) Habitats Directive (Council Directive 92/43/EEC) as Special Areas of Conservation (SAC) under habitat types 7230 and 7210 respectively. These fens are peat-forming wetlands predominantly fed by groundwater containing significant concentrations of calcium, magnesium and bicarbonate. The hydrogeological dynamics and hydro-chemical signature supports small sedge and brown moss communities in a mosaic of different habitats. Despite being an important part of the natural landscape in Ireland and one of the most threatened wetland habitats in Europe, little is known about the hydrology and hydrochemistry that support fen habitat than for other GWDTE's (Groundwater Dependent Terrestrial Ecosystems) such as bogs and turloughs. As part of a three year EPA funded research project (Ecometrics) on GWDTE's, this research aims to quantify the eco-hydrological and groundwater linkage for calcareous fens in Ireland with the following research question: What are the hydrological and hydro chemical controls that support fen vegetation in Irish calcareous fens? In order to answer this research question four fen sites were chosen located in the Eastern Lowlands limestone region. The conditions of the selected sites cover an eco-hydrological gradient from pristine to highly degraded caused by drainage as well as nutrient pollution. An intensive hydro-chemical monitoring programme was set up for the fens as well as for the surrounding parent aquifers. Ground and surface waters are monitored hydrologically through monthly measurements supplemented by a continuous water table time series. Furthermore, monthly ground and surface water samples are taken and analysed for nutrients, minerals and metals. Data collection started in July 2018 and is ongoing. These data will then be collated together with geology and vegetation surveys in order to find appropriate metrics that characterise the environmental supporting conditions in fens, as required by the EU Water Framework Directive.

**Keywords:** GWDTEs, SAC, peat, fen, hydrology, hydrochemistry, ecology, geology, drainage, nutrient pollution

## Biodiversity & Ecosystems (L115)



**BE1 Plant diversity effect on intensively managed grassland productivity and sustainability**

Guylain Grange 1, 2, Caroline Brophy 2, John Finn 1
[1]Soils, Land Use and Environment Dept, Teagasc, Johnstown Castle.
[2]Dept of Mathematics & Statistics, Maynooth University, Ireland.

Corresponding Author Email Address: guylain.grange@teagasc.ie

We investigated farm-scale practices to improve the sustainable production of grassland. In southern Ireland, milk and meat are mainly produced from intensively managed ryegrass pastures with significant addition of nitrogen fertiliser. We examine how functional group (FG) diversity can affect productivity (measured as above-ground biomass) at a reduced fertilizer input level. In a field experiment sown in Co. Wexford, we used a simplex design to create 20 distinct grassland communities (1-6 species, and 1-3 FGs). Six species within three FGs were combined: grasses: ryegrass (Lolium perenne L.) and timothy (Phleum pratense L.); legumes: red clover (Trifolium pratense L.) and white clover (Trifolium repens L.); herbs: chicory (Cichorium intybus L.) and plantain (Plantago lanceolata L.). All experimental plots received 150 kg ha-1 of nitrogen fertiliser per annum. A ryegrass monoculture with 300 kg ha-1 of nitrogen was included as a comparison. Aboveground dry matter yield was analysed using linear models. Annual production was strongly influenced by grassland composition. Legumes had higher yields and stronger interaction effect with other FGs. Ryegrass with 300 kg ha-1 of nitrogen was significantly outperformed by any community having at least 30% legumes and maximum 60% of herbs, showing mixtures potential for sustainable intensification.

**Keywords:** diversity, grassland, functional group, grass, legume, herb nagement, Internet of Things, Blockchain, District Energy

## Biodiversity & Ecosystems (L115)



**BE64 Lough Arrow - Conservation status assessment and collaborative actions for the Natura Network**

Darren Garland 1, Frances Lucy 1, Nicolas Touzet 1, Sara Meehan 1, Yvonne McElarney 2, Joerg Arnscheidt 3, Joe Caffrey 4

[1]Centre for Environmental Research, Innovation and Sustainability (CERIS), Institute of Technology, Sligo, Ash Lane, Sligo.

[2]Agri-Food and Biosciences Institute (AFBI), 18a Newforge Lane, Belfast.

[3]Environmental Sciences Research Institute, Ulster University, Cromore Road, Coleraine.

[4]Invas Biosecurity Services, 6 Lower Ballymount Road, Walkinstown, Dublin 12.

Corresponding Author Email Address: darren.garland@mail.itsligo.ie

Lough Arrow, Sligo and Roscommon, is a designated Special Area of Conservation under the European Union's (EU) Habitats Directive (92/43/EEC). The lake contains the Annex I habitat "Hard oligo-mesotrophic waters with the benthic vegetation of Chara spp". The current conservation status of this habitat is significantly impaired and deemed, by the most recent Article 17 conservation assessment, to have a "Bad" classification nationally. This is due to a number of pressures impacting the habitat at a national scale, notably, impacts from pollution and invasive species. This research aims to determine the conservation status of the Lough by utilising national and EU standards. The research is integral to the CANN project (INTERREG) and involves producing a Conservation Action Plan. Additionally, the project aims to potentially improve the conservation condition of the Annex I habitat through the utilisation of novel in situ conservation measures. The project will implement actions to suppress growth and spread of invasive macrophyte species which are competing with native charophytes. These actions will be implemented in conjunction with the promotion of biosecurity awareness and appropriate training for stakeholders. Temporal changes in relation to habitat quality will be monitored to determine the significance of the methods implemented both in situ and with stakeholders. The project will also investigate the significance of certain biotic and abiotic variables in relation to their contribution to habitat assessment under the Habitats Directive (92/43/EEC). These conservation actions in conjunction with assessment techniques will facilitate the delineation of appropriate conservation measures for this Annex I habitat. The project is funded under the INTERREG VA programme (2017-2022).

**Keywords:** biodiversity, water quality, Habitats Directive, Water Framework Directive, environmental monitoring

## Biodiversity & Ecosystems (L115)



**BE105 Managing the small stream network for improved water quality, biodiversity and ecosystem services protection (SSNet)**

Edward Cox 1, Michael Bruen 2, Jens Carlsson 1, Angela Gurnell 3, Helen Jarvie 4, Jeremy J. Piggott 5, Mary Kelly-Quinn 1

[1]School of Biology and Environmental Science & Earth Institute, University College Dublin, Dublin, Ireland
[2]Dooge Centre for Water Resources Research, University College Dublin & Earth Institute, University College Dublin, Dublin, Ireland.
[3]Queen Mary University of London, London, United Kingdom.
[4]Centre for Ecology & Hydrology, Wallingford, United Kingdom.
[5]Trinity Centre for the Environment & Department of Zoology, School of Natural Sciences, Trinity College Dublin, Dublin, Ireland.

Corresponding Author Email Address: edward.cox.1@ucdconnect.ie

SSNet is a recently-initiated four-year project on the small stream network in Ireland. The overarching objective of SSNet is to advance knowledge on the role of small streams in water quality, biodiversity, and ecosystem services protection that will inform policy, measures, and management options to meet water quality and other resource protection targets. The project started with a synthesis of available information on the importance of small streams to initiate communication with stakeholders and introduce the project. Currently being undertaken is a compilation and analysis of existing data on small streams in Ireland to inform the selection of sites for the proposed research. Three work packages will collect new data on hydrochemistry with a focus on the nutrient retention potential of headwater streams, hydromorphology, and biodiversity. All three investigations will share common sites to enable interconnections between the three elements to be explored and provide an integrated approach to the research. Modelling based on the results from each of the aforementioned tasks will be used to estimate the level of intervention in the small stream network required to have measurable effects throughout a catchment on both water quality (N, P, & sediment) and flows, and overall delivery/maintenance of ecosystem services. We will also engage volunteers in both biological water quality and hydromorphological assessments and evaluate the potential of citizen science in facilitating greater monitoring coverage of the small stream network.

**Keywords:** small stream network, headwaters, small water bodies, water quality, hydromorphology, ecosystem services, biodiversity protection

## Water Quality & Resources 2 (L114)



**Antimicrobial resistant bacteria in the subsurface environment: a global systematic review**

Luisa Andrade 1, 2, Madeleine Kelly 3, Paul Hynds 4, John Weatherill 1, 2, 5, Anna Majury 3, 6, Jean O'Dwyer 1, 2, 5
[1]School of Biological, Earth and Environmental Sciences, University College Cork, Cork, Ireland.
[2]Irish Centre for Research in Applied Geosciences, Dublin 4, Ireland.
[3]Queen's University, Kingston, Ontario, Canada.
[4]Environmental Sustainability and Health Institute, Technological University Dublin, Dublin 7, Ireland.
[5]Environmental Research Institute, University College Cork, Cork, Ireland.
[6]Public Health Ontario, Kingston, Ontario.

Corresponding Author Email Address: 118222159@umail.ucc.ie

Compared to other aquatic environments, groundwater is considered a "naturally" safe drinking resource. However, long residence times and low transmissivity commonly found in the subsurface may lead to ideal conditions for antimicrobial-resistant bacteria (ARB) to thrive and for further resistance traits to emerge. This is globally significant as antimicrobial resistant infections have been classified by the World Health Organization as perhaps the greatest future threat to global health. Despite this, no comprehensive synthesis of ARB prevalence, frequency and their drivers in the subsurface environment has been undertaken to date. Accordingly, a systematic review of international literature was carried out, with seventy distinct studies identified which specifically reported on the occurrence of ARB in groundwater sources via sampling regimes of no less than ten samples. In all, 8,160 samples were studied, with 7,156 isolates tested against almost 100 different antibiotics. Results show that 67.6% of studied bacteria were resistant to at least one antibiotic and 54.6% were resistant to 3 or more, values acquired from 47 and 38 studies that reported it, respectively. Moreover, by calculating Multiple Antibiotic Resistance (MAR) Indices as a mean to uniformly measure levels of antimicrobial resistance in all studies, it was found that 70% (n=49) of groundwaters analysed can be classified as high-risk sources of ARB (i.e. MAR Index>0.2). Globally, groundwater is a critical natural resource, particularly in rural areas, where it is largely used for domestic and agricultural purposes. As such, these results offer valuable insights into the prevalence of ARB in different subsurface environments and can be used to inform future groundwater-related interventions to reduce ecological, human and animal exposures to ARB, thus lessening associated health risks.

**Keywords:** antibiotic resistance, antimicrobial resistant bacteria, groundwater, systematic review

## Water Quality & Resources 2 (L114)



**Science of the future? – Does citizen science provide a means of monitoring water quality for the Sustainable Development Goals (SDGs)?**

Lauren Quinlivan 1, Deborah Chapman 2, Timothy Sullivan 3

[1, 2] UN Environment GEMS/Water Capacity Development Centre, Environmental Research Institute, Lee Road, Cork, Ireland.

[3] School of Biological, Earth and Environmental Science, University College Cork, Cork, Ireland.

Corresponding Author Email Address: timothy.sullivan@ucc.ie

Citizen science has been suggested as a cost-effective approach to routine environmental monitoring and has received significant interest from the scientific community in recent years. Citizen science may be described as research carried out by members of the public with the aim of gathering scientific information at a scale that might not be possible with professional scientists alone. Indeed, the recent availability of relatively inexpensive water quality monitoring field equipment to emerging citizen science networks suggests great potential for increased spatial coverage far beyond that of traditional, laboratory-based monitoring networks. However, despite general recognition of the potential utility of citizen science in water quality monitoring for example, challenges remain with regard to the incorporation and acceptance of citizen science as a means of producing reliable scientific data that can be used to support decision making around environmental management. This research addresses whether citizen science is a viable means of supporting the UN SDG Indicator 6.3.2 for determining whether waterbodies have good ambient water quality. An examination of whether citizen scientists can produce high-quality data on water quality parameters associated with SDG Indicator 6.3.2 has drawn positive conclusions. This on-going research explicitly investigates the ability of a group of 30 potential citizen scientists, sampling water quality in "at-risk" Irish water bodies, to produce high-quality data comparable to that of a professional scientist and professional water quality laboratory. To this end, we will discuss how citizen science can have a role in supporting capacity development for the UN Sustainable Development Goal 6 on Clean Water and Sanitation.

**Keywords:** citizen science, sustainable development goal, water quality, water quality monitoring, capacity development

## Water Quality & Resources 2 (L114)



**Assessment of the potential environmental impacts arising from mercury-free dental restorative materials**

Hannah Binner 1, 2, Naghmeh Kamali 1, 2, Mairead Harding 2, Timothy Sullivan 1
[1] Department of Biological, Earth and Environmental Science, University College Cork, Ireland.
[2] Oral Health Services Research Centre, Cork University Dental School and Hospital, UCC, Ireland.

Corresponding Author Email Address: timothy.sullivan@ucc.ie

Dentists have traditionally used mercury-based amalgam materials for dental filling applications. However, the recent introduction of Article 10 of Regulation (EU) 2017/852 has restricted the use of dental amalgam in Europe, and even prohibited amalgam for dental treatment for certain patient categories unless deemed strictly necessary by the dental practitioner on the grounds of specific medical needs of the patient. This has led to an increased application of mercury-free dental alternatives. Furthermore, the Regulation (EU) 2017/852 made it a requirement that all dental facilities are equipped with an amalgam separator at least 95% efficient in removing amalgam particles from wastewater. However, while the environmental impacts of mercury have been widely documented and addressed, dental wastewater containing alternative dental materials leaves dental facilities untreated. Here, we examine if the wastewater resulting from the application and the removal of mercury-free dental materials poses a risk to the environment. We report the results of dental wastewater analysis, including particles that can potentially be discharged to the environment despite primary filtering technologies in place. These filtering technologies and amalgam separation have the potential to filter out heavier particles contained in the dental wastewater. Preliminary results show that each mL of dental wastewater sample analysed contains particles, including aluminium and zinc. Further analysis will be carried out to determine whether the type and quantity of particles found are significant to represent an environmental impact. This study addresses a knowledge gap, which has the potential to aid further guidelines and policy-making and make recommendations for dental wastewater treatment before release into the environment.

**Keywords**: particles, wastewater, environment, mercury-free, alternative dental materials

## Water Quality & Resources 2 (L114)



**Sulphate detection using Raman spectroscopy from Dublin rivers**

Patricia Loren 1, Madhumidha Murugan 1, Ganga Chinna Rao Devarapu 1, Michael AP McAuliffe 1, Aurora Gitto 2, Niamh Martin 2, Liam Reynolds 2, Laura Sala-Comorera 2, Wim G. Meijer 2, Kevin Fitzgibbon 3, Colin O'Sullivan 3, Ashfaque Azad 3, Liam O'Faolain 1

[1]The Centre for Advanced Photonics & Process Analysis (CAPPA), Cork Institute of Technology, Rossa Avenue, Cork, Ireland.

[2]UCD School of Biomolecular and Biomedical Science, University College Dublin, Belfield, Dublin 4, Ireland.

[3]Water Systems & Services Innovation Centre, Nimbus Centre, Cork Institute of Technology, Cork, Ireland.

Corresponding Author Email Address: patricia.loren@cit.ie

Achieving and maintaining high water quality standards is an important topic all over the world. Although surface water is being permanently monitored in most parts of the the European Union, there is a great concern about increasing water pollution. Beyond normal human activities, the release of ionic nutrients (sulphates, nitrates and phosphates) and agrochemicals from intensive agricultural and animal waste accelerates eutrophication of freshwater and coastal marine ecosystems. Sulphates, for example, occur naturally in drinking water. However, health concerns regarding sulphates in drinking water have been raised due to reports indicating that diarrhoea may be associated with the ingestion of water containing high levels of sulphates. Within this context, Raman spectroscopy is seen as a very powerful technique which provides detection of chemical and biological contaminants in a water environment. With Raman spectroscopy, it is possible to identify different substances since, a Raman spectrum consists of many Raman lines and each line can be associated with a particular chemical structure or bond. River water from 20 different regions in Dublin was analysed using Raman spectroscopy consisting of a compact probe, which allows to connect a laser (MOPA/ 785 nm @300mW) via optical fibre and collect the scattering with another optical fibre which will be connected to a spectrometer (Wasatch Raman 785nm, resolution 10 µm slit 4 cm-1), with integration time set to 2.5s and 25 averages. In 5 samples peaks corresponding to sulphates (980 cm-1) were found. The same samples were sent to a laboratory (Environmental Research Institute/UCC) for identification and quantitative analysis, proving the presence of high levels of sulphates in the 5 identified by the Raman method. The highest sulphate levels observed were around 2622 mg/L, which is considered to be detrimental to public health in river water.

**Keywords:** water pollutants, sulphates, Raman spectroscopy

## Water Quality & Resources 2 (L114)



**Arsenic detection in water using microfluidic detection systems**

Annija Lace 1, David Ryan 1, Mark Bowkett 2, Patrick Roche 2, John Cleary 1
[1]Institute of Technology Carlow, Kilkenny Road, Carlow, Co. Carlow, Ireland.
[2]TE Laboratories Ltd. (TelLab), Loughmartin Business Park, Tullow, Co. Carlow.

Corresponding Author Email Address: annija.lace@itcarlow.ie

Arsenic can be found at very high concentrations in numerous drinking water sources around the world posing a great risk to human health. Standard laboratory methods such as atomic absorption spectroscopy and inductively coupled plasma mass spectroscopy are not cost effective, and therefore, not suitable for mass monitoring of arsenic in groundwater and surface waters. Alternatively autonomous microfluidic detection systems could enable rapid in situ monitoring of various water sources at a low cost. The aim of the study was to develop a simple and robust method for arsenic detection in water using microfluidic detection system. A colorimetric method based on leucomalachite green dye was optimised and integrated into the microfluidic detection system. One to one reagent ratio was chosen for the method and run time was optimised to 25 minutes. The linear range was found to be between 0.2 and 3 mg L-1. The limit of detection of the method was 0.32 mg L-1. A range of environmental samples were analysed using the optimised method. The average % RSD and recovery were found to be 21.1% and 93.7 %, respectively. Additionally, blind analysis of samples was carried out to determine the optimised method's performance.

**Keywords**: heavy metals, arsenic, microfluidics, leuco malachite green, environmental monitoring

## Energy 2 (K103)



**An investigation and comparative study of the levels of particulate matter 2.5 (PM2.5) produced by different solid fuel burners and fuel in indoor ambient air at different stages of combustion**

Damian Smyth, Aoife Donnelly
School of Food Science and Environmental Health, College of Sciences and Health, Technological University Dublin, Cathal Brugha Street, Dublin 1, Ireland.

Corresponding Author Email Address: C10309211@mydit.ie

Indoor air quality (IAQ) is a common cause for concern and some studies have estimated that indoor pollution levels can be up to 100 times higher than outdoor levels depending on the environment (US EPA, 2017). The presence of particulate matter (PM) in the indoor environment is attributable to activities such as cooking and combustion, with the heat generation of wood and coal estimated to cause 61,000 premature deaths in Europe every year (WHO, 2015). 91% of the world's population is living in places exceeding the WHO PM2.5 (PM of less than 2.5µm in diameter) annual outdoor mean guideline value of 10µg/m3 leading to an increased risk of premature mortality (WHO, 2018). Currently, IAQ limit values do not exist for PM. This project aims to investigate and compare levels of PM2.5 present in indoor ambient air for different solid fuel burners and for fuels at different stages of combustion. PM2.5 levels, temperature and relative humidity were measured while coal and wood were combusted in a rotation in an open fire and closed stove for twenty-eight days. The results showed concentrations of PM2.5 in the indoor environment to be statistically significantly higher when the open fire was in use rather than the closed stove. Similarly, the use of coal as a fuel resulted in statistically significantly higher increases in PM2.5 levels than the use of wood. Exceedances of the WHO 24-hour mean outdoor guideline value of 25µg/m3 were found for both wood and coal combustion on the open fire. This study emphasises the need for further research in the area of IAQ, particularly in households using solid fuels for heat generation and cooking. As an increasing number of studies have demonstrated association between PM and negative health outcomes, further development of our understanding of the factors influencing IAQ is important.

**Keywords:** indoor air quality, particulate matter, solid fuel combustion

## Energy 2 (K103)



**Engaging communities on future re-use options for decommissioned wind turbine blades**

Thomas Fergal Gough 1, 2
[1]Department of Sociology, University College Cork, Western Road, Cork, Ireland.
[2]School of Engineering, University College Cork, Western Road, Cork, Ireland.

Corresponding Author Email Address: fergal.gough@umail.ucc.ie

Wind energy is widely considered one of the more sustainable options for energy, due to its potential to produce renewable clean energy in large amounts. Yet, is this source of renewable energy fully sustainable, when one considers the end-of-life management of the wind turbine blades? This research project addresses this challenge for a significant part of the wind turbine – the blade. But how to engage with societal stakeholders to ensure the best possible future re-use options for the blades are achieved? And can engagement result in socially acceptable re-use options that benefit the local economy and the environment? Models of community engagement are presented alongside recent thinking on circular economy, citizen engagement and participatory democracy techniques. Community engagement on end-of-life disposal of wind-blade waste has the potential both to secure revenue generating models for re-use of waste material and also to enhance societal acceptance for future wind energy developments. This paper reports on the initial explorations of the various re-use options to this interesting and visible waste material, and outlines the work to be undertaken in devising appropriate community engagement techniques that will direct future re-use options for the decommissioned blades.

**Keywords:** wind energy, community engagement, circular economy, rural development

## Energy 2 (K103)



**An appraisal of Miscanthus x giganteus (Greef et Deu.) as a Negative Emissions Technology in Ireland**

Paul Rice 1, Barry McMullin 2, Paul Price 2, Michael B. Jones 1
[1]TCD Botany Department, College Green, Dublin 2, Ireland.
[2]DCU School of Electronic Engineering, Glasnevin, Dublin 9, Ireland.

Corresponding Author Email Address: PRICE@tcd.ie

Bioenergy continues to make a significant and possibly expanding contribution to renewable energy production both nationally and globally. Second generation lignocellulosic bioenergy crops are high yielding, with high output/input ratios, whilst having the potential to be a successful greenhouse gas (GHG) reduction strategy, i.e. a negative emissions technology (NET); where NETs are any process that removes carbon dioxide from the atmosphere and stores it in the biosphere or geosphere). Negative emissions technologies (NETs) and their potential role in meeting emission targets is a rapidly growing and contentious area of climate change mitigation research. In an Irish context bioenergy crops are established practices and could readily be considered in possible emission pathways that use NETs. Miscanthus x giganteus (Greef et Deu.), a C4 perennial rhizomatous grass, native of SE Asia, has shown to have the greatest potential in the Irish climate, grown in the various soil types that exist throughout Ireland. Within the field of NETs, a gap exists in the application of this growing body of research to the unique limitations and opportunities of a specific nation. The aim of this study was to assess the potential capacity of Miscanthus x giganteus as a terrestrial NET option for Ireland and review the nation-specific context for its deployment. This appraisal was carried out using life cycle assessment (LCA). The scope of this 'cradle to processor gate' LCA study incorporates Miscanthus giganteus cultivation, maintenance, harvest, processing, and transport to the end user gate. The scenarios include accounting for the nitrogen (N) emissions from the N contained in the leaf litter, whilst also accounting for the nitrogenous emissions resulting from synthetic fertiliser N, leaf litter N meeting the crops total N requirement. Three impact categories are considered; climate change impact, acidification impact, and eutrophication impact. In addition, the cumulative energy demand and energy ratio of the system are also evaluated.

**Keywords:** bioenergy, Miscanthus grass, greenhouse gas, negative emissions technology

## Energy 2 (K103)



**E132 Preliminary evaluation of functional coatings for marine based renewable energy applications**

Hegde, M. 1, Kavanagh, Y. 1, Duffy, B. 2, Tobin, E.F. 1
[1]Institute of Technology Carlow, Ireland.
[2]CREST, Technical University of Dublin, Ireland.

Corresponding Author Email Address: edmond.tobin@itcarlow.ie

Cavitation erosion of tidal turbines is found to be a major problem for reliability and maintenance. The presence of hydrogen sulphide in the microbes leads to Microbially Induced Corrosion (MIC) in objects in the marine environment which can instigate biofouling to occur. Together, the synergistic effect of erosion, corrosion and fouling leads to reduced lifespan of the structural and operational components. Given the sheer scale of the marine renewable industry which is estimated to reach around €9 billion by 2030, the effects of cavitation, corrosion and biofouling can cause large losses to the industry which will further spur significant costs in the operation of such offshore technology. This is the main driver behind developing eco-friendly multi-functional sol-gel coatings for marine renewable applications. The present research is designed to investigate the cavitation-erosion characteristics along with abrasive wear of several classes of protective coatings synthesised from a wide range of non-toxic polymers, viz. polyurethane, methacrylate and epoxy. In the course of this research, the coatings will be inspected for different conditions. Preliminary characterisation using FTIR, XRD, UV-Vis will be conducted. Initial testing of coating will involve standardised tests such as cross-cut adhesion, pencil hardness, Taber abrasion and slurry erosion, to analyse the physio-mechanical properties of the coatings Subsequent characterisation and tests such as corrosion studies, failure analysis, anti-fouling trials, salt spray, humidity exposure and surface metrology will be conducted to evaluate the corrosion resistance of the coatings on the metal. Consequently, the coatings will be compared in terms of their barrier properties. The developed coatings will offer a superior protective layer for providing increased efficiencies and reduced maintenance costs. These two factors will lead to a positive environmental impact by reducing current coating production rates and increasing net energy production from renewable sources.

**Keywords:** cavitation erosion, renewable energy, marine energy, sustainable energy

## Climate Change (L115)



**The role of nitrogen in climate change and agriculture**

Vivien Pohl 1, 2, Alan Gilmer 1, 2, David O'Connor 3, Eugene McGovern 2, John Cassidy 3, Vivienne Byers 4
[1]Environmental Sustainability & Health Institute, Technology University Dublin.
[2]College of Engineering & Built Environment, Technological University Dublin.
[3]School of Chemical and Pharmaceutical Sciences, Technology University Dublin.
[4]Health Research & Innovation Centre, National College of Ireland, Dublin.

Corresponding Author Email Address: vivien.pohl@mydit.ie

Climate change poses one if the biggest challenges of the 21st century. Climate change is expected to significantly affect future weather with associated changes in animal and crop productivity. The environmental impacts of intensive agriculture represent a significant driver effecting climate change and have contributed to the global alteration of the nitrogen (N) cycle through the emission of reactive N species. Reactive N dynamics affect all aspects of climate change, including climate mitigation, adaptation and impacts. A major reactive N species which arises from agricultural practices is ammonia (NH3). NH3¬ is emitted to the atmosphere where it reacts with acid pollutants such as the products of oxides of sulphur and nitrogen, producing fine particulate matter. Furthermore, NH3 does not respect any boundaries and emissions from one region may induce effects in other regions some distance from the original source. To avoid production losses and make use of emerging technologies with the potential to improve agricultural practices, adaptations in agricultural management will inevitably be required. Models can be utilised to support decision making for both short-term incremental responses and long-term transformative strategies. This research seeks to address the relationship between arable agricultural practice and NH3 emissions. The study will involve the monitoring of air, water and soil quality parameters in an arable setting, through the implementation of a systematic NH3 monitoring network. This new field data will be combined with published data and an understanding of local NH3 dynamics to formulate a novel model of the role of NH3 in these arable settings. The developed model will be valid for low gradients of soluble gaseous pollutants and will be suitable for predicting NH3 concentrations in the atmosphere, transfer pathways, source production and climatic interactions. The model will be operationalised on a localised basis, with geo-spatial and temporal forecasting.

**Keywords:** nitrogen, climate change, ammonia, atmospheric pollution, transboundary pollution

## Climate Change (L115)



**Soil management, carbon sequestration and climate change mitigation: The solution under foot**

Brian Murphy 1, Brian Kelleher 2
[1] Enrich Environmental Ltd, Larchill, Kilcock, Co.Meath.
[2] Environmental Science and Technology, School of Chemical Sciences, DCU, Glasnevin, Dublin 11.

Corresponding Author Email Address: bmurphy@enrich.ie

Soil is a major source and sink of carbon and accounts for the biggest carbon pool in earth's terrestrial ecosystem. Increasing carbon sequestration in soil represents a potential solution to rising atmospheric carbon concentrations and decreasing carbon levels in agricultural soil. There are several practical soil management techniques that can be implemented to increase the carbon stored in Irish soils including use of stable organic amendments like compost, low/no tillage farming and use of cover crops. Often under-estimated, soil microbial populations have a significant role to play in mitigating carbon loss from soil. Studying carbon dioxide sequestration is challenging, due mainly to the multiplicity of relationships that exist not only between microbial consortia but between the organic components, nutrients and break down products. Here we discuss the practical soil management techniques that can increase soil carbon and offset climate change. We look in detail at the CO2 sequestration of soil microbes and how advanced analytical techniques allowed us to track the fate of carbon sequestered to soil by chemoautotrophs. We show that the use of common fertilisers such as sulfur stimulate both respiration and sequestration of CO2. Agricultural soil amended with elemental sulfur was incubated under an atmosphere of 13CO2 in an environmental carbon dioxide incubation chamber. Gas chromatography-mass spectroscopy (GCMS), isotope ratio mass spectroscopy (IRMS), nuclear magnetic resonance (NMR) and metagenomic techniques were combined to track 13C in soil biomass. NMR showed that sulphur addition resulted in a 20 fold increase in 13C fixed to the soil. This increase correlated with RubisCO gene production. RubisCO is found in autotrophic organisms and catalyses the first major step in the CO2 fixation by the soil microbiology, such as Thiobacillus spp. With many countries, including Ireland failing to meet CO2 reduction targets and agriculture under pressure to reduce its carbon footprint. Soil management schemes to actively increase carbon storage in soils present a climate positive solution and even the potential for farmers to sell carbon credits.

**Keywords:** climate change, carbon sequestration, soil, compost

Publication: Kelleher BP, Flanagan PV, Hart KM, Simpson AJ, Oppenheimer SF, Murphy BT, O'Reilly SS, Jordan SF, Grey A, Ibrahim A, Allen CCR. 2017, "Large perturbations in CO2 flux and subsequent chemosynthesis are induced in agricultural soil by the addition of elemental sulfur.", Scientific Reports, no. 7, pp. 4732.

## Climate Change (L115)



**An analysis of drought during the Irish summer in 2018**

Simone Falzoi 1, Emily Gleeson 2, Keith Lambkin 2, Jesko Zimmermann 3, Robert O'Hara 3, Richa Marwaha 3, Stuart Green 3, Simona Fratianni 1, 4

[1]Earth Science Department, University of Torino, via Valperga Caluso 35 - 10125, Torino, Italy.

[2]Met Éireann, Glasnevin, Dublin 9, Ireland.

[3]Department of Agrifood Business and Spatial Analysis, Teagasc Food Research Centre, Ashtown, Dublin 15, Ireland.

[4]Research Centre on Natural Risks in Mountain and Hilly Environments NatRisk, via Leonardo da Vinci 44, 10095 Grugliasco, Torino, Italy.

Corresponding Author Email Address: simone.falzoi@unito.it

A climatological analysis of the unusually dry summer that happened in Ireland in 2018 was conducted evaluating different characteristics. The drought episode was analysed considering climatological indices and remote sensing data in order to assess the impact on agriculture as determined through changes in biomass production. That was compared to the long-term mean of the both datasets, 1981-2010 for climatic data and from 2001 to 2018 for the remote sensing data. Meteorological data recorded at Met Éireann's networks of stations were used to calculate the Standardized Precipitation Index, SPI, the Percent of Normal Index, PNI and the Soil Moisture Deficit (SMD). In addition, a time series vegetation index (Enhanced Vegetation Index, EVI) was calculated based on MODerate Resolution Imaging Spectroradiometer, MODIS. The progress of extreme weather event in 2018 have been shown by applying an ordinary kriging interpolation to estimate the national coverage of the indices at monthly scale. PNI and SPI illustrated that whilst January and April were very wet, subsequent months had low rainfall. The SMD indicated dryer values during May and June, reaching a maximum soil moisture deficit on the 14th of July (94.3 mm). EVI, which measuring the greenness of vegetation, can be associated with stress related to drought. The greatest difference between EVI 2018 and the average EVI in long term period (2001-2017), occur during the summer months in the South and East of Ireland. This analysis shows that whilst drought may occur on a national scale the impacts vary locally. Local variations in biophysical conditions soil type, influence the effects of drought on vegetation. For example, heavy soils held moisture longer than other soil type, allowing plants to take advantage of the higher temperatures. However, if the drought continues it is likely that growth in these regions was also had been impacted.

**Keywords:** Drought indices, PNI, SPI, SMD, MODIS data, EVI

## Climate Change (L115)

Oral Presentations Session
Tuesday April 16th 14.00 – 15.30

**Assessing Ireland's energy CO2 emissions under the first (draft) National Energy and Climate Plan (NECP)**

Barry McMullin, Paul Price
Dublin City University, School of Electronic Engineering, Glasnevin, Dublin 9, Ireland.

Corresponding Author Email Address: barry.mcmullin@dcu.ie

Under the terms of the EU Regulation on the Governance of the Energy Union, which entered into force in December 2018, all member states are now required to prepare and submit National Energy and Climate Plans (NECPs) on an ongoing basis. The plans should cover ten-year periods and provide an overview of the current national energy system and policy situation, should set out national objectives, with corresponding policies and measures to meet those objectives, and have an analytical basis. The first plans, covering the period 2021-2030, were due for submission in draft form by 31st December 2018. Following assessment by the European Commission, and "early and effective opportunities" for public participation, the plans should be finalised by the end of 2019. In this presentation we focus on one of the key dimensions of the Energy Union addressed in the NECP process, having central environmental importance, namely energy system decarbonisation as a critical contributor to climate change mitigation. We review the provisions of the Irish (draft) NECP, and specifically assess its alignment with the goals of the Paris Agreement. We find that, under all scenarios currently presented in the NECP, Irish energy CO2 emissions would show negligible absolute reduction over the period of the plan. This would lead to early, and escalating, overshoot of the estimated Irish "fair share" of the remaining, Paris-aligned, Global CO2 Budget, thereby transferring onto young Irish people today responsibility for very large scale and very rapid, future carbon dioxide removal (CDR) from the atmosphere. Given large uncertainties in CDR technical feasibility, scale and ultimate cost, this is classified as a prima facie high risk and inequitable approach to this key policy domain.

**Keywords:** climate change mitigation, EU policy, National Energy and Climate Plan (NECP)

## Climate Change (L115)



**Observing the impacts of extreme precipitation events on wastewater systems**

Sukanya D Saikia 1, 2, 3, Eoghan Clifford 1, 2, 3, Sudeep Nair 4, Paraic Ryan 5
[1]College of Engineering and Informatics, National university of Ireland, Galway, Ireland H91 TK33.
[2]Ryan institute, National University of Ireland, Galway, Ireland H91 TK33.
[3]Informatics Research Unit for Sustainable Engineering, National University of Ireland, Galway, Ireland H91 TK33.
[4]School of Science, Engineering and Built Environment, Deakin University, Geelong, Waurn Ponds, Australia.
[5]Discipline of Civil, Structural and Environmental Engineering, School of Engineering, University College Cork, Ireland.

Corresponding Author Email Address: s.saikia1@nuigalway.ie

Climate change impacts are undeniable with the frequent occurrence of extreme events like drought and excessive rainfall. Such events affect one of the most important natural resources available to us; water. One of the current biggest challenges is access to clean water and hence wastewater treatment plants (WWTPs) play a crucial role in treating the wastewater generated in order to be reused. Climate change induced extreme events disturb the functionalities of existing wastewater infrastructures. Drought like events lead to decreased water volume with the same rate of contaminant load coming into the WWTPs, resulting in system corrosion. Intense and frequent rainfall on the other hand, results in flooding and hydraulic overloading of wastewater systems, particularly in the case of combined sewerage systems. An initial case study on the Mutton Island wastewater treatment plant in Galway City, Ireland, reveals the impacts of precipitation variables on influent wastewater volume. The city is located on the west coast of Ireland and receives an average annual rainfall of about 1200 mm (Irish Meteorological Service Report) and has an approximate population of 79,934 (CSO, 2016). The WWTP has a population equivalent of 170,000 PE (EPA, 2017). This study analysed (a) the relationship between monthly average of daily precipitation and influent volumes, (b) the impact of (i) dry spell (characterised by 5 or more consecutive days of zero or less than 1mm rainfall), (ii) isolated extreme event (defined in this study by any day with rainfall > 20 mm but at the same time preceded by at least 5 zero or < 5 mm rainfall days) on influent volumes. The overall results demonstrate the effects of precipitation variability on wastewater volumes and thus the change in its inflow to wastewater systems. This research would help inform the design and operation of climate-resilient wastewater infrastructures.

**Keywords:** climate change, extreme events, combined sewerage systems, wastewater volumes

## Climate Change (L115)



**CC21 Climate change attribution: extreme weather events and their impacts from the perspective of the stakeholder (EUPHEME)**

Jevon Keane-Brennan 1, Saji Varghese 1, Keith Lambkin 1, Pete Walton 2, Peter Stott 3
[1]Research Environment Applications (REA) Division, Met Éireann, 65-67 Glasnevin Hill, Glasnevin, Dublin 9, D09 Y921.
[2]ECI, OUCE, South Parks Road, Oxford, OX1 3QY, UK.
[3]Met Office Hadley Centre, Met Office, FitzRoy Road, Exeter, EX1 3PB, UK.

Corresponding Author Email Address: jevon.keanebrennan@met.ie

Hazardous weather events across Europe occur on an annual basis. These events are increasing in frequency, and that this positive rate of occurrence is likely as a result of anthropogenically produced climate change. Understanding the link between extreme weather events and climate change is vital, when trying to mitigate their impacts upon stakeholders in society. The EUPHEME project aims to study and decipher this connection by developing state of the art methods for the attribution of extreme climate and weather events. The project also wishes to create a platform upon which such analyses will be conducted, while also developing a climate change attribution service for stakeholders to use. This service would have a positive impact for stakeholders across Europe, with the objective that it may help reduce the economic and operational impacts of extreme weather events. An analysis of stakeholders who may be impacted by such extreme weather has been undertaken. It was discovered that there are many groups, organisations and companies who are affected by such events, with the largest stakeholder group being the general public. By distributing questionnaires to stakeholders, information about how they conduct their operations and make decisions, which are impacted by extreme weather events, was discovered. This was then fed back into other EUPHEME work packages, where it was used to start the development an event attribution service and website. This website will be exposed to stakeholders in the coming months to allow for further development. Maintaining a cycle of feedback, development and exposure, positive benefits are expected. These include an increased awareness of extreme weather, a better understanding of the rate of change of risk of certain weather events occurring, a potential reduction in any financial costs and providing better planning and services for the general public.

**Keywords:** climate change, extreme weather, event attribution, stakeholder interaction

## Sustainable Transport, Infrastructure, Land Use & Agriculture (K104)



**Closing the nutrient cycle: what are the properties required by farmers, to encourage the use of recycling-derived fertilisers in North West Europe?**

Niamh Power 1, Vesna Jaksic1, Imke Harms 2, Katharina Laub 3, Hélène Lagrange 4, Inès Verleden 5
[1]Cork Institute of Technology, Bishopstown, Cork, Ireland
[2]Nutrient Management Institute, Nieuwe Kanaal 7c, 6709 PA Wageningen, Netherlands
[3]IZES, Altenkesseler Str., Building A1 17, 66115 Saarbruecken, Germany
[4]Arvalis Institut du Végétal, 6, chemin de la côte vieille, 31450 BAZIEGE, FRANCE
[5]Inagro, Ieperseweg 87, 8800 Rumbeke, Belgium

Corresponding Author Email Address: niamh.power@cit.ie

Recycling rates for nutrients need to be increased, to reach a circular economy in Northwest Europe and to increase sustainability of farming and food production. The ReNu2Farm project aims to increase recycling rates of the plant nutrients Nitrogen (N), Phosphorus (P) and Potassium (K). P and K are limited and finite resources, and production of N fertilizers is energy intensive. Recycling-derived fertilisers (RDF) have essential plant nutrients and are available from various sources, including products from different origins such as animal manure, urban waste including household food waste, catering waste or green cuttings from recreational areas as well as human waste such as sewage sludge. However, despite recovery technologies having been developed, the use of RDF products by farmers is limited throughout North West Europe. ReNu2Farm uses a bottom-up approach to put the farming community at the centre of this research. Through stakeholder engagement and close collaboration with farmers the desired fertiliser properties will be identified and characterised. In addition, potential barriers as well as farmers' attitude to the use of RDF will be characterised. As part of this research, a survey of farmers is being undertaken across seven countries: Belgium, France, Germany, Ireland, Luxembourg, The Netherlands and the UK. The preliminary results suggest that one of the potential barriers to the use of RDF is biosecurity, especially the concern over the spread of disease and weeds. The preliminary results of the survey have also indicated that there is a lack of awareness on the types of RDF that are available. However, on a positive aspect from the survey over 77% of respondents indicate they are willing to use RDF fertiliser(s) in the future. Once the farmer's requirements have been identified, then producers of RDF will be in a better position to encourage their use and close the nutrient cycle.

**Keywords:** circular economy, nutrient recycling, recycling-derived fertilisers

## Sustainable Transport, Infrastructure, Land Use & Agriculture (K104)



**Characterisation of residual soil P indices using recovered P fertiliser as a comparison to TSP**

Ciaran O'Donnell 1, Niamh Power 1, Denise Barnett 1, Joe Harrington 2
[1]Department of Civil, Structural and Environmental Engineering and Sustainable Infrastructure Research & Innovation Group, Cork Institute of Technology.
[2]School of Building & Civil Engineering and Sustainable Infrastructure Research & Innovation Group, Cork Institute of Technology.

Corresponding Author Email Address: c.odonnell@mycit.ie

The EU INTERREG Phos4You project is investigating the recovery of phosphorus (P) from municipal wastewater streams with the return of P to agricultural land. The EU recognises that phosphorus is a finite element that is vital to sustain all life. Mineral P is derived from P rich rock and is used as an artificial fertilizer. P fertilizer is vital to sustain modern farming practice. This research aims to review Ireland's dependency on imported phosphorus fertilizers and establish a method to replace it with indigenous, recovered raw P from Irish wastewater treatment plants (WWTPs) thereby closing the P cycle and also potentially reducing the eutrophication effects of wastewater effluents on ground and receiving waters. The research presented involves field growth trials on grassland. Two types of fertilizers are compared: a recovered Struvite compound fertilizer and a commercially available triple super phosphate compound fertiliser. Its effects on grass dry matter production and its impact on residual soil indices are established. The trial follows the three-crop silage system, with three individual grass crops cut and measured throughout the growing season. Each trial plot was soil sampled before and after the test to establish the residual soil P content determining if the low water solubility of Struvite prevents losses to groundwater while still producing a sustainable grass crop. The findings of this research indicate that the recovered phosphorus fertiliser produced a similar level of grass dry matter yield, while increasing the average soil P level by 1.4mg/l over the comparison. This would suggest that the low solubility of recovered P fertilisers prevents the premature dissolution and loss to the water table

**Keywords:** phosphorus, phosphorus recovery, field trials, wastewater treatment plant (WWTP)

## Sustainable Transport, Infrastructure, Land Use & Agriculture (K104)



**Suitability of selected natural fibres for improving concrete performance**

Ana Caroline da Costa Santos, Paul Archbold
Faculty of Engineering & Informatics, Athlone Institute of Technology, Dublin Road, Athlone, Co. Westmeath, Ireland.

Corresponding Author Email Address: a.cdcosta@research.ait.ie

The addition of fibres in concrete is a common method of reinforcement to increase the residual post-cracking tensile strength of members submitted to heavy impact, high abrasion, etc. Their addition also improves the ductile behaviour of concrete and limits the macrocracks onset. Synthetic and steel fibres are the materials most used by the construction sector to this purpose; nevertheless, their production is from non-renewable sources and require a significant amount of energy. As alternative, researchers worldwide have been studying more environmentally friendly options, such as natural fibres. Natural fibres can be extracted from vegetable, mineral or animal sources and are abundant in nature. While some industries already use natural fibres in composites, the construction industry still is studying more efficient options for their application. Natural fibre-reinforced concrete (NFRC) is a cementitious composite being considered as an alternative to reduce or even replace the use of regular fibres in concrete members, decreasing consequently the impact of construction on the environment. One of the biggest problems around natural fibres is their non-uniform composition and the difficulty in characterising their properties. This paper presents the spectrums of Fourier Transform Infrared Spectroscopy (FTIR) measured in laboratory, as a possible test to estimate the chemical composition of abaca, banana, basalt, flax, hemp, jute and sea-grass fibres. It also presents numbers obtained experimentally for compressive stress test conducted on concrete mixtures with addition of basalt, flax and polypropylene fibres in 0.5% of the mass, comparing them with a control mix and with results already published. As result, basalt fibres with 45mm length interfere in 18% when compared to the control mix and the stress, in average, was 5% higher than the same amount of polypropylene fibres. On the other hand, flax fibres reduced the results in 75% in relation to 0% and in 103% to polypropylene.

**Keywords:** natural fibres, cementitious bio-composites, natural fibre-reinforced concrete, compressive strength, sustainability

## Sustainable Transport, Infrastructure, Land Use & Agriculture (K104)



### Fin embedded composite phase change material (PCM) thermal management system for li-ion battery packs

FS Hwang, T Confrey 1, S Scully1, B Flannery 2, D Callaghan 1, C Nolan 1
[1]Institute of Technology Carlow, Kilkenny Rd, Moanacurragh, Carlow, Ireland.
[2]Xerotech Limited, Oranmore, Galway, Ireland.

Corresponding Author Email Address: Foo.Hwang@itcarlow.ie

In concert with the growth in the electric vehicle (EV) market is a demand for range enhancement. EV range is primarily inhibited by 2 main factors, the capacity of the on-board batteries and their efficiency. Lithium-ion batteries (LIB) are a current major player for EV power sources and the primary driver for their efficacy lies in management of the operational temperature. Typically, LIBs operate optimally between 15-35oC and outside this range energy capacity degrades. Thus, effective thermal management solutions are required to maintain peak LIB performance and prolong EV lifespan. This paper focuses on the design and development of a thermal management system composed of an extended metallic fin structure embedded in a phase change material (PCM) matrix. A housing unit maintains the lithium-ion (18650 Panasonic) batteries in place completing a module unit. Computational fluid dynamics (CFD) simulations were carried out to investigate the thermal performance of the system with the battery being discharged at varying discharge rates ranging from 0.5 to 3.0oC. A variety of PCM materials including paraffin and fatty acids were modelled to determine the suitability of each material for cooling applications. For the purpose of future studies and scalability, the battery pack is arranged in a reduced scale module. Simulations were then carried out for varying ambient temperature cycles ranging from -20 to 50oC. Cooling rates of the system were experimentally validated permitting optimization of the embedded fin structure through parametrisation of the fin thickness, spacing length and overall heat transfer surface area. From the results obtained, it was indicative that the thermal management system was able to maintain optimal battery temperatures across the varying conditions introduced.

**Keywords:** thermal management, cooling, battery packs, electric vehicles

## Sustainable Transport, Infrastructure, Land Use & Agriculture (K104)



**S85 Recycling-derived fertilisers as alternative to triple super phosphate in Irish grassland**

Lea Johanna Deinert 1, Israel Ikoyi 1, Patrick Forrestal 2, Achim Schmalenberger 1
[1]University of Limerick, Department of Biological Sciences, Co. Limerick.
[2]Teagasc Agriculture and Food Development Authority, Johnstown Castle, Co. Wexford.

Corresponding Author Email Address: Lea.Deinert@ul.ie

Various nutrient recycling technologies in waste streams management are currently under development in many European countries in order to alleviate the dependency of the EU on imports of non-renewable raw material for the production of mineral phosphorus (P) fertilisers commonly used in agriculture. The resulting products such as struvites and sewage sludge ashes need to be assessed for their application as so-called recycling-derived fertilisers (RDF) in the agricultural sector prior to commercialisation. To investigate the impact of different phosphorus fertilisers on plant growth and the soil microbiome, a pot trial was conducted over the period of 54 days. Lolium perenne (var. AberGreen) was grown with application of triple super phosphate (TSP) as conventional P-fertiliser, two sewage sludge ashes and two struvites in rates of 20 and 60 kg P/ha in four replicates. A P-free control was also included in the trial. All treatments received a full complement of nutrients including nitrogen and potassium. Results from the present trial revealed a trend of reduced microbial utilisation of organically bound phosphorus (phytate) at the high P application rates for all fertiliser types. Acid phosphatase activity increased significantly in the high P applications for the TSP and struvite fertilised pots when compared to the control. Increased dry matter yield was obtained with higher P fertilisation for TSP, both ashes and one of the struvites. The other struvite showed higher yields at the 20 kg P/ha rate instead. Analysis of the bacterial community structures in the rhizosphere soils of L. perenne across all treatments revealed limited variability. Overall, these initial results suggest that the tested RDF amendments delivered results comparable to conventional TSP treatments and would therefore be a suitable alternative to traditional mineral P fertilisers such as TSP. Further analyses are underway to quantify labile P, abundance and diversity of P mobilizing bacteria.

**Keywords:** ash, incinerated sewage sludge, nutrient recycling, P mobilisation, recycling-derived fertilisers, rhizosphere soil, struvite

## Sustainable Transport, Infrastructure, Land Use & Agriculture (K104)

Oral Presentations Session
Tuesday April 16th 14.00 – 15.30

**S99 Analysis of local pollutant dispersion through full scale three-dimensional modelling of wind flows in Dublin City Centre**

N Kut, T Confrey, J Cleary, D Callaghan, C Nolan
Institute of Technology Carlow, Kilkenny Rd, Moanacurragh, Carlow, Ireland.

Corresponding Author Email Address: Thomas.Confrey@itcarlow.ie

Urbanisation and the continued migration of people to densely populated areas present significant sustainability challenges to modern society. Human population in cities is predicted to increase significantly throughout the course of the 21st century. These modern habitats create microclimates, which are distinct from that of the extended surrounding rural and meteorological climates. Consequently, negative environmental effects such as increases in local pollution concentrations and ambient temperatures occur. These aspects have a direct impact on the morbidity and mortality rates of citizens and consequently planning bodies and policy makers require advanced tools and guidelines for optimal urban design. The current project takes Dublin City Centre as a case study and investigates the effects of wind flows on pollution concentration and pedestrian comfort. The study focuses specifically on the college green area where vehicular pollution will be analysed. The methods employed in the studies are simulation based using computational fluid dynamics (CFD) to model wind flows of real urban areas at a meteorological microscale level capturing analyses at the scale of groups of buildings. Quantitative validation will reference existing models, which can calculate averaged pollution concentrations for given inputs where populated field measurement data is also available in the literature.

**Keywords**: urban air flows, pollutant dispersion, CFD simulation

## Water Quality & Resources 3 (L114)



**New and traditional methods to determine the impacts of river fragmentation on salmonids**

Siobhán Atkinson 1, 5, Michael Bruen 2, Jonathan Turner 3, Craig Bullock 4, John O' Sullivan 2, Colm Casserly 3, Jeanette Carlsson 5, Bernard Ball 5, Mary Kelly-Quinn 1, Jens Carlsson 5

[1]School of Biology and Environmental Science, University College Dublin, Belfield, Dublin 4.

[2]UCD Dooge Centre for Water Resources Research, School of Civil Engineering, University College Dublin, Belfield, Dublin 4.

[3]School of Geography and Earth Institute, University College Dublin, Belfield, Dublin 4.

[4]School of Architecture, Planning and Environmental Policy, University College Dublin, Belfield, Dublin 4.

[5]Area52 Research Group, School of Biology and Environmental Science/Earth Institute, University College Dublin, Belfield, Dublin 4.

Corresponding Author Email Address: siobhan.atkinson@ucdconnect.ie

River obstacles fragment and alter the hydromorphology of a river, with significant implications for aquatic fauna. Management of river obstacles from a fisheries perspective requires an understanding of their impacts on fish movement, population structure and density. The aim of this study was to assess the impacts of weirs and bridge aprons (<3m in height) on salmonids using both new environmental DNA (e)DNA approaches and traditional electrofishing surveys. An environmental DNA assay for detecting Atlantic salmon was used to infer the migratory impacts of obstacles. Species-specific primers and a minor groove binding (MGB) probe were designed for the assay, based on the mitochondrial cytochrome oxidase I (COI) gene. Electrofishing surveys were used to establish the density and age structure of salmonid populations in impounded and natural river reaches. The electrofishing study provided an insight into the local impacts of the impoundments, revealing an overall decrease in Atlantic salmon and brown trout fry density in this habitat. Environmental DNA analysis was an effective method for deriving the presence Atlantic salmon above and below river obstacles, and in some instances was more sensitive than traditional methods. This research shows the value of using both traditional and eDNA methods for detecting the local and longitudinal impacts of weirs on salmonids. In addition, it demonstrates the potential for eDNA as an alternative, non-invasive tool for determining the distribution of species.

**Keywords**: river barrier, eDNA, impoundment, salmonids

## Water Quality & Resources 3 (L114)



**Microfluidic analysis of chemical oxygen demand**

Jaime Edwards 1, David Allen 2, Patrick Roche 3, Mark Bowkett 3, John Cleary 1
[1]enviroCORE, Institute of Technology Carlow, Kilkenny Road, Carlow, Ireland.
[2]engCORE, Institute of Technology Carlow, Kilkenny Road, Carlow, Ireland.
[3]T.E Laboratories, Loughmartin Business Park, Tullow, Co. Carlow.

Corresponding Author Email Address: jaime.edwards@itcarlow.ie

Chemical oxygen demand (COD) is an important measurement of organic pollutants within wastewater and natural water systems. However, the standard potassium dichromate-based (K2Cr2O7) method for measuring COD is time consuming, labour intensive, and expensive. Autonomous monitoring systems based on microfluidics and low-cost optical sensing systems represent a viable solution to this analytical problem. By combining photocatalytic reactions with microfluidic systems, a rapid, low-power, low-cost alternative to traditional monitoring techniques can be achieved. The method utilises the UV-photocatalytic oxidation of organic compounds, replacing the heating process employed in the standard method. Potassium permanganate (KMnO4) is used as the oxidant, eliminating the highly toxic wastes produced during the dichromate method. For an initial assessment of the method, sample plus acidified permanganate (8x10-4 mol L-1) was combined with a carrier stream (0.3 mol L-1 H2SO4 containing 0.1 mol L-1 (NH4)2SO4) and injected into the analytical well. The mixture was then exposed to ultraviolet light (254nm) for 1 hour using a 4 W lamp, before analysing in a UV-vis spectrophotometer (HACH DR6000). The measured absorbance was inversely proportional to COD within the range 10 – 175 mg L-1 (potassium hydrogen phthalate standard), with a mean r2 of 0.9522 (n = 8). Total volume per measurement (sample plus reagents) was 300µL. The spectrophotometric HACH method (ISO 15705), with a linear range of 0 – 150 mg L-1, was employed as the reference method (r2 of 0.9982 (n = 20)). The method has been transferred to a microfluidic system with LED and photo-diode based detection, and its performance is currently being assessed and optimised at the micro scale.

**Keywords:** water quality monitoring, microfluidics, chemical oxygen demand

**Fat-anaerobic digestion to energy: unlocking the forgotten resource**

Conall Holohan 1, 2, Sandra O'Connor 2, Vincent O'Flaherty 1
[1]Microbial Ecology Laboratory, Ryan Institute, National University of Ireland Galway, Ireland.
[2]NVP Energy Ltd., IDA Technology & Business Park, Mervue, Galway, Ireland.

Correspondence Author Email Address: b.conall.holohan@gmail.com

Fat is a ubiquitous residue from the food and beverage industry which is present in high concentrations in wastewater. Taking into account the massive volumes of wastewater Ireland's food industries alone produce (e.g. dairy fats ~375 million litres p.a.), this is a major waste of a bio-energy resource with a biogas potential when treated by anaerobic digestion (AD). However, fat is extremely difficult compound to degrade and treat, causing inhibition of conventional biological wastewater treatment technologies and methods. This has yet to be resolved and none of the current technologies on the market provide a reliable or sustainable treatment method for fat-rich wastewater that befits mainstream rapid uptake by the industry. Here we present a system that provides a potential solution, through microbial biotechnological innovation - coupling engineering and microbiology. One novel Fat-Anaerobic Digestion-to Energy (FADE) bioreactor (5 l) was ran. This anaerobic reactor is a microbiological fermentation bioreactor system that was fed fat-rich wastewater from a dairy (Arrabawn Co-op). The process harnesses microbial action to breakdown the long carbon chains and rebuild them into the versatile and renewable fuel - methane (biogas). Through a foundation of solid diverse microbial consortia the inhibitory bottlenecks previously associated with the biological treatment of fat in wastewater are removed and thus a novel and sustainable solution to a valorisation of fat-rich wastewaters is provided. The FADE reactor received dairy wastewater with an average chemical oxygen demand (COD) of 5,315 ± 1137 mg/l over the course of 110 days. The system ramped gradually up to a 24 hour Hydraulic Retention Time (HRT) dealing with varying concentrations of wastewater at an average organic loading rate of 5.2 (± 1.2) kgCOD/m3/d at this HRT. The total COD removal rate at averaged at 87.3 ± 9.1 % stably as did the methane recovered averaging at 73.3 ± 8.9 % in the biogas. The stability and success of the system at this HRT is extremely successful when compared with literature and current technologies. As such provides the possibility of it being a clear step forward for the field to potentially renewably valorise fat-rich wastewaters.

**Keywords:** anaerobic digestion, fat, fat-rich wastewater, biogas, resource recovery

## Water Quality & Resources 2 (L114)



**Developing historic and predictive groundwater flood maps for Ireland**

Owen Naughton 1, 2, Ted McCormack 2, Rebecca Bradford 2, 3, Joan Campanyà 2
[1]Department of Built Environment, Institute of Technology Carlow, Ireland.
[2]Geological Survey Ireland, Beggars Bush, Haddington Road, Dublin, Ireland.
[3]Tobin Consulting Engineers, Block 10-4, Blanchardstown Corporate Park, Dublin 15.

Corresponding Author Email Address: owen.naughton@itcarlow.ie

Identifying and mapping areas vulnerable to flooding is a key step in the management of flood risks. However, groundwater flooding on the lowland karst limestone plains of Ireland poses significant technical challenges in this respect. These areas are susceptible to groundwater flooding due to the combination of low soil and aquifer storage, high diffusivity and limited surface drainage. Unprecedented flooding in winter 2015/2016 reinforced the need for a greater understanding of groundwater flooding as a geohazard, and improve our ability to quantify the location and likelihood of flood occurrence. This paper describes the novel approach developed for the production of historic and predictive groundwater flood maps for Ireland in line with the 2nd implementation cycle of the EU Floods Directive. A monitoring network of over 50 sites was established during the winter of 2016/2017 to improve our understanding of groundwater flood regimes and provide baseline model calibration data. A methodology for delineating flood extents and water elevations from multi-temporal Synthetic Aperture Radar (SAR) imagery was developed to provide flood data from the 2015/2016 extreme flood event at gauged and ungauged sites. Maximum flood extents derived from SAR imagery from this event were combined with limited field observations to produce historic groundwater flood maps. Hydrological models capable of reproducing groundwater flooding time series from antecedent rainfall and soil moisture conditions were developed. Models for viable groundwater flooding locations were calibrated on a combination of observed and SAR hydrographs. Using long-term observational and stochastic meteorological series as input, the models have been used to construct long-term hydrological series suitable for extreme value analysis and the generation of predictive groundwater flood extents and maps.

**Keywords:** flooding, groundwater, karst, geohazard, mapping

## Water Quality & Resources 3 (L114)



**WR84 Raman probe on chip**

Madhumidha Murugan 1, 2, Marie Lamard 1, 3, Patricia Loren 1, Ganga Rao Chinna Devarapu 1, 2, Liam O'Faolain 1, 2

[1]The Centre for Advanced Photonics & Process Analysis (CAPPA), Cork Institute of Technology, Rossa Avenue, Cork, Ireland.

[2]Tyndall National Institute, Lee Maltings Complex Dyke Parade, Cork, Ireland.

[3]École Nationale Supérieure de Chimie et de Physique de Bordeaux, France.

Corresponding Author Email Address: madhumidha.murugan@mycit.ie

Raman spectroscopy has proved to be an excellent analytical technique in detecting pollutants in water with high accuracy. It provides the ability to detect fingerprint of contaminants in water at levels below the Environmental Protection Agency specified limits of detection. Currently, existing Raman spectrometry equipment are costly, bulky, confined to the lab, and thus not suitable for field deployment. To overcome this limitation, we realized a 3D printed Lab-On-Chip (LOC) consisting of 2 groves which hold excitation and collection fibers orthogonal to each other. The chip was fabricated using clear resin with Formlab's 3D printer with pre-defined fiber insertion waveguide channels. Two multimode optical fibers with core sizes of 400 µm (Polymicro Technologies) were embedded into the chip for the excitation and collection of Raman signals. Four samples of nitrate solutions varying from 10g/L to 0.2g/L were tested using the LOC. Raman excitation was performed with 350 mW of laser at 785nm wavelength coupled to a multimode excitation fiber. The other end of the collection fiber coupled into a spectrometer (WP785, Wasatch Technology). Raman spectra of the sample were recorded with a 2s acquisition time with a resolution of 4cm-1 and at the maximum power (350mW) of the laser. All the major peaks of nitrates are clearly distinguishable in the acquired Raman spectra. With our setup, we successfully achieved limit of detection, limit of quantification and accuracy as 200ppm, 500ppm and 100 ppm respectively. We are developing a more robust version of the LOC device by 3D printing of aluminium.

**Keywords:** lab-on-chip, Raman spectroscopy, water quality, nitrates detection

## The Human Built Environment and Nature Based Solutions for resilient communities (L115)



**A wetland efficiency index was developed using constructed wetland sampled data. Combining Principal Component Analysis and Fuzzy indices to realise the wetlands efficiency**

John L. Byrne, David N. Dowling, Dina Brazil
Institute of Technology Carlow, Kilkenny Road, Carlow.

Corresponding Author Email Address: john.byrne@itcarlow.ie

Traditional hydraulic wetland efficiency (λ) is based on pond shape, location of inlets/outlets and hydraulic loadings as an established method of determining a wetland's efficiency. With a (λ) less than 0.5 (50%) considered poor efficiency, between 0.5 and 0.7 of satisfactory efficiency and (λ) greater than 0.7 (70%) considered good efficiency. An alternative efficiency metric using the sampled data from a monthly sampling of specific sites over a year, within the constructed wetland was developed. The data was sampled at six different sample locations within a twelve pond constructed wetland treating abattoir waste. The sampling locations were the dissolved air floatation system (DAF), pond 1, pond 6, pond 9, pond 12 and the local stream. The wetland sampled data-set contained twenty two variables from physical-chemical data, inorganic ions, bacterial loadings and included wetland water depth, area and volume. Using Principal Component Analysis (PCA) encompassing Kaiser-Meyer-Olkin (KMO) and Bartlett's test of sphericity. To find the principal variables within the data-set. Three iterations of PCA was run to reduce the wetlands from twenty two variables, to twelve and finally to seven key variables. The seven variables were BOD5 (mg/L), redox potential (mV), conductivity (µS/cm), turbidity (NTU), total bacterial loadings (CFU/100ml), water depth (m) and dissolved oxygen (mg/L). With a final KMO value = 0.85 indicating the seven variables are adequate for PCA and Bartlett's test of sphericity ($p < 0.05$) indicating the variables are unrelated, adding further validation to proceeding with PCA. The seven wetland variables were incorporated into Fuzzy Indices software to develop a wetland efficiency index for each site sampled within the wetland. The following mean efficiencies, including standard deviation, for each of the sampled sites over the year was realised: DAF = 7.79 ± 2.41, pond 1 = 27.27 ± 16.28, pond 6 = 67.32 ± 7.6, pond 9 = 71.66 ± 5.69, pond 12 = 58.55 ± 39.46 and the local stream = 77.64 ±13.18.

**Keywords:** constructed wetland, efficiency, principal component analysis, Fuzzy indices

## The Human Built Environment and Nature Based Solutions for resilient communities (L115)



### BioPack Project: The use of concurrent design in the generation of bioplastics with high environmental impact

Colin Eyer, Brian Casey 1, Martina Moyne 1, 2, 3, Adriana Cunha Neves 1
[1]Institute of Technology Carlow, Kilkenny Road, Carlow.
[2]University College Dublin, Belfield Downs, Dublin.
[3]Harvard School of Engineering and Applied Science, Cambridge, Massachusetts, USA.

Corresponding Author Email Address: brian.casey@itcarlow.ie

The need of companies to fulfil the legislative requirements by Europeans Union's plastic strategy with strict targets for the ban of single use plastics by 2030 is leading to a rapid development of alternative environmentally friendly plastics. Though the opportunity for bioplastics are great their adoption has been hampered by complex and interdependent challenges typical of many "wicked problems" (Buchanan, 1992). The BioPack project seeks to engage with this problem through concurrent uses design research informing the material development. Design processes can help identify and translate user needs into tangible products and systems (Krippendorf, 2016). Techniques such as innovation tournaments and stakeholder mapping were employed to identify key stakeholders, perceived stakeholder needs and critical assumptions. These factors were then challenged or validated through a series of semi structured interviews and contextual enquires across the full spectrum of stakeholders dealing with packaging and packaged goods including individual consumers, retailers, composters, environmental groups and political parties. These results were then coded using NVivo and analysed using visual mapping techniques to identify recurring themes and relationships with the ultimate purpose of identifying true user need. These identified needs were then communicated to the partner scientists with ideal characteristics and red line issues expected for a tailor-made high impact bioplastic. Through the application of a concurrent design process where potential end users (both processors and consumers) are at the centre, it was possible to start developing a novel set of compostable plastics that address the true needs of the widest range of stakeholders.

**Keywords:** concurrent design, bioplastics, industrial design, environmental packaging

## The Human Built Environment and Nature Based Solutions for resilient communities (L115)



**NB61 A strategic look at natural water retention measures in Ireland**

Mary Bourke 1, Simon Harrison 2, Paul Quinn 3, Mark Wilkinson 4
[1]Department of Geography, Trinity College Dublin.
[2]University College Cork, Cork, Ireland.
[3]Newcastle University, Newcastle, UK.
[4]James Hutton Institute, Dundee, Scotland, UK.

Corresponding Author Email Address: bourkem4@tcd.ie

We introduce a newly funded large-scale Environmental Protection Agency (Ireland) project (2019-2023): SLOWATERS: a Strategic LOok at natural WAter reTention mEasuReS. The research aims to assess the benefits of Natural Water Retention Measures (NWRM) for agricultural catchments in Ireland. We will use GIS-based mapping techniques, topographic indices, hydrological modelling, and full-scale field demonstrations to develop a portfolio of potential approaches and methodologies to reduce flood risk and generate co-benefits including sediment and nutrient attenuation and ecosystem enhancement. Demonstration sites will show how to design, build and instrument NWRM. Scaling up methodologies will use hydro-geomorphic patterns to investigate NWRM in other Irish catchments, at a range of spatial scales. The research will underpin policy by identifying across scale the measures that are most effective at targeting flood flows, providing beneficial ecosystem functions whilst having minimum effect of farm economics. The project outputs will specifically provide recommendations for the management of specific catchment types relevant to the Irish environment by quantifying the magnitude of NWRM required to reduce flood peaks.

**Keywords**: flood, NBS, NWRM, agriculture

## The Human Built Environment and Nature Based Solutions for resilient communities (L115)



**NB74 Effects of different gelatin sources on characteristics of starch and gelatin blend bioplastic**

Marta Mroczkowska, Kieran Germaine, David Culliton, Adriana Cunha Neves
Institute of Technology Carlow, Kilkenny Road, Carlow.

Corresponding Author Email Address: marta.mroczkowska@itcarlow.ie

Plastic pollution is a major global concern. Contaminated marine environments and food chains populated by toxic microplastic have increased international interest in synthetic polymer-alternatives. Biomass-based bioplastics offer real, ecologically-benign alternatives as they are biodegradable and based on renewable materials such as starch, cellulose and gelatine. The fish processing industry generates large quantities of waste, up to 75% of total catch weight. This waste can be rich in collagen and can be used to produce gelatin to serve as a base for biodegradable bioplastic, while reducing the costs associated with fish waste disposal. A formulation of bioplastic based on fish waste sourced gelatin has been developed and compared to other gelatin sources. Colorimetric analysis, water solubility, transparency, opacity and bioplastic thickness were preliminary tests used to study the effects of different sources of gelatin and to characterise the fish gelatin based bioplastic. The colour of bioplastic has been improved from pale yellow to pale white by incorporation of fish gelatin without compromising on the transparency. The difference in colour has been measured using a Konica Minolta instrument and significant differences were observed especially in the intensity of yellow colour. The colour is an important aspect of bioplastic with potential to be used as clear packaging, as this is desirable in many industries and food applications. Future research will focus on biodegradation tests in soil and sea sediment along with environmental risk assessment with nematodes as bio-indicators.

**Keywords:** bioplastic, fish gelatin, biodegradable

## The Human Built Environment and Nature Based Solutions for resilient communities (L115)



**NB127 Development of natural bioplastics with applicability in the packaging industry**

Hui Ming Tew 1, Martina Moyne 1, 2, 3, Brain Casey 1, David Culliton 1, Kieran Germaine 1, Adriana Cunha Neves 1
[1]Institute of Technology Carlow, Kilkenny Road, Carlow.
[2]University College Dublin, Belfield Downs, Dublin.
[3]Harvard School of Engineering and Applied Science, Cambridge, Massachusetts, USA.

With the increase of consumer awareness of sustainability and pollution problems associated with high volumes of plastic in the food industry, alternative plastics with higher biodegradability properties are starting to be developed (Peelman et al., 2013). Moreover, high volume of production and short lifecycle use of plastics, in particular with packaging has led to the European Union's Plastic Strategy aiming to ban all single used plastics by 2030 (Peelman et al., 2013). Although natural polymers based on starches, cellulose and proteins have been developed in Ireland in the last number of years, to date, there is no significant change in the packaging industry from the single use plastic to these compostable natural polymers. Currently, with low production volumes and lack of competition within the sector, the production costs of these bioplastics remains high. This coupled with high costs of input materials has made the transition to bioplastics unpalatable to many producers (Lagaron et al., 2011). Moreover, more work needs to be done to match the physico-chemical characteristics of these natural polymers to the currently used plastics. The aim if this project is to assess properties linked with the physico-chemical characteristics and environmental impact of natural based polymers that can be used in the packaging industry. Different formulations of bioplastics were developed and physico-chemical characteristics as well as environmental impact studied. Of all formulations tested, one was chosen as the most appropriate to be used in the packaging industry. This choice was based on studies done in collaboration with product/industrial designers.

**Keywords:** bioplastics, natural polymers, environmentally friendly packaging, compostable packaging

## Smart Technology and Nanotechnology for the Environment (K103)



**Development of a lab-on-chip electrochemical immunosensor for detection of polycyclic aromatic hydrocarbons (PAH) in environmental water**

Shifa Felemban 1, 2, Patricia Vazquez 2, Eric Moore 1, 2
[1]Sensing and Separation Group and Life Science Interface Group, Tyndall National Institute.
[2]School of Chemistry ,University College Cork, Cork, Ireland.

Corresponding Author Email Address: shifa.felemban@tyndall.ie

Polycyclic aromatic hydrocarbons (PAHs) are environmental pollutants found in water, soil, and air, and human exposure to these compounds is a concerning health hazard. Current methods used to determine PAHs in water require complex analysis, are time-consuming and not portable. To overcome these difficulties, this work presents the integration of electrochemical techniques in combination with a tailored immunoassay method that aims to detect benzo[a]pyrene (BaP) in water. Nanoparticles were used as a substrate for the antibodies that are the main biomolecules of our immunoassay. Covalent immobilization was carried out, where the antibody linking occurs through chemical processes with one of its functional group to group generated in the surface of the nanoparticles. To target BaP, a connection between BaP-specific antibodies and the ferromagnetic beads is required. We have prepared magnetic particles by covering them with an O-(2-Aminoethyl) PEG, and then covalently connect them to the antibodies by using protein immobilization techniques. This covalent immobilization method provides a strong bond between the antibodies to the nanoparticle, offering then a very reliable protocol for BaP detection. The limits of detection obtained (0.1ng/ml) are comparable to those of available using state-of-the-art tools and close to the values requested by European Drinking Water Directive (0.01ng/ml). It also presents a linear range of (13.7 to 123 ng/ml) that is practical in the detection of PAHs in water. The use of a magnetic platform offers the opportunity to integrate it into a portable solution that could be used for in situ monitoring of PAH in water. Having an in situ monitoring device is important for real-time and early detection of potential presence of PAHs in water. This is a potential solution for domestic testing that would allow consumers to determine the quality of their drinkable water.

**Keywords:** polycyclic aromatic hydrocarbons (PAHs), nanomaterials, electrochemical immunosensor, environmental monitoring, Benzo[a]pyrene

## Smart Technology and Nanotechnology for the Environment (K103)



**An event-triggered fault detection for non-residential water distribution system: a case-study**

Hafiz M. Hashim 1, Paraic Ryan 2, Sudeep Nair 3, Eoghan Clifford 3
[1]College of Engineering and Informatics, National University of Ireland, Galway, Ireland H91 TK33.
[2]Ryan institute, National University of Ireland, Galway, Ireland H91 TK33.
[3]Informatics Research Unit for Sustainable Engineering, National University of Ireland, Galway, Ireland H91 TK33.
[3]Civil and Environmental Engineering, University College Cork (UCC), Cork, Ireland.

Corresponding Author Email Address: h.hashim1@nuigalway.ie

With the advent of complex non-residential facilities as a result of urbanisation, it has become increasingly challenging to effectively detect and isolate faults in water distribution systems (WDS). The potential for reducing water consumption by effectively detecting faults in large buildings has been shown to be significant, however the application of fault detection and isolation to building water networks remains largely unexplored. This paper, utilizing case-study data, presents the application of Principal Component Analysis (PCA) to carry out event-triggered fault detection for non-residential building WDSs. In the absence of a process model, PCA has been successfully used as a data driven fault detection technique. Hoteling T2 – statistics and Q – statistics were employed to detect abnormality within incoming data. Despite the relatively limited training data available from the case study (which would reflect many buildings), the fault detection (FD) model performed well in detecting meaningful faults. Such a strategy could provide a robust method that can be applied to buildings to reduce inefficient water use and helps in saving water.

**Keywords:** water distribution system (WDS), principal component analysis (PCA), fault detection and isolation (FDI)

## Smart Technology and Nanotechnology for the Environment (K103)



**Introducing GRAppLE: groundwater risk application for local evaluation**

Jean O'Dwyer 1, 2, 3, Paul Hynds 3, 4
[1]School of Biological, Earth and Environmental Sciences, University College Cork, Cork, Ireland
[2]Environmental Research Institute, University College Cork, Cork, Ireland.
[3]Irish Centre for Research in Applied Geosciences, Dublin 4, Ireland.
[4]Environmental Sustainability and Health Institute, Technological University Dublin, Dublin 7, Ireland.

Corresponding Author Email Address: Jean.ODwyer@ucc.ie

Up to 500 million Europeans currently use a groundwater source for daily household consumption, of which 10-20% are private (unregulated) wells. Private groundwater sources in the Republic of Ireland (RoI) currently provide drinking water to an estimated 750,000 people, with recent studies reporting that groundwater users have an increased risk of enteric infection from waterborne pathogens. Due to the socioeconomic, cultural, linguistic and demographic diversity characteristic of Europe, successful "Top Down" approaches to groundwater protection have remained elusive. Similarly, the dispersed, decentralised and ubiquitous nature of private groundwater sources add to the inherent complexity of legislative processes. Accordingly, "Bottom Up" approaches, whereby individual custodianship is facilitated via 'pocket technologies' may aide in safeguarding public health at the household level. GRAppLE employs existing Irish data and predictive models pertaining to microbial groundwater contamination coupled with mobile device technology to provide a 'pocket' Groundwater Risk Application for Local Evaluation for non-expert risk assessment and management. Upon opening the application, in-built GPS implementation automatically employs coordinates to retrieve locally-specific model inputs (e.g. groundwater vulnerability, subsoil type, bedrock geology, antecedent precipitation) and populate the risk model via "live call" fetch and entry functionality (device-server-device connection). Source-specific model criteria (user-derived inputs) are collated via well user/owner engagement directly with their mobile device. Once the risk estimation equation has been populated, the application presents the user with a "contamination risk" (%) estimate and associated recommendations. Early validation studies using quality results from a groundwater sampling regime (n=100) indicates that GRAppLE can accurately predict groundwater contamination with Escherichia coli in 78% of cases. GRAppLE narrows the gap between laboratory science, hydrogeology, social engagement, and 'pocket technology', thus representing the state of the art in both environmental research and citizen science, providing scope for future integrations to protect natural resources and public health in Europe.

**Keywords:** environmental technology, groundwater, health, citizen science

## Smart Technology and Nanotechnology for the Environment (K103)



**Cost effective sensing platform for the detection of phosphate in fresh and marine waters**

Andrew Donohoe, Cameron Hazel, Akshay Shinde, Margaret McCaul, Dermot Diamond
Insight Centre for Data Analytics, National Centre for Sensor Research, Dublin City University.

Corresponding Author Email Address: andrew.donohoe@insight-center.org

Nutrients such as phosphate, ammonia, nitrite, and nitrate are central in many environmental processes within the marine environment, including microbial, plant, and animal metabolic processes. The phosphate analyser is based on a combination of microfluidic analytical systems, colorimetric reagent chemistry, low-cost LED-based optical detection, low cost pumps, and wireless communications. Development of the precompetitive phosphate analyser was made possible through the use of rapid prototyping techniques such as 3D printing, laser ablation techniques, and micro fabrication methods. These techniques allow components to be quickly and easily manufactured in house. Automation of the system is carried out using Arduino Microcontrollers, used to control the fluid handling of the system and also integrated with GPRS for real time transmission of data. Low cost piezoelectric pumps and solenoid valves are used for fluidic control within the system. Microfluidic technologies have been employed for sample–reagent (1:1) mixing using shear forces in a serpentine channel, followed by colorimetric detection via an integrated 2 cm path length flow cell using a pulse width modulated LED, coupled with an in-line photodiode detector. The sensing platform has a linear detectable range up to 50 μM PO43□ and a limit of detection (LOD) of 0.09 μM PO43□.

**Keywords**: environmental sensor, fluidics, nutrients, eutrophication, in-situ

## Smart Technology and Nanotechnology for the Environment (K103)



**ST30 Effect of praseodymium (Pr) for high temperature anatase stability of titania and its visible light photocatalytic activity**

Snehamol Mathew1, 2, Priyanka Ganguly 1, 2, Vignesh Kumaravel 1, 2, Ciara Byrne 1, 2, John Bartlett 1, 2, Suresh C. Pillai 1, 2

[1]Nanotechnology and Bio-Engineering Research Group, Department of Environmental Science, School of Science, Institute of Technology Sligo, Ash Lane, Sligo, Ireland.

[2]Centre for Precision Engineering, Materials and Manufacturing Research (PEM), Institute of Technology Sligo, Ash Lane, Sligo, Ireland.

Corresponding Author Email Address: Snehamol.mathew@mail.itsligo.ie

Photocatalysis has been identified as an efficient and cost- effective promising technology, that can address existing environmental and energy issues. Titania (TiO2) is one of the widely explored catalysts in this area due to its multi-functionality and low-cost. Impurity doped TiO2 in its anatase phase exhibit improved absorption and photocatalytic activity in the visible region due to its reduced band gap. In the current study, various mol % (0.5, 1, 1.5, 2) of Pr- TiO2 have been synthesised by using sol-gel method. The temperature stability of anatase phase in titania was evaluated by calcining the samples at various temperatures ranging from 500 °C to 1000 °C. X-ray diffraction (XRD), Raman spectroscopy, X-ray photo-electron spectroscopy (XPS) and UV-visible spectroscopy techniques were employed to analyse the effect of Pr doping in physical and chemical properties of titania. Photocatalytic degradation of Doxycycline used to investigate the visible light photocatalytic efficiency of the prepared sample. The bactericidal effect of Pr-TiO2 also tested against E. coli and S. aureus strains.

**Keywords:** Antibacterial, doping, nanomaterials, photocatalyst

## Ecotoxicology (K104)



**Microplastics bound to the duckweed Lemna minor are ingested by the amphipod Gammarus pulex: an unexplored microplastic trophic transfer route in freshwater systems.**

Mateos-Cárdenas Alicia 1, 3, van Pelt Frank N.A.M. 2, 3, O'Halloran John 1, 3, Jansen Marcel A.K. 1, 3
[1]School of Biological, Earth and Environmental Sciences, University College Cork, North Mall, Cork City, Ireland.
[2]Department of Pharmacology and Therapeutics, Western Gateway Building, University College Cork, Western Road, Cork City, Ireland.
[3]Environmental Research Institute, Lee Road, Cork City, Ireland.

Corresponding Author Email Address: alicia.mateoscardenas@ucc.ie

Microplastics are small plastic particles (< 5 mm) made of synthetic polymers and of different shapes. Microplastics have been considered freshwater pollutants of emerging concern, although the physical impacts on organisms and ecosystems are not clear yet. Monitoring studies have shown that microplastics are ubiquitous in the aquatic environment. Current technologies only allow accurate detection and identification of microplastics up to < 300 µm in size, but smaller micro- and nanoplastics are predicted to be abundant, and potentially more biologically available. Studies on the effects of microplastics on aquatic organisms have predominantly focused on marine fauna. The effects of microplastics on freshwater aquatic plants and the fate in the freshwater trophic chain are still largely unexplored. Here we show for the first time that 10-45 µm polyethylene (PE) microplastics can strongly bind on all surfaces of the duckweed Lemna minor, suggesting L. minor as a potential vector of microplastics for trophic transfer. We also show that the freshwater amphipod Gammarus pulex can ingest 10-45 µm PE microplastics by feeding on contaminated L. minor. Moreover, despite microplastics binding on plant tissue, our results show that this has no short term effects on L. minor biomass, frond number growth, root length and photosynthetic efficiency. Similarly, microplastic ingestion had no impact on amphipod mortality or mobility. Our trophic transfer bioassay can be a starting point for more complex microplastic feeding trials from freshwater producers to consumers.

**Keywords:** microplastics, polyethylene, freshwater, aquatic plants, freshwater macroinvertebrates, ecotoxicology, trophic transfer

## Ecotoxicology (K104)



**Nematode identification using artificial neural networks**

Jason Uhlemann 1, Oisin Cawley 1, Thomais Kakouli-Duarte 2
[1]gameCORE, Department of Computing, Institute of Technology Carlow.
[2]enviroCORE, Department of Science and Health, Institute of Technology Carlow.

Corresponding Author Email Address: jason.uhlemann@itcarlow.ie

Nematodes are suitable bio-indicator organisms, with applications in environmental biomonitoring. Their species diversity in various habitats can be analysed to observe potential ecosystem damage or recovery but nematode identification is a difficult and time-consuming task. Their morphological identification process is fundamentally one of pattern matching, where a nematode image under a microscope is compared to sketches in a classical taxonomic key. Recent advances within the area of Artificial Intelligence, in particular image classification, have been making huge improvements to the state of the art. Specifically, a modelling process utilising Convolutional Neural Networks (CNNs) has taken the lead in terms of the accuracy benchmark. In a collaborative project between the enviroCORE and the gameCORE research centres of IT Carlow, we cultured three entomopathogenic nematode species, Heterorhabditis bacteriophora, Steinernema carpocapsae, and Steinernema feltiae. Using a digital microscope, we photographed juvenile nematodes at 10 and 20 times magnification, and using a state-of-the-art CNN model (Xception), trained the model to recognise these new images. We trained the model using 10,000 images (100 images with 100 rotations each) with 80% used for training and 20% used for validation. Two training approaches were compared: Transfer Learning and Random Initialization. Transfer Learning uses a pretrained network for feature extraction and only retrains the final layer, whereas Random Initialization trains the whole network from scratch. Two key measures of any neural network are the loss (the number of errors it is making), and the accuracy (how well the network is making correct predictions). During our preliminary tests, Transfer Learning achieved a loss of 0.21626 and an accuracy of 94.92%. Random Initialization took longer but achieved a loss of 0.00016 and accuracy of 100%. The latter would appear to have performed better, however, we believe this to be misleading since a 100% accuracy is often associated with a phenomenon called overfitting which we are currently investigating. A second issue was identified with the misclassification of non-nematode images. Results have been encouraging but there is more work to be done to fine tune the CNN parameters, and further experimentation with adult nematode images is progressing.

**Keywords:** nematodes, identification, artificial intelligence, neural network

## Ecotoxicology (K104)



**Molecular and behavioural characterisation of neonicotinoid exposure on bumblebees reveals trends between chemical effect and their mode of action**

Felipe Guapo, Dearbhlaith Larkin, James C. Carolan
Applied Proteomics, Biology Department, Maynooth University.

Corresponding Author Email Address: felipeguapom@gmail.com

Bombus terrestris (L.) is one of the most important native and commercial bumblebee pollinator species worldwide. Along with many other pollinators their populations are in decline due to a multifactorial phenomenon that includes the extensive use of agrochemicals, among them, neonicotinoid insecticides. Although the characterisation of insecticide effects on bees is not new it is essential to understand these effects on a pharmacological level to better mitigate the risks of their use in the environment. This study characterised the behavioural and molecular effects of acute exposure to eight different sub lethal and field relevant concentrations of agonistic and antagonistic neonicotinoids. Thirty, three and four bees from at least 3 different colonies per treatment were used respectively for each experiment (n= 311 bees in total). Patterns of hyperactivity were identified for bees exposed to clothianidin while bees exposed to imidacloprid showed signs of temporal paralysis. The accumulation of synapsin in bumblebee brain cells was quantified using confocal microscopy with higher levels observed in imidacloprid-exposed bees. The characterization of the brain proteome using quantitative mass spectrometry resulted in the identification of hundreds of statistically significantly differently abundant (SSDA) proteins between exposed and non-exposed bees. Functional annotation analysis on these proteins indicated that an impairment of intracellular transport, a decrease in cellular communication and an increase in cytoskeleton organization occurred in clothianidin exposed bees, whereas imidacloprid exposed bees displayed an increase in translational activity, RNA transport and axon guidance and a decrease in synaptic vesicle exocytosis and neuron maturation. Our results demonstrate individual and distinct response trends that are correlated with the mode of action of each insecticide.

**Keywords:** neonicotinoids, pesticides, bumblebees, pollination

## Waste Management 1 (L114)



**Dairy processing wastewater as a potential feedstock for microbial bioplastic production**

Arno Fricke 1, 2, Jerry D. Murphy 1, Niall D. O'Leary 1, 2
[1]Environmental Research Institute, Lee Road, Cork, Ireland.
[2]UCC School of Microbiology, University College Cork, College Road, Cork, Ireland.

Corresponding Author Email Address: a.fricke@umail.ucc.ie

The end of the European milk quotas in 2015 resulted in a steep increase of milk production from 5 to 7.2 billion litres annually. Dairy processing can generate up to 10 litres of wastewater (WW) per litre of milk processed, containing high concentrations of organic pollutants requiring treatment prior to discharge. The NEWTRIENTS project investigates the capacity for dairy processing wastewater to serve as a feedstock for value-added, microbial biodegradable polymer production. Microbial bioplastics such as polyhydroxyalkanoates (PHAs) are promising bioplastics with the potential to reduce our dependency on fossil fuel derived materials and their environmental impacts. Poor economic competitiveness of PHAs within the plastics market is attributed to feedstock costs, axenic culture system requirements and downstream processing needs. The use of wastewater streams as feedstocks, together with mixed culture production systems has therefore gained considerable interest. The NEWTRIENTS approach involves pre-adaption of the dairy processing WW in an anaerobic, hydrolytic reactor where acidogenic bacteria metabolise the organic fraction to form volatile fatty acids (VFAs), the building blocks of PHA. The second step comprises the adaption of biomass towards PHA accumulation, driven by an aerobic dynamic (feast/famine) feeding strategy. In a final production step the adapted WW and biomass is combined in a fed-batch reactor to produce the end product PHA. Herein we report system optimisations and VFA/PHA outputs to date.

**Keywords:** wastewater, bioplastic, resource recovery, dairy industry, bioeconomy

## Waste Management 1 (L114)



**Influence of density and light on the capacity of Lemna minor to treat dairy processing wastewater**

Éamonn Walsh, Gavin Burnell, Marcel Jansen,
School of Biological, Earth and Environmental Science, & Environmental Research Institute, University College Cork, Cork, Ireland.

Corresponding author e-mail address: eamonn.walsh@ucc.ie

This research focuses on the remediation of dairy processing wastewater, which is formed during the processing of raw milk into dairy products such as cheese, yogurt and dried milk powder. Aquatic plants from the Lemnaceae family, commonly called duckweeds are being used for remediation. There are two key goals of this research, first, to remediate the wastewater and second, to produce high-protein content duckweed. As part of a circular economy approach duckweed that has remediated dairy wastewater will be added back into the economy as part of feed for agricultural animals. In this way duckweed that has remediated dairy processing wastewater of environmentally damaging compounds such as ammonia and phosphate will then be used as a source of nutrition for agricultural animals. Duckweed is used in this way because of its fast growth rate, tolerance for pollution, high protein content and excellent amino acid profile. However, there are a number of important factors, such as light and plant surface density, that affect duckweed production. These parameters are also important in the context of a scaled-up duckweed remediation reactor. Lemna minor were grown in 100 mL of a 'synthetic' dairy wastewater in short, week-long, experiments in a range of light and density conditions. In these experiments growth rates, protein content and total nitrogen (TN) and total phosphorous (TP) removal rates were measured. In this way the most optimal light and plant density conditions for a range of parameters were observed. As light intensity is increased plant growth rates and TN and TP removal rates also increase. However, L. minor protein content is stable. As plant density is increased the growth rate slows. However, the TN and TP removal rate increases. Again, protein content remains unchanged. These experiments provide key information on the way in which a duckweed remediation reactor should be set-up to maximise growth, removal rates and plant protein content.

**Keywords:** wastewater, remediation, duckweed, circular economy

## Waste Management 1 (L114)



### VALOR - Valorisation alternatives to landfill for organic residues

Jessica Graça 1, Brian Murphy 2, Brian Kelleher 1
[1]DCU- Dublin City University, Chemical Sciences Department, Glasnevin, Dublin 9, Ireland.
[2]Enrich Environmental Ltd, Co. Meath, Ireland.

Corresponding Author Email Address: jessica.graca@gmx.com

In 2016, the Environmental Protection Agency (EPA) reported that near 2.8 million tonnes of municipal waste was generated in Ireland. Although most was sent to energy recover and recycling, 122 ktonnes of organic fines were also generated. Organic fines of municipal solid waste (OFMSW) mainly comprise the putrescible fraction of "black bin" waste after it has been subjected to mechanical separation. When composted and reaching a stability standard of < 7mg O2 g DM-1, the bio-stabilised residual waste (BSRW), can be used as landfill daily cover or alternative uses agreed with the EPA. From 2013 – 2016, an increase of 51% in the quantity of BSRW generated was recorded by the EPA and used as landfill cover. Landfilling of waste has been a solution to managing waste for decades across the world. Currently, only five landfills are accepting municipal waste for disposal in Ireland. BSRW has the potential to be recovered and used for valuable alternatives. The VALOR project will investigate suitable recovery options of this waste (e.g. soil amendments, energy production, biofuels) and will determine the best end-use recovery options based on an assessment of risks and benefits. This project is driven by the need to achieve waste management sustainability in line with national and EU goals (e.g. reduce landfill disposal of waste). The recovery of residual municipal waste towards a higher rank in the waste hierarchy, contributes towards a circular economy and the mitigation of climate change.

**Keywords:** biodegradable waste, waste management, high-value options

## Waste Management 1 (L114)



**Low-cost physicochemical treatment for removal of ammonia, phosphate and nitrate contaminants from landfill leachate**

Sinead Morris 1*, Guiomar Garcia-Cabellos 1, David Ryan 1, Deirdre Enright 2, Anne-Marie Enright 1
[1]enviroCORE, Institute of Technology Carlow, Kilkenny Road, Carlow, Ireland.
[2]Institute of Technology Tralee, Clash, Tralee, Co. Kerry, Ireland.

Corresponding Authors Email Address: Sinead.Morris@itcarlow.ie

Four low-cost materials, oyster shells, pumice stone, sand and zeolite were employed as adsorbents in an adsorption batch assays investigating the removal of ammonia, phosphate and nitrate from an aqueous solution. These compounds were chosen as they represent typical compounds found in landfill leachate (LFL). Assay performance was evaluated by the Langmuir and Freundlich adsorption isotherms and the adsorbent materials were ranked in terms of their adsorption capacity for each test compound. The top two materials, oyster shells and pumice stone, were then employed as adsorbents in a fixed-bed column optimisation trial that examined the effect of bed height and flow rate on the treatment of a synthetic LFL containing ammonia, phosphate and nitrate at an applied flow rate of 5 ml.min-1. The optimisation trial was evaluated by both adsorption isotherms and the percentage removal efficiency of each compound. The trial indicates that the highest rates of adsorption were achieved using bed heights of 20 cm with an applied flow rate of 5 ml.min¬-1. After optimisation, the system was employed for the treatment of LFL from Powerstown landfill, Carlow, Ireland. Column performance was evaluated by percentage removal efficiency of each compound. Ammonia and nitrate were effectively removed by both adsorption materials resulting in a reduction of influent ammonia and nitrate concentrations to below the national discharge limits set for these compounds of ≤4 mg.l-1 and ≤50 mg.l-1, respectively. . Although similar high removal efficiencies were observed for phosphate these rates were not maintained during the test period with overall results indicating a reduced phosphate adsorption in comparison to the other compounds tested.

**Keywords**: landfill Leachate, adsorption, adsorption isotherms, fixed-bed column, ammonia, phosphate, nitrate

## Waste Management 1 (L114)



**Effect of trace element supplementation on anaerobic digestion of chicken litter with enzyme treatment**

Navodita Bhatnagar 1, David Ryan 1, Richard Murphy 2, Anne-Marie Enright 1
[1]enviroCORE, Institute of Technology Carlow, Kilkenny road, Ireland.
[2]Alltech, Dunboyne, Co. Meath, Ireland.

Corresponding Author Email Address: navodita.bhatnagar@itcarlow.com

Animal manure, composed of digested organic matter, represents a rich source of minerals including nitrogen, phosphorus, calcium, potassium and magnesium. However, due to the presence of inorganic minerals improper disposal of this waste stream can result in contamination of ground and surface water. The poultry industry is one of the largest producers of organic waste within the agriculture sector. Specifically, Irish chicken production and consumption is higher compared to other poultry animals, thus generating large volumes of chicken litter (CL). Anaerobic digestion (AD) is an ecofriendly technology which not only stabilizes this waste by converting it to biogas (CH4, CO2 and N2) but also reduces the volume. However, mono-digestion of CL results in low methane yields. The current study examined the effect of enzyme and trace element supplementation in small scale batch biomethane potential (BMP) assays in 150 ml serum bottle. The experiment included ten different enzyme and trace element combination assays including negative controls containing CL alone and a positive control containing cellulose. All batch assays were carried out in triplicate at 37 □C. Results indicate that both enzyme treatment and trace element supplementation enhanced the biogas yield (10 % to 60 % increase) and methane yield (35 % to 100 % increase) of AD of CL. The CL treated with1 % enzyme and the CL that received a 1 % enzyme pretreatment plus a trace element supplementation effected the highest specific biogas and methane yields.

**Keywords:** co-digestion, biogas, biomethane potential, organic matter

## Environmental Policy & Communication (K103)



**Irish Climate Policy Evaluation: The value of social and environmental impacts in policy uptake**

Sabrina Dekker, Diarmuid Torney
School of Law and Government, Dublin City University.

Corresponding Author Email Address: sabrina.dekker@dcu.ie

The Irish Climate Policy Evaluation project is an ex-post analysis of climate change policy in Ireland. Considering policies developed between 1996 and 2018 the project aims to understand the challenges with policy development and establish a framework for the development of future climate policy based on the research findings. To date analysis of policies across the four sectors identified in the National Mitigation Plan: built environment, transportation, electricity generation, and agriculture, forestry and land-use, using six evaluation criteria has been undertaken. The criteria used to evaluate the policies are: effectiveness, efficiency, coherence, relevance, distributional impacts and governance. Workshops were conducted with key stakeholders in each sector to understand how the climate change mitigation policies were developed and to identify one policy in each sector for further analysis. What has emerged from our research is that the criteria for selecting and implementing policy is limited to primarily economic value, in particular the costs of implementation and the cost savings in the short term. As such, policies have been chosen for their economic impacts, while consideration of the broader environmental and social impacts has largely been absent. The outcome has been silo'd policy actions that have not achieved the anticipated mitigation of greenhouse gas (GHG) emissions. This paper will focus on two sectoral case studies: the Better Energy Homes programme and support measures to incentivise electric vehicles. We argue that these policies have not consider adequately the capacity of the individuals being targeted to participate in key programmes. There needs to be an understanding of the social and environmental impacts of policy in the short and long terms to avoid the creation of new policy problems.

**Keywords:** climate change, policy, mitigation, communication, environmental, social

## Environmental Policy & Communication (K103)



**Towards knowledge transfer and stakeholder alignment in development of private well risk communication interventions: A qualitative interview study of national and international experts**

Simon Mooney, Paul Dylan Hynds
Environmental Sustainability & Health Institute (ESHI), Technological University Dublin, Dublin 7.

Corresponding author email address: D17125411@mydit.ie

Concerted engagement with rural (private) domestic well users has been increasingly recognised as a vital component of ensuring pristine potable groundwater quality. As demonstrated nationally, prevailing gaps in private groundwater policy and the human health implications of inaction heighten the exigency for effective outreach. Approximately 750,000 Irish people derive drinking water from unregulated private wells, many of which are susceptible to pathogenic contamination. In 2014, exposure to private well water accounted for as many as 80% of documented VTEC (Verotoxigenic E. coli) cases. Given the range of established and potential constraints to private well maintenance, communication with rural private well users is a highly complex undertaking. Low levels of risk awareness and supply stewardship combined with growing pressures deriving from climate change and rural development prescribe a holistic, interdisciplinary approach to form practical behaviour change interventions. To date, however, no such steps have been documented in Ireland – nor have more cost-effective means of expert consultation, e.g. expert interviews. Accordingly, the current study sought to elicit experts across a range of relevant spheres via a qualitative interview study. A target of 50 interviews was set and attained, with 25 assigned to national experts and 25 assigned to international experts. National interviews were undertaken face-to-face and international interviews via Skype video calls. Interviews utilised a semi-structured, formalised interview guide and were coded using NVIVO 12 Pro qualitative software, enabling comprehensive thematic analysis. Experts noted the significance of longstanding behavioural norms and the potential efficacy of community leaders and civil institutions in encouraging better behaviours. The most frequently suggested communication activities comprised public events, local radio segments, workshops and community meetings, indicating the importance of family-oriented, discursive and interpersonal channels in raising groundwater risk awareness. Study findings may serve as a frame of reference for authorities intending to implement future groundwater risk interventions.

**Keywords:** groundwater quality, groundwater stewardship, human health, public engagement, risk communication

**Circular economy framework on recycling-derived fertilisers**

Laura van Schöll
NMI BV nutrient management institute, Nieuwe Kanaal 7c, 6709 PA Wageningen, Netherlands.

Corresponding Author email Address: laura.vanscholl@nmi-agro.nl

In a circular economy resources are optimised by reducing losses to the environment and recycling of wastes. However, the use and (transnational) marketing of recycled-derived fertilisers (RDF) is hampered by legislation. The legal status of RDF products is not determined by product quality but by origin. The marketing of fertilisers is either regulated by the EC-regulation relating to fertilisers (EC-fertilisers) or by national legislation (national fertilisers). The current EC regulation on fertilisers is limited to inorganic fertilisers from mining or industrial chemical or physical processes. Most RDF products are regulated by national legislations on the use of fertilisers. These however differ strongly between EU member states, both in structure, definitions and criteria. The legal status as waste and/or animal by-product of most RDF products implies that they must comply with the detailed and far reaching restrictions and requirements of the Waste Framework Directive and regulations on animal by-products. These lay an administrative and logistic burden on the (transfrontier) transport and handling of the recycling-derived fertiliser products. The lack of a fair level playing field hinders the development of a transnational market for recycling derived fertilisers. A transnational market within the EU is needed to balance regions with nutrient surpluses to regions with nutrient shortages. This lack also slows down the implementation of innovative techniques for nutrient recovery from waste or manure. The upcoming revision of the EC-fertiliser regulation is intended to stimulate the use of RDF products by broadening the scope to organic fertilisers, soil improvers and biostimulants. Inclusion of RDF products as struvite, ashes, biochar and products of manure treatment is envisioned at a later stage. The North-West Europe Interreg project ReNu2Farm will provide a clear overview of legislation applying to RDF products and identify obstacles, challenges and scope for solutions and policy recommendations. For more information, see https://www.biorefine.eu/projects/renu2farm.

**Keywords:** circular economy, recycling-derived fertilisers, legislation, regulations

**EP73 Environmental compliance requirements: awareness in Irish SMEs**

Margaret Savage 1, 2
[1]Dept. Environmental Science, Institute of Technology, Ash Lane, Sligo
[2]PhD research undertaken at School of Law, University of Manchester

Corresponding author email address: savage.margaret@itsligo.ie

Small and medium enterprises (SMEs) comprise 99.7% of Irish enterprises and whilst individual SMEs may present minimal environmental risk, the aggregate risk posed is large. The aim of environmental legislation is to encourage the regulated to behave in ways that they might otherwise not. Thus, extensive environmental compliance would likely contribute significantly to environmental protection. Environmental compliance behaviours and perceptions in SMEs are not well understood. There is little empirical evidence in the literature regarding the extent of environmental compliance awareness in SMEs. The literature indicates that SMEs are unlikely to fully know and understand their environmental compliance obligations, which raises the question: how can they be in compliance? The aim of this study is to discover whether, why and how SMEs in the food sector in Ireland access information on environmental legislative requirements. The awareness and understanding of some legislative requirements in relation to waste and wastewater was studied by conducting semi-structured interviews with owner-managers in 27 SMEs in the food processing and manufacturing sector in Ireland. The largely qualitative interview data will be analysed using thematic analysis. Preliminary observations indicate that many owner-managers had limited knowledge of their environmental compliance requirements and limited involvement in the environmental regulatory system, although most aimed to operate in an environmentally responsible manner. Environmental compliance information does not appear to have been actively provided to the firms. The results of this study may suggest evidence-based enhancements to environmental regulatory support systems for SMEs.

**Keywords:** SMEs, environmental regulation, wastewater, waste, regulatory awareness

**EP126 Irish shortfall in achieving the SDGs: business responsibility and opportunity**

Angela Nagle
School of Engineering, University College Cork, Western Road, Cork, Ireland.

Corresponding Author Email Address: AngelaJaneNagle@umail.ucc.ie

The United Nations' Sustainable Development Goals (SDGs) outline how the world could become more sustainable, prosperous and peaceful through economic, environmental and social sustainability practices. Since their release in 2015, Ireland has performed poorly against the goals. This paper will argue that in order to correct this shortfall, Irish businesses should take the lead in engaging with the SDGs, and not wait for Government and NGO action. The SDGs could be incorporated into business models and used as KPIs for all new projects. Businesses will realise that profit can be made in alignment with the SDGs, and that potential business risks will increase by not doing so. Economic opportunity will come through regaining trust through pricing and internalizing externalities, and business participation in legislating for a level playing field. An example is Unilever, who state clearly that business growth should not be at the expense of the planet. Unilever are reporting 4 consecutive years in which its most sustainable brands grew nearly 50% faster than the rest of the business, and delivered 70% of the overall growth. The Re-Wind Project is an academic research project comparing sustainable end-of-life reuse strategies of decommissioned wind turbine blades, from an economic, social and environmental perspective (www.re-wind.info). A project in its infancy, like the Re-Wind Project, should use the SDGs as a baseline when defining project indicators. Re-Wind could consider all 232 SDG sub-indicators as to how they might relate to the project, and eliminate all that are not applicable. From the remaining list of sub-indicators, ten or fewer SMART project goals could be developed. If this project goes on to become a viable business, while maintaining sustainable practices in its business model, it might later gain extra financial benefits if carbon or polluting taxes come into effect.

**Keywords:** sustainable development goals, business models, wind turbine blades, reuse

## Marine & Coastal 1 (L115)



**Impact of processing on total and inorganic arsenic content in edible seaweeds**

Jenny Smith 1, Evin McGovern 1, Dagmar B. Stengel 2
[1]Marine Institute, Rinville, Oranmore, Galway, Ireland.
[2]NUI Botany and Plant Science, School of Natural Sciences and Ryan Institute, National University of Ireland, Galway.

Corresponding Author Email Address: jenny.smith@marine.ie

Both nationally and globally, there is a renewed interest in using seaweed resources for a host of products in the food, feed, agricultural, cosmetics and biotechnology sectors. Marine biota, including many seaweeds (macroalgae), often contain high levels of arsenic which occur with a complicated chemistry and toxicology. Of the many forms or species of arsenic present, inorganic arsenic (iAs) is among the most toxic. While many seaweeds contain negligible amounts of iAs, Laminaria digitata studied within this project were found to contain significant amounts of iAs. The EC have set Maximum Limits for arsenic in macroalgae used in animal feed, which can be frequently be exceeded; also, Maximum Limits for inorganic arsenic may be in the pipeline for seafood. The effects of drying method, storage conditions and duration, soaking and cooking on total and inorganic arsenic concentrations in Laminaria digitata, Palmaria palmata and Saccharina latissima were investigated. The results show that the drying method did not alter the concentration or ratio of total to inorganic arsenic, however differences in both content and ratio of inorganic to organic arsenic were observed following storage. Soaking seaweeds prior to cooking was found to reduce total arsenic in all species, with subsequent cooking reducing this further. In L. digitata, inorganic arsenic was also greatly reduced following soaking, with additional reductions after cooking.

**Keywords:** macroalgae, seaweeds, arsenic, ICP-MS, HPLC

## Marine & Coastal 1 (L115)



**Microplastics in Galway Bay: preliminary results from the benthos**

Elena Pagter 1, Otto Storan 1, Shane Keegan 1, João Frias 1, Róisín Nash 1
[1] MFRC-GMIT – Marine and Freshwater Research Centre, Galway-Mayo Institute of Technology, Dublin Road, H91 T8NW, Galway, Ireland.

Corresponding Author: elena.pagter@research.gmit.ie

Plastic production is expected to increase in the coming years as it is an economical and versatile material. As plastics are products of fossil fuels and natural gas, the anticipated increase in demand will add to greenhouse gas emissions. After production and use, plastics can fragment into smaller pieces and become microplastics. Microplastics are an anthropogenic litter that is now ubiquitous in terrestrial and marine environments. Sediment samples were retrieved with a box corer from 30 sites in Galway Bay. Of the 20 sites, 15 have been analysed. At all 15 stations, debris was present with a current total 371 particles were found in 0.95kgd.w. of sediment. The identified particles were made of fibres made up a majority (97%) of the particles while the rest were fragments. The most prominent colours in both fibres and fragments was blue (80%) followed by red (7%) and clear (3%). The station with the most particles (85) was located at the inflow of the Atlantic into the bay. Within the sediment, all benthic invertebrate species had an average of 1 piece of plastic in their gut. The beam trawl samples collected 24 marine species. While all analysed individuals did not have microplastics in their gut, all species had microplastics in their gut. In both benthic trawl and benthic invertebrate samples, fibres made up more than 95% of the identified plastics followed by fragments and films. These preliminary results are indicative of the serious nature of this type of pollution in the marine environment. The results of this research will ideally be used to inform relevant stakeholders and the creation of management tools that can contribute to knowledge for the Marine Strategy Framework Directive in Ireland.

**Keywords**: marine pollution, marine sediments, benthic fauna

## Marine & Coastal 1 (L115)



**Development and testing of "ecologically friendly" concrete for use in marine artificial structures**

Bryan J. Thompson 1, Paul R. Brooks 1, Ally J. Evans 2, Atteyeh S. Natanzi 3, Ciaran McNally 3, Pippa Moore 2, Tasman P. Crowe 1
[1]Earth Institute and School of Biology and Environmental Science, University College Dublin, Ireland.
[2]Institute of Biological, Environmental and Rural Sciences, Aberystwyth University, UK.
[3]School of Civil Engineering, University College Dublin, Ireland.

Corresponding Author Email Address: bryan.thompson@ucdconnect.ie

With a growing global population and a subsequent demand for infrastructure, marine artificial structures (e.g. seawalls and breakwaters) are proliferating along our coastlines in a phenomenon termed as 'ocean sprawl'. In addition, artificial structures are also being constructed to protect coasts from impacts associated with global climate change (sea-level rise, coastal erosion, increased storminess). In general, these structures often support lower species diversity across key functional groups compared to natural shores and can have an increased potential to facilitate the spread of non-natives. Research suggests that a lack of topographic complexity and unsuitable building materials may potentially be linked to this diversity deficit. In particular, the construction material used may affect the recruitment and the early stage composition of marine biofilms which form on artificial surfaces. Such effects may influence recruitment of other taxa and reduce availability or quality of food for invertebrate grazers, leading to different assemblages compared to natural shores. In response, there has been growing interest in ecological engineering as a means of enhancing the ecological value of artificial structures. Despite progress in this field, there is still a need to develop eco-engineering materials that support greater biodiversity while adhering to engineering standards. We have developed nine structurally viable concrete types, which varied in terms of their binder, aggregate, compression strength, chloride resistance, surface pH and roughness. Tiles were deployed in exposed and sheltered locations along a breakwater in County Meath. Algal and invertebrate recruitment measurements are being taken quarterly over a 12-month period. From this study, tile mixtures which exhibit maximal biodiversity will be used in future tile experiments which will test the effect of topographic complexity on community composition. Analyses are underway and preliminary findings will be presented.

**Keywords**: artificial marine structures, materials, concrete, enhancement, recruitment, surface roughness

## Sustainable Crop Science (K104)



**Role of Alltech crop science formulations in biological control of root-knot nematodes.**

Anusha Pulavarty 1, Karina Horgan 2, Thomais Kakouli-Duarte 1
[1] Molecular Ecology and Nematode Research Group, enviroCORE, Department of Science and Health, Institute of Technology Carlow, Kilkenny Road, Carlow.
[2] Alltech Bioscience Centre, Dunboyne, County Meath.

Corresponding Author Email Address: anusha.pulavarty@itcarlow.ie

Root-knot nematodes (RKN) are widely spread and highly damaging pests that are currently a serious constraint for global food security. They have a broad host range causing global yield losses of about 30% in susceptible crop varieties annually. This work is part of larger collaborative project between IT Carlow and Alltech, on sustainable nematode management alternatives. Two commercial formulations of Alltech, a proprietary blend of fermentation products and plant extracts with micronutrients (ACS-5075), and a microbial based product (ACS-3048), were evaluated against two RKN species, Meloidogyne incognita and Meloidogyne javanica. In laboratory tests, effectiveness of both products was recorded in terms of RKN egg hatching and juvenile mortality at different concentrations compared to untreated. In greenhouse trials, prophylactic treatment was conducted to study RKN infestation. Of the RKN eggs exposed to ACS-5075, only 10□0.5%, 0□0%, 0□0% and 0□0% hatched at 0.5%, 1%, 2% and 3% concentrations of the product, respectively, compared to 100% egg hatching observed in untreated. A 10-fold reduction in juvenile survival was observed in 0.5% treatment, however it dropped to zero in concentrations 1% and above for M. javanica. Juveniles did not survive with all treatment concentrations in the case of M. incognita. ACS-3048 was found effective in ceasing egg hatching process at concentrations 3% and above, while it did not induce juvenile mortality at 10% concentration for both species of RKN tested. After a treatment period of 2 months, the tomato plants were assessed in terms of number of root galls formed, shoot length and fresh weight in comparison to inoculated control plants (nematode infection). Prophylactic treatment of ACS-5075 on M. javanica infected plants was found to be effective in terms of all growth parameters with 2.04 and 1.4 fold reduction in number of galls at 1% (8□3.5) and 3% (11□3.07) treatment concentrations, respectively (p□0.05). However, the product was not found effective against M. incognita infestation in tomato seedlings. Our results indicate that ACS-5075 was more effective against M. javanica compared to M. incognita. Therefore, the product could provide a sustainable solution for M. javanica management.

**Keywords:** root knot nematodes, sustainability, fermentation and plant extracts, tomatoes, nematode mortality

## Sustainable Crop Science (K104)



**Exploring the demand for recycling-derived nutrients and organic matter in Northwest Europe**

Imke Harms 1, Niamh Power 2, Renata Sultanbaeva 3, Franky Coopman 4, Alain Bouthier 5
[1]Nutrient Management Institute, Nieuwe Kanaal 7c, 6709 PA Wageningen, Netherlands.
[2]Cork Institute of Technology, Bishopstown, Cork, Ireland.
[3]IZES, Altenkesseler Str., Building A1 17, 66115 Saarbruecken, Germany.
[4]Inagro, Ieperseweg 87, 8800 Rumbeke, Belgium.
[5]Arvalis Institut du Végétal, chemin de la côte vieille, 31450 BAZIEGE, France.

Corresponding Author Email Address: imke.harms@nmi-agro.nl

In the project ReNu2Farm we put farmers' requirements towards recycling-derived fertilisers (RDFs) into focus. Up to now, development of nutrient recovery technology is mainly driven by technological feasibility. In ReNu2Farm we focus on which fertiliser is demanded by the end users. Subsequently, the possibilities to produce the desired fertiliser will be explored. The reuse of nutrients and organic matter in agriculture is a major challenge to obtain a circular economy in Europe. RDF include products from different origins such as animal manure, urban waste including household food waste, catering waste or green cuttings from recreational areas as well as human waste such as sewage sludge. The waste material is treated to produce a safe fertiliser with a high plant nutritional value. The presented results of ReNu2Farm activities give insight into the demand for RDF in selected regions of Northwest Europe from an agronomic perspective. The desk study is based on agricultural statistics as well as expert knowledge from the participating institutions. The regionally desired Nitrogen–Phosphorous-Potassium (N-P-K) ratio of fertilisers for the most important crops grown in each region was derived, while considering the current soil nutrient status in each region. EU regulations and fertiliser recommendations were also taken into consideration. These region-specific desired N-P-K ratios should be fulfilled by a RDF that potentially replaces mineral fertiliser. First results show that in regions with high availability of animal manure (Flanders in Belgium, Netherlands, pastures in Ireland), a pure Nitrogen fertiliser without any P and K is likely to be demanded. In arable regions with a low livestock density (Northern France) but also hay and silage land (Ireland) require a N-P-K fertiliser. RDF products that meet farmers' needs will have a better perspective to replace mineral fertilisers in the fertiliser market.

**Keywords:** circular economy, nutrient recycling, regional nutrient demand, soil organic matter

## Sustainable Crop Science (K104)



**Plant growth promoting bacteria biocontrol of the plant parasitic nematode Meloidogyne javanica**

Aoife Egan, Thomais Kakouli-Duarte
Molecular Ecology and Nematode Research Group, enviroCORE, Department of Science and Health Institute of Technology Carlow, Kilkenny Road, Carlow, Ireland.

Corresponding Author Email Address: aoife.egan@itcarlow.ie

The damage caused by the plant parasitic nematode Meloidogyne javanica is estimated to be in the region of up to €10 billion per year in economic losses to agriculture in Europe. These micro invertebrates are round worms that invade and infect plants. Their control relies mainly on heavily regulated chemical pesticides. Therefore, there is huge potential for the development of a low-cost, natural and sustainable bio-based solution. Beneficial plant growth promoting (PGP) bacteria, such as Pseudomonas spp, are associated with increased plant growth and the control of parasitic nematodes. The work presented investigates the (1) PGP capacity of IT Carlow P. fluorescens strains residing on or in tomato plants and (2) biocontrol capacity of PGP bacteria both (a) in vitro through susceptibility and egg hatch testing, and (b) in planta by assessing nematode development in bacterial treated host plants. The PGP and biocontrol compounds P. fluorescens produced were also investigated by GC-MS analysis. The PGP results indicated up to 27% increase in tomato plant height when treated with the bacterial strain. The results of the in vitro testing showed up to 100% M. javanica mortality on exposure to the bacteria directly, and to their associated metabolites. Nematode egg hatch was inhibited when subjected to the bacterial metabolites. The in planta experiment results displayed delayed M. javanica infection in plants treated with bacterial strains L124 and L321. Stages of nematode development were inhibited in plants treated with bacterial strain L321. There were 12 different compounds produced by P. fluorescens strains identified that were associated with PGP and biocontrol. The results obtained from this research contribute to the toolkit of sustainable agricultural practices that can be utilised (1) as effective alternatives to chemical applications for phytoparasitic nematode management and (2) for plant growth promotion thus reducing the use of mineral fertilisers.

**Keywords:** plant parasitic nematodes, Meloidogyne javanica, Pseudomonas fluorescence, biocontrol, plant growth promotion, sustainable agriculture

## Environmental Management (K103)



**Peat-based biochar as an additive in the control of greenhouse gas emissions in manure management systems**

Josephine Getz 1, Alan Gilmer 1, 2, John Cassidy 1, 2 and Vivienne Byers 1, 3
[1]Environmental Sustainability & Health Institute, Greenway Hub, Technological University Dublin, Dublin.
[2]School of Chemical and Pharmaceutical Sciences, College of Sciences and Health, Technological University Dublin, Dublin.
[3]Health Research and Innovation Centre, National College Ireland, Dublin.

Corresponding Author Email Address: josephine.getz@mydit.ie

The role of biochar in regulating the production of greenhouse gases (GHGs) has been well recognised. A point which can help to reduce GHGs in Ireland's intensive agricultural sector, as in 2018 it accounted for around 30 % of the total national GHG emission. Traditional applications of biochar have used a wide variety of feedstock sources and production pathways which in turn determine the efficacy of the resultant biochar as a GHG regulator. Any organic non-poisonous material is suitable as feedstock for thermal processing such as pyrolysis. Examples are agricultural and woody biomass as well as agricultural, industrial or municipal wastes. In this study slow pyrolysis, a thermal decomposition of materials in an oxygen limited atmosphere, at temperatures of 450 - 750 °C with a heating rate of 7.5 °C min-1 is used to produce biochar. Although the biochar production from many common sources is well understood, there remains considerable uncertainty over the efficacy of biochar production from defined peat sources and the ability to reliably replicate feedstock-production systems. This study seeks to explore the production and utilization of biochar produced from harvested peat in the Irish midlands relative to other feedstock sources to mediate reductions in greenhouse gas emissions for manure management systems. Preliminary results show that drying as a pre-treatment in production does not increase the peat-based biochar yield, if calculated on a dry matter basis, making the process less emission intensive. It was also observed that the thermal treatment increases the pH of the tested materials, making the biochars slightly more alkaline than the original materials. At the same time, rising process temperatures led to a decrease in yield for all materials used.

**Keywords**: biomass, peat, biochar, greenhouse gas abatement, manure management

## Environmental Management (K103)



**The AREST Project - Antimicrobial Resistance and the Environment – Sources, Persistence, Transmission and Risk Management**

B. Hooban 1, C. Chique 1, J. Cullinan 1, K. Burgess 2, F. Leonard 3, F. Walsh 4, E. Cummins 3, C. Monahan 3, L. O'Connor 1, F. Brennan 2, R. Hendriksen 6, S. Fanning 3, M. Healy 1, B. Mc Mahon 3, X. Zhan 1, G. Duffy 2, L. Morrison 1, R. Gately 7, D. Crowley 8, S. Nolan 1, D. Prendergast 9, M. Cormican 1, 5, D. Morris 1.
[1]National University of Ireland Galway.
[2]Teagasc.
[3]University College Dublin.
[4]Maynooth University.
[5]Health Service Executive.
[6]Technical University of Denmark.
[7]Galway County Council.
[8]Cork County Council;
[9]Department of Agriculture, Food and the Marine.

Corresponding Author Email Address: b.hooban1@nuigalway.ie

Antimicrobial resistance (AMR) is recognised as one the greatest threats to human health as acknowledged in a series of authoritative reports in Ireland and elsewhere. The emergence and dissemination of AMR is related to use of antimicrobial agents. Antimicrobial agents have been used for decades in humans and animals and for other applications. It is only recently that attention has been given to the pivotal role that the environment plays as that link between AMR in animals and humans which makes a "One Health" approach to AMR imperative. The EPA-funded AREST project will generate national level data on the key sources, hot spots and drivers of AMR in the environment from various sectors using a unique approach combining conventional microbiology, geographical information systems, high-throughput sequencing technologies, and risk analyses. The evidence gathered at selected local authority areas and inclusion of key drivers will provide a clear picture of the extent of contamination of the environment. Data generated will inform relevant policies. The AREST project will also embed the "One Health" concept and build the capacity of Ireland's research community to support Ireland's National Action Plan on AMR.

**Keywords:** One Health, AREST, environment, antimicrobial resistance

## Environmental Management (K103)



**Remote sensing for mapping groundwater floods in the Republic of Ireland**

Joan Campanyà 1, Ted McCormack 1, Rebecca Bradford 1, 2, Owen Naughton 1, 3
[1]Geological Survey Ireland, Beggars Bush, Haddington Road, Dublin, Ireland.
[2]Tobin Consulting Engineers, Block 10-4, Blanchardstown Corporate Park, Dublin 15.
[3]Department of Built Environment, Carlow Institute of Technology, Ireland.

Corresponding Author Email Address: joan.campanya@gsi.ie

Groundwater flooding represents a significant hazard in many rural communities in Ireland. The unprecedented flood events in recent years have reinforced the need to improve our ability to quantify the location and likelihood of flood occurrence. Geological Survey Ireland, in collaboration with Trinity College Dublin and Carlow Institute of Technology, has established a collaborative project to investigate groundwater flooding specifically related to seasonal lakes known as turloughs. There are over 400 recorded turloughs across Ireland, the majority of which located on limestone lowlands. Turloughs can completely dry during summer months but extend to hundreds of hectares during the winter flood season. The practical limitations of establishing and maintaining a network of over 400 turloughs supported the use of remote sensing and GIS techniques to delineate flood extents using passive satellite imagery such as the ESA Sentinel programme. Measurements at 50 sites for over 18 months were used to calibrate and validate results from satellite data. With limited recorded groundwater flood data, the use of remote sensing data provides historical archives of images to look at past flood conditions to optimise the detection of groundwater and delineate maximum groundwater flood maps. This project will provide essential technical knowledge to key stakeholders to develop scientifically-informed decisions with regard to groundwater flood mitigation and prevention.

**Keywords:** remote sensing, groundwater, geo-hazard, mapping

## Environmental Management (K103)



**EM43 Environmental change in Ireland's small marl lakes**

Raymond Wilson
Ulster University, Coleraine, School of Geography and Environmental Sciences.

Corresponding Author Email Address: Wilson-r30@ulster.ac.uk

Highly calcareous (marl) lakes have mostly been associated with oligotrophic conditions with striking water clarity and extensive abundance of specific communities of aquatic plants like charophytes. However, Ireland's small marl lakes in the Magheraveely / Kilroosky cross border region are showing signs of eutrophication with frequent algal blooms and concurrent declines of charophytes. The Interreg CANN project therefore seeks to document level and causes of the lakes' apparent decline as a first step towards identification of suitable mitigation options. Here we present results from current lake monitoring. There is strong evidence for internal hypolimnic P-mobilisation at all sites.

**Keywords:** phosphorus, enrichment, marl, lake, remediation

## Marine & Coastal 2 (L115)



**The development of a biomarker to monitor fish health in aquaculture**

Sandra Bohan, David Dowling and Rosemary O'Hara
enviroCORE, Department of Science and Health, Dargan Centre,
Institute of Technology Carlow, Kilkenny Road, Co. Carlow, Ireland.

Corresponding Author Email Address: sandra.bohan@itcarlow.ie

Aquaculture is becoming a more common and convenient way to produce large quantities of fish for consumption and to help reduce fish depletion as a result of overfishing. Therefore, the fish raised in the farms need to be as stress-free and healthy as possible. Stress is a non-specific response the body has in response to any demand (either physical or biochemical) that is placed on it. Once the system has become stressed then the Acute Phase Response (APR) is activated to combat the stress and return the body to its normal physiological state. During the APR, Acute Phase Proteins (APP's) are produced which help combat the effects of the stress response. The APP of interest is Serum Amyloid A (SAA), particularly Acute-Phase Serum Amyloid A (A-SAA), which has been known to increase by up to 1000-fold during the APR. This study uses farm bred fish to measure SAA levels as a potential biomarker for stress in the fish. Biomarkers are used as indicators of response changes either biochemical or cellular that occur as a result of toxins entering the host system. Using Oncorhynchus mykiss as the initial test species, SAA levels have been detected in various organs (liver (where most APPs are produced), heart, kidneys and spleen) of both healthy and diseased fish obtained from local fish farms. Using qPCR, the liver (3.43E+09ng/µl), heart (1.34E+10 ng/µl) and kidney (4.44E+09 ng/µl) from the diseased fish show an increase in A-SAA concentration when compared to the liver (9.26E+06 ng/µl), heart (3.06E+06 ng/µl) and kidney (3.54E+07 ng/µl) from healthy fish. Spleen A-SAA levels (7.99E+06 ng/µl) show a decrease when compared to the healthy fish (2.57E+09 ng/µl). The results recorded correspond with previous reports that show increases in A-SAA levels of diseased samples when compared to healthy ones. Further testing is needed to determine the cause of the decrease in spleen A-SAA levels.

**Keywords:** fish farms, biomarker, Oncorhynchus mykiss

## Marine & Coastal 2 (L115)



**MC32 A baseline study of the variability of pCO2 in Irish coastal and shelf waters – preliminary results**

Aedín McAleer 1, Rachel Cave 1, Brian Ward 2
[1]School of Natural Sciences, NUI Galway,
[2]School of Physics, NUI Galway.

Corresponding Author Email Address: aedin.mcaleer@nuigalway.ie

CO2 is an important greenhouse gas implicated in climate change. Its atmospheric concentrations are increasing rapidly, largely due to anthropogenic emissions from the combustion of fossil fuels and land use changes. The ocean is an important sink for CO2, and is believed to have taken up a substantial proportion of the CO2 from anthropogenic activities over recent centuries. While uptake and cycling of CO2 in the open ocean is becoming well understood, limited information exists about CO2 in coastal waters. The carbon chemistry of Irish coastal waters is determined by the cycle of growth and decay of phytoplankton (biological pump), exchange of waters with the Atlantic (physical pump) and CO2 exchange with the atmosphere (solubility pump). Irish coastal waters may act as both a source and a sink of CO2, switching between them at different seasons. To study this, a pCO2 system was installed on RV Celtic Voyager in 2018 as part of the Marine Institute funded VOCAB project. Surface seawater and the overlying atmosphere are simultaneously and continuously sampled for CO2 as the ship carries out research and monitoring surveys around Ireland. Results from April 2018 show atmospheric pCO2 (pCO2atm) ranges from 406 to 413ppm west of the Aran islands, while seawater pCO2 (pCO2sw) is much lower, from 300 to 366 ppm, indicating that this shelf area is acting as a substantial sink of CO2. In the Irish Sea, pCO2atm ranges from 406 to 420 ppm with pCO2sw from 376 to 410 ppm, indicating this region is only a moderate sink of atmospheric CO2. As salinity lowers approaching the coast near Dublin, pCO2sw increases indicating nearshore waters are a source of CO2 to the atmosphere, whereas pCO2sw within Galway Bay declines rapidly with lower salinity indicating Galway Bay water is drawing down even more CO2 than local shelf waters.

**Keywords:** climate change, pCO2, coastal waters, VOCAB

## Marine & Coastal 2 (L115)



**MC113 Rays and Skates in the Irish Sea**

Danielle Crowley, Jens Carlsson
School of Biology and Environmental Science, University College Dublin, Ireland.

Corresponding Author Email Address: danielle.crowley@ucdconnect.ie

Under ICES management, all ray and skate species in the Irish Sea are managed as one group, and not on a species-by-species basis. This is cause for concern as rays and skates tend to be particularly vulnerable to fishing pressures when compared to other fish species. Species level management is not currently possible due to a knowledge deficit of what species occur in this area. This project will use the cytochrome c oxidase subunit 1 (CO1) gene to conduct DNA barcoding of species sampled during a groundfish survey in the Irish Sea to assess if these species can be identified using DNA barcoding and how accurate the morphological identifications were. Samples consisted of both mucus swabs and tissue samples. The results so far indicate that the swabs were not able to produce usable DNA, however this may have been due to how they were stored, and that tissue samples can produce DNA of a high standard. Sequences obtained so far show that rays and skates can be identified using DNA barcoding in a short period of time, and that the morphological based identifications were correct. This indicates that rays and skates can be identified to a species level with relative ease and that it should be possible for ICES to manage them on a species level basis. Further research into this topic could involve optimising the use of DNA swabs as a non-invasive sampling technique, as well as minimising the harm done when tissue samples are taken.

**Keywords:** Elasmobranchs, CO1 sequencing, DNA barcoding, rays, skates, fisheries management, conservation



# Environ 2019

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AEngagement for Climate Action
29th Irish Environmental Researchers Colloquium

**POSTER PRESENTATION ABSTRACTS**
**(Listed by Theme)**

**Water Quality & Resources (WQ)**
**Ecotoxicology (ET)**
**Energy (EN)**
**Waste Management (WM)**
**Biodiversity & Ecosystems (BE)**
**Marine & Coastal (MC)**
**Sustainable Transport, Infrastructure,**
**Land Use & Agriculture (ST)**
**Sustainable Crop Science (SC)**
**Smart Technology and Nanotechnology**
**for the Environment (SN)**
**Environmental Management (EM)**

**WQ1 Development of the lake MImAS hydromorphological risk assessment tool in Ireland**

Caroline Wynne 1, Ailbhe Douglas 2, Bryan Kennedy 1, Ferdia Murray 3, Deirdre Tierney 1, Wayne Trodd 1
[1]Environmental Protection Agency, Johnstown Castle Estate, Co. Wexford.
[2]Local Authority Waters Programme, Mayo County Council, The Mall, Castlebar, Co. Mayo.
[3]Galway Mayo Institute of Technology, Dublin Road, Galway, Co. Galway.

Corresponding Author Email Address: c.wynne@epa.ie

Alterations to the hydrological regime and morphological character of surface water bodies are recognised as pressures on water quality globally. In the European Union, the Water Framework Directive requires that Member States characterise the hydromorphology of water bodies and assess any impacts from the pressures identified. As a first step to achieving this aim, the Lake Morphological Impact Assessment Tool was developed to characterise hydromorphological condition and gain insight into pressures. The current study presents outputs from a 224 lake survey in the Republic of Ireland, which augments previous field level assessments of hydromorphological condition, with desk-based assessment of aerial imagery, historical maps and geospatial data related to pressures. Results show that 14 % of monitored lakes have their levels actively controlled by the presence of a managed control structure, while at least 41 % have a passive control exerted on water levels, either through a control structure or drainage works on the outflow. Although data on the extent of abstractions is incomplete, pending voluntary registration through the EPA's Registration of Water Abstractions, current numbers indicate that a further control on lake levels through abstraction may be present for more than a third of monitored lakes. The outputs of the study allow the first large scale assessment of major hydrological alterations to our lake landscape by quantifying the extent of these pressures.

**Keywords:** hydromorphology, water management, abstraction, water level fluctuation, Water Framework Directive

**WQ2 Investigating the occurrence of Verotoxigenic E. coli (VTEC) in Irish private drinking water wells**

Murphy, M. 1, Stone, N. 1, O'Connor, L. 1, 2, Morris, D. 1, 2, Ryan, M.P. 3, Hynds, P. 4, O'Dwyer, J. 5 and Burke, L.P. 1, 2

[1]Discipline of Bacteriology, School of Medicine, College of Medicine, Nursing and Health Sciences, National University of Ireland Galway, Galway, Ireland.

[2]Centre for Health from Environment, Ryan Institute, NUI Galway, Ireland.

[3]Department of Chemical Sciences, School of Natural Sciences, University of Limerick, Limerick, Ireland.

[4]Environmental Sustainability and Health Institute, Technological University of Dublin (TUD), Dublin, Ireland.

[5]School of Biological, Earth and Environmental Sciences, University College Cork, Cork, Ireland.

Corresponding Author Email Address: liam.burke@nuigalway.ie

Approximately 750,000 people in the Republic of Ireland (ROI) get their drinking water from a private well, with many more served on a transient basis. Waterborne transmission of Verotoxigenic Escherichia coli (VTEC) through private wells has emerged as a likely infection pathway in rural Ireland, with cattle manure and septic tanks identified as probable sources of contamination and persistent heavy rainfall a contributing factor. VTEC infection is a notifiable and potentially deadly disease, with a low infective dose. Ireland has consistently had the highest incidence of human infection with VTEC in Europe, with 795 cases notified in 2017, 36.8% of which required hospitalisation3. This study aimed to investigate what proportion of E. coli isolated from private wells are verocytotoxigenic. A collection of E. coli isolated from private wells in the Mid-West region of Ireland1 were retrospectively analysed for the presence of the VTEC associated virulence factors vtx1, vtx2 and eae by real time PCR. Three of the 42 isolates (7.1%) were positive for vtx2. No isolates were vtx1 or eae positive. The VTEC isolates did not belong to any of the 6 most clinically important serotypes (O157, O26, O153, 0145, O111 and O104), as assessed by PCR, and were phenotypically susceptible to a panel of 16 human/veterinary antimicrobials. Private wells in Ireland are at increased risk of contamination with pathogenic strains of E. coli capable of causing human disease. This is preliminary data from an ongoing study, which will be the first to identify the extent to which Irish private wells are contaminated with VTEC. This study will help inform the development of policy to protect private well users.

**Keywords:** VTEC, E. coli, private wells, waterborne zoonosis

**WQ3 Remote sensing of Irish surface waters: INFER Project**

Kevin French 1, Jennifer Hanifan 2, Eleanor Jennings 1, Sita Karki 2, Valerie McCarthy 1, Alistar McKinstry 2, Vicky Veerkamp 1, Moataz Ahmed 2, Aaron Golden 3 and Conor Delaney 3
[1]Dundalk Institute of Technology, Dundalk, Co, Louth, Ireland.
[2]Irish Centre for High end Computing (ICHEC), IT302, IT Building, NUI Galway, University Rd, Galway.
[3]National University of Ireland Galway, University Rd, Galway, Ireland.

Corresponding Author Email Address: kevin.french@dkit.ie

Aquatic ecosystems are crucial for human well-being and have important functions in the environment. Their importance is well recognised through the implementation of national and international regulations, foremost being the EU Water Framework Directive. Management of these waterbodies needs an integrative and adaptive approach that can provide a comprehensive and reliable overview of current status. This in turn requires reliable and cost-effective monitoring programmes. Conventional monitoring is often time consuming, labour intensive, and costly. In many cases, this means waterbodies are sampled infrequently and at relatively few sampling points. Such low spatial and temporal resolution only provides a snapshot in time and does not allow for detailed studies of events and temporal trends, and also does not take short-term extreme events into account. Remote sensing is one option that can be used to address spatial and temporal limitations of traditional monitoring programmes, while also increasing the number of surface waters that can be monitored. Research has identified water quality parameters that have potential to be estimated using remote sensing. These include chlorophyll a (a proxy for phytoplankton biomass), water colour (a proxy for the concentration of coloured dissolved organic matter), turbidity, and related suspended sediment levels. The project aims to develop remote sensing products that will allow for improved efficiency and implementation of aquatic monitoring programmes. The aims are to: (i) Review existing lake, transitional and coastal waters (TRAC) datasets to produce a cohesive dataset of in-situ observations to match with satellite data, (ii) Develop an infrastructure for analysis of Earth observation data, to allow Earth observations to be compared with in-situ water quality parameters, (iii) Develop algorithms specifically adapted for lake and TRAC monitoring in Irish conditions, (iv) Conduct field validation of calibration models using newly collected in-situ data from a range of lake and TRAC water sites.

**Keywords**: remote sensing, earth observation, water quality, monitoring, lakes, coastal water

**WQ4 Environmental risk assessment of selected pharmaceuticals in three different Wastewater Treatment Plants (WWTPs), Riyadh, Saudi Arabia.**

Obaid Alharbi, David E. Jarvis, Deborah V. Chapman

School of Biological, Earth and Environmental Sciences, UCC

Contamination from pharmaceutical residues and their potential toxic risk to the environment is a growing concern among environmental scientists. These chemical residues have been detected in aquatic and terrestrial ecosystems at extremely low concentrations, but even these level (ug L-1 to ng L-1) can potentially have toxic effect. In this study, Acetaminophen (Paracetamol), Cephalexin, Metformin, Allopurinol and Baclofen in the influent and effluent of three wastewater treatment plants (WWTPs) in Saudi Arabia have been studied. These five compounds were chosen because of the high possibility that they could occur in the environment at concentrations that may pose a risk to human health and the environment. In order to evaluate the ecological risk of these pharmaceutical residues, a Risk Quotient method (RQ) was applied. Result to date indicate that Paracetamol concentrations are detected at a level higher than the other compounds. The concentration of Baclofen was just below the Limit of Quantification (LOQ) which was 0.1 ng L-1. This is the first reported occurrence of Baclofen in WWTP influents and effluents. Pharmaceuticals were measured at the King Saud University wastewater treatment plant (WWTP-KSU) were found to pose a higher risk (RQ≥1) than compounds detected at other WWTPs. This can be potentially attributed to wastewater from both King Khalid University Hospital (800 beds) and the University main campus which are discharged directly to this WWTP. Paracetamol in the WWTP-KSU inlet was estimated to pose a higher risk (RQ ≥ 1) than the other pharmaceuticals. RQ was evaluated as 3, 1 and 0.5 for Paracetamol, Cephalexin and Metformin respectively in this study. Risk Quotients were found to range from medium to low at the outlet of these WWTPs because of high removal rate in these tertiary treatment plants (≈90%).

**Keywords:** environmental risk assessment, contamination, wastewater, acetaminophen, RQ.

## Energy (EN)



**EN1 Assessment for a typical season of energy consumption, of autoproduction from wind, and suitable energy storage for onsite potato storage**

Gerard Reaburn, Paul MacArtain, Raymond Byrne
Centre for Renewables and Energy, Dundalk Institute of Technology.

Corresponding Author Email Address: gerard.reaburn@dkit.ie

In Ireland, to maximize their profitability, many larger arable farmers store their autumn harvested potatoes over the winter and spring months. This allows the selling of the produce onto the market in a more controlled way at a time and price that is more advantageous. The recommended temperature to store the potatoes is below 50C (ideally at our site 30C) to maximize their lifespan. However, when the potatoes are harvested their temperature is approximately 100C so potatoes entering storage require an intensive and controlled cooling cycle to prevent degradation and waste. Potato storage requires specific buildings and often cooling systems to produce the optimum storage conditions. This storage can be costly for the producer and the environment due to emissions related with the energy consumed. As Ireland moves towards decarbonising, the farming sector has an important part to play and energy use is one pillar to be assessed. In this research the energy consumption for potato storage and associated costs on a specific site was analysed for a typical storage period of October to March. The study matched the measured energy with the energy available from wind resource measurement on the same farm and also analysed the size and cycling frequency of energy storage on the customer side of the meter. The possibilities for summer potato storage to maximize shed usage all year round were also presented. A number of wind turbine options were investigated and optimised to possible battery solutions at 10kWh, 20kWh and 50kWh sizes. The economic benefit of the overall system depends on understanding the seasonal variability of the energy load at the site and matching that load with a dispatchable solution. The optimum financial return is from autoproduction, particularly as future Irish government policy limits reward for export from these types of systems.

**Keywords:** potato storage, energy, wind, PV, energy storage

## Energy (EN)



**EN2 Search for novel photovoltaic materials: first-principles study of alkali metal based bismuth chalcogenides**

Syam Kumar 1, Akinlolu Akande 1, Fadwa El Mellouhi 2, Stefano Sanvito 3
[1]School of Science, Institute of Technology Sligo, Ash Lane, Sligo, Ireland.
[2]Qatar Environment and Energy Research Institute, Hamad Bin Khalifa University, Doha, Qatar.
[3]School of Physics, Trinity College Dublin, Dublin 2, Ireland.

Corresponding Author Email Address: syamkumar.rameshkumar@mail.itsligo.ie

The 21st century is witnessing rising demands for an efficient and dependable alternative source of energy to substitute the rapidly depleting fossil fuels. Solar energy has been recognised as an excellent alternative but the ways of harvesting it is still a challenge. Silicon has been widely used as a photovoltaic material that converts photons in to electricity but the high cost of fabricating silicon solar cells and its indirect band gap restricts its usage. Lead perovskites were found to have good efficiency but the toxicity of Lead and the instability of the materials upon exposure to moisture limits its usage as well. Bismuth, which is less toxic than Lead and with its 6p-states in the lower conduction band, is expected to be a good replacement for Lead. We employ first-principles methods to model a few alkali-metal based ternary chalcogenides (ABiX2 and ABiX3, where A is either Sodium or Potassium and X either is Oxygen or Sulphur). The well-tested and computationally efficient Fritz Haber Institute - ab initio molecular simulations (FHI-AIMS) package was used to investigate their structural, electronic and optical properties. These materials were found to be stable by the formation energy analysis and were found to have band gap values in the range of 0.577 to 1.805 eV which lies in the far infrared-visible region of the electromagnetic spectra. It was found that ABiX2 type compounds have better profile for the Upper Valence Band (UVB) and Lower Conduction Band (LCB) over ABiX3 type compounds, which means that the ABiX2 compounds could exhibit better transport properties. Few of these materials were found to have direct band gap and hence promising. Further works are being carried out on the absorption and transport properties of these materials which could possibly serve as a suitable contender for photovoltaic applications.

**Keywords:** solar energy, photovoltaics, first-principle, alkali-metal based ternary chalcogenides

## Energy (EN)



**EN3 Ecosystem services within water protection and bioenergy production**

Laub Katharina, Pertagnol Joachim, Bur Anna
IZES gGmbH, Department Material Flow Management, Saarbruecken, Germany.

Corresponding Author Email Address: laub@izes.de

Existing biogas plants in France, Germany, Luxemburg and Wallonia are at risk, as for many facilities the funding through national compensation schemes is running out e.g. German Renewable Energy Act (EEG). From today's perspective, further use of existing biogas plants is not a possibility, and new plants except for those in France are not profitable any more. The regional biogas production is very important even nowadays. Here not only energy generation should be mentioned, but also the usage of digestate as an organic fertilizer. Moreover, there is a possibility to establish further new technologies on biogas plants (algae production and others), as energy and raw materials for a bio-based industry are present there. The project Persephone, funded by the programme Interreg VA Grande région (European regional development fund) focuses on the positioning of biogas production in the framework of bioeconomy in the region. Basis for this should be existing agricultural farms with biogas plants. The project investigates opportunities to improve water protection through biogas production and develops methods to integrate the fulfilment of ecosystem services by bioenergy production within existing remuneration systems for renewable energies.

**Keywords:** ecosystem services, bioenergy production, bioeconomy, water protection

## Energy (EN)



**EN4 Thermo-chemical conversion of waste cooking oil to biodiesel**

Ankit Singh, Rahul Chatterjee, Shrikant Mishra, Vishakha Raina
Kalinga Institute of Industrial Technology, Bhubaneswar, Odisha, India.

Corresponding Author Email Address: c00234155@itcarlow.ie

Utilization of waste cooking oil to produce biodiesel with a zero waste and no carbon emission (green chemistry) strategy in commercially viable, cost effective and sustainable approach. As a process to generate clean fuel, biodiesel from waste cooking oil can contribute to meeting the current energy demands of the nation, strengthen the national fuel security and bio-economy for a green ecosystem. Samples of waste vegetable oil were collected from 20 different point sources around Bhubaneswar from cafeterias in KIIT University, restaurant waste oil (RWO), University mixed batch (UMB), and used sunflower oil (USO). The samples were filtered, pre-treated, and processed by trans-esterification to their methyl esters for conversion into biodiesel. The processed samples were washed with water, heat dried and purified by magnesol and finally stored for fuel quality analysis. The biodiesel fuel quality results showed acid value within the range of 0.1682 mg KOH/gram of sample and 0.22 mg KOH/gram of sample, which are within the ASTM standard values (0.50 mg KOH/gram of sample). The pH value ranged from 7.1 to 8.20 (ASTM standard 7±1) and the soap content was between 32.06 ppm to 64.20 ppm, both of which lie within the standard ASTM values (66 ppm for KOH as catalyst). The density of the biodiesel sample majorly ranged between 0.86 gm /ml to 0.889gm/ml where the ASTM standard limit is 0.88±0.2. This study thus predicts that the objectives of initiating a waste management strategy along with generating clean energy would be a feasible option as a closed loop efficiency model in a university setup.

**Keywords**: waste cooking oil, biodiesel, sustainability, green chemistry

## Energy (EN)



**EN5 Techno-economics analysis of small-scale anaerobic digestion in an Irish dairy farm context**

Seán O'Connor 1, Aaron Black 2, Vignesh Kumaravel 1, Suresh Pillai 1, Ehiaze Ehimen 1, & John Bartlett 1
[1]Department of Environmental Science, Institute of Technology Sligo, Bellanode, Sligo, Ireland.
[2]South West College, Northern Ireland.

Corresponding Author Email Address: sean.oconnor2@mail.itsligo.ie

Small-scale anaerobic digestion (SSAD) is a promising technology for the treatment of livestock wastes and the organic fraction of municipal wastes. The technology uses a natural process in which microorganisms (hydrolytic, fermentative, acetogenic, and methanogenic bacteria) break down biodegradable material in the absence of oxygen producing biogas (a mixture mainly composed of carbon dioxide and methane). These systems are benificial for improving on-site energy generation, upgrading wastes and providing a nutrient-rich fertiliser from the digester effluents, while reducing pathogenic loads, odours and greenhouse gas emissions emanating from the agricultural processes. Small-scale farming processes can further exploit the portable and flexible options made available by implementing SSAD systems, to effect on demand conversion of organic waste streams to useful heat (and potentially electricity), with significant economic benefits accruable (especially when such energy carriers are exported). SSAD is particularly applicable to the Irish agricultural sector where the average dairy herd consisted of approximately 80 cows in 2016. Despite the apparent benefits of SSAD, the technology is still not well implemented, with much of the research to date focused on large-scale centralised systems. A literature search proved no previous assessment of SSAD looking specifically at the Irish context. This study seeks to shed light on the topic of SSAD by modelling the technical, environmental, and economic considerations for the construction and operation of an SSAD plant on commercial Irish dairy farms. These considerations include modelling the energy input/output, CO2 input and output, and financial indicators such as net present value (NPV), internal rate of return (IRR), and payback period. The study has been carried out under the EU INTERREG funded Renewable Engine project and works with an industry partner for the delivery and optimisation of a demonstration-scale SSAD unit.

**Keywords:** Anaerobic digestion, biogas plant, techno-economics analysis.

## Biodiversity & Ecosystems (BE)



**BE1 Analysis of the soil microbiome in response to the application of ecycling produced fertilisers under Irish grassland conditions**

Demi Ryan, Kieran Germaine, David Dowling
enviroCORE, Institute of Technology Carlow, Kilkenny Road, Carlow, Ireland.

Corresponding Author Email Address: demi.ryan@itcarlow.ie

Phosphorus is an essential nutrient for all living organisms. In plants, phosphorus is required to support several biological processes, with deficiencies ultimately resulting in stunted growth. Hence, phosphorus is very important as an agricultural fertiliser. However, phosphorus is usually applied to soils in the form of inorganic fertilisers, and with the worlds finite phosphorus resources depleting and the population growing, innovation in terms of phosphorus recovery has become more important than ever in order to maintain global food supplies. ReNu2Farm is a North-Western European project funded by Interreg, which aims to efficiently recycle nutrients from varying sources, such as ash from sewage sludge, poultry litter and struvite, for use as fertiliser, and to encourage replacement of inorganic fertilisers by farmers. Part of this project is to assess the impact of these recycling-derived fertilisers on the soil microbiome, which provides key ecosystem services to our planet. Thus, in order to maintain these services, it is crucial that the recycling-derived fertilisers exhibit no adverse effects on soil microbial diversity or biomass. Preliminary tests were conducted in greenhouse scale experiments through controlled pot trials using Irish grassland soil planted with perennial ryegrass. The trial assessed 4 recycling-derived fertilisers (2 struvite and 2 ashes), as well as a commercial inorganic fertiliser and a control (no P fertiliser) for comparison. Sampling for microbiome analysis took place at five time points, once prior to P application, then 2,4, 6 and 8 weeks after P application. DNA was extracted from the samples and sent to a sequencing company for analysis of bacterial 16S ribosomal DNA. The results are pending and will be used to inform a field trial beginning in late spring 2019.

**Keywords:** soil microbiome, recycling-derived fertilisers, phosphorus

**BE2 Two-way engagement with stakeholders to improve biosecurity around invasive alien species in the workplace**

Eithne Davis 1, Sonia Vanderhoeven 2, Emily Smith 3, Caitriona Shannon 4, Stephanie Bradbeer 4, Joseph M. Caffrey 5, Julien Carlier 1, Neil Coughlan 6, Jaimie Dick 6, Sara Meehan 1, Frances E Lucy 1

[1]Centre for Environmental Research, Innovation and Sustainability, Institute of Technology, Sligo, Ireland.

[2]Belgian Biodiversity Platform, Brussels, Belgium.

[3]University College, London, UK.

[4]School of Biology, Miall Building, University of Leeds, Leeds, LS2 9JT, UK

[5]INVAS Biosecurity, Dublin, Ireland.

[6]Queens University, Belfast, Northern Ireland, UK.

Corresponding Author Email Address: Eithne.Davis@mail.itsligo.ie

Being an island means that Irelands biodiversity is particularly vulnerable to the threat of invasive alien species (IAS). However, islands also offer greater opportunities for protection from IAS than individual states in a continental land mass. Promoting good biosecurity and a strong sense of biosecure citizenship must become a priority among the broad range of stakeholder groups who engage in risky behaviour for the spread of IAS. In April 2017, a daylong workshop, part-funded by the ESAI Grassroots Workshop Support Scheme, took place at the Institute of Technology, Sligo. This workshop drew together a broad range of stakeholders, from state-sponsored competent authorities, to consultants, members of community groups and recreational water-users. The measureable outcomes from the workshop were a repeated survey, plus the collated outputs from an elicitation session. Rather than identifying any specific species, the emphasis for the workshop was on practicing good generic biosecurity. With a small amount of guidance towards reliable sources of information, participants reported an increased confidence in identification skills. The most significant change after the workshop was in participants' confidence in designing good biosecurity plans and carrying out effective biosecurity measures in the field. Of those who attended, 93.8% reported that their behaviour would change as a result of the workshop. The facilitated elicitation process identified some of the existing obstacles to practicing good biosecurity in the workplace, drawn from participants' experience on the ground. During the elicitation process, extensive information was gathered in the form of a prioritised range of obstacles affecting participants' ability to engage in effective biosecurity, and a list of opportunities that these stakeholders perceived as open to promoting good biosecurity. This information is now available to managers and policy-makers to inform future biosecurity measures on the island of Ireland, and is potentially transferrable to other jurisdictions.

**Keywords:** invasive species, biosecurity, stakeholder engagement

**ST1 Factors that affect willingness of a segment of the Irish population to try insects**

Briana Kane and Maria Dermiki
School of Science, Institute of Technology Sligo, Ash Lane, F91 YW50, Sligo, Ireland.

Corresponding Author Email Address: dermiki.maria@itsligo.ie

Entomophagy (the practice of eating insects) is growing in popularity in some European countries as a nutritious way to reduce global warming. Insects are a highly sustainable food source, needing far less resources and producing far less greenhouse gases than traditional farm animals. While several consumer acceptance studies have been carried out in some Western societies, there is currently no information on people living in Ireland. The aim of this study was to explore the factors that affect willingness to try (WTT) insects between students and staff from IT Sligo. An online survey was used and 333 responses were received. The effect of sociodemographic characteristics, knowledge and previous exposure to entomophagy, diet, food neophobia, opinion on meat, health consciousness and environmental consciousness on WTT were all assessed in the survey. Gender, diet, previous knowledge, previous experience, neophobia and meat score significant affected WTT insects. Age, education level, nationality, course, frequency and quality of experience, environment score and health score had no effect on WTT. Males were more willing than females and vegetarians were less willing than those on non-specific diets. Those with previous knowledge of entomophagy and previous exposure were more willing to try them. The more food neophobic a person and the stronger a person's opinion about meat, the less willing they were to try insects. The findings present a clear marketable Irish demographic; males with no specific diet who are adventurous in their food intake and who have a weak attachment to meat. The findings also suggest that education and taste tests will be useful for improving WTT insects in Ireland. Despite the fact that the results of this study offer important information on WTT insects, future surveys should focus on a representative sample of the population in the island of Ireland.

**Keywords:** entomophagy, food neophobia, willingness to try (WTT)

**ST2 Sulphur response in grassland: soil and season effects**

Claire Aspel 1, 2, Paul N.C. Murphy 2, 3, Patrick J. Forrestal 1

[1]Soils, Land Use ad Environment Department, Teagasc, Johnstown Castle

[2]School of Agriculture and Food Science, University College Dublin, Dublin 4

[3]UCD Earth Institute, University College Dublin 4

Corresponding Author Email Address: Claire.Aspel@teagasc.ie

Growing the Agriculture industry and achieving the goals of the Food Wise 2025 strategy will require further optimisation of grassland production potential and sulphur (S) nutrition has an important role to play. Sulphur is essential for optimised crop yield, quality and nutrient use efficiency, particularly of nitrogen. Atmospheric deposition of S has declined in recent decades while grass yields have increased. Sulphur deficiency may, therefore, be more prevalent than in the past. However, S response is likely to vary considerably across soil and seasons. Sulphur, an essential nutrient has received less attention with the focus on the lime, nitrogen, phosphorus and potassium. When these nutrients are supplied in the correct amounts, S deficiency will still limit the yield and quality of crop. The objective of the current studies is to investigate the response to sulphur application in perennial ryegrass across seven different soil series under the same environmental conditions using an existing lysimeter facility. The experimental treatments are, calcium ammonium nitrate (CAN) (27%N) and CAN+5%S delivered as SO4- and a zero N control. The annual N rate for the fertiliser treatments was 200kg N/ha. Fertilizer was applied in six applications beginning at the end of January with the last application in September. Preliminary results show large variation in S response across soil series to annual yield. Out of the seven soils four showed a significant response to sulphur (P≤0.05). The largest sulphur response gave 1.7t DM/ha more than the CAN treatment. The annual additional yield response to S ranged from -4% to 25% across the seven soils. Sulphur response also varies across the growing season. Results suggest the need for better understanding of soil and time of year effects on S availability so that fertiliser programmes can be optimised for S.

**Keywords:** agriculture, sulphur, deficiency, perennial ryegrass, crop yield, crop quality, lysimeter

**ST3 The use of waste from Black Soldier Fly (Hermetia illucens) farming as an organic fertilizer**

Daniele Cristina Souza & Caroline Gilleran Stephens
Department of Agriculture, Food & Animal Heath, Dundalk Institute of Technology, Dublin Road, Dundalk, Co. Louth, Ireland.

Corresponding Author Email Address: caroline.gilleranstephens@dkit.ie

As global population expands into the future at an alarming rate, the potential impact of the inevitable increased demand for food and alternative protein sources for both human and animal consumption is of huge environmental concern. This demand for protein presents a huge global challenge in terms of increasing production in a sustainable and low-carbon manner. Proteins are an important component in animal feeds and conventional feed resources include soymeal and fishmeal, however, these are costly and their long term viability poses a challenge. Insect farming has the potential to offer a low carbon solution to this problem, due to the low land and water requirements and the ability of insects to feed on food waste. However, the environmental impact of the mass production of insects must be evaluated and all waste outputs from the process investigated. Black soldier fly, Hermetia illucens, is capable of efficiently converting a wide variety of organic wastes including fruit waste, vegetable peelings and manure into insect biomass. Black Soldier Fly Larvae (BSFL) can be harvested with ease and is valued as source of protein. This study looks at the outputs from this process, the organic waste not consumed by the insects and their nitrogen rich frass and investigates the use of these residues as an organic fertilizer, generating value and closing nutrient loops.

**Keywords:** black soldier fly, insect frass, industrial ecology, Hermetia illucens, fertiliser

**ST4 Building information modelling: design, life cycle assessment of infrastructure and life cycle costs of case-study aquaculture systems**

Gareth Diver 1, Laura Patton 1, Eoghan Clifford 1, 2, Ronan Cooney 1, 2

[1]College of Engineering and Informatics, National University of Ireland Galway, University Road, Galway, Ireland.

[2]Ryan Institute, Environmental, Marine, and Energy Research, Martin Ryan Building, National University of Ireland Galway, University Road, Galway, Ireland.

Corresponding Author Email Address: L.Patton1@nuigalway.ie

Globally, aquaculture has been the fastest growing food industry over the past three decades whilst during the same period Irish aquaculture has stagnated or even reduced in terms of output. However, given challenges in relation to food security, climate change and the need for sustainable food production, aquaculture in Ireland can assist in meeting government initiatives such as FoodWise 2025 and national climate targets. There is room for large growth in the sector and it is envisaged that by 2023 there will be an increase of 45,000 tonnes in output from the Irish aquaculture sector. Building information modelling (BIM), which has previously been underused in the aquaculture industry can connect key areas such as facility design, economic sustainability and environmental sustainability leading to more efficient output from the sector. Combining BIM with Life Cycle Assessment (LCA) and Life Cycle Costing (LCC) offers designers and farmers the opportunity to increase operational efficiency, make informed environmentally conscious decisions and improve on the design of aquaculture infrastructure. To date there have been no studies that have linked the potential of using BIM in conjunction with LCA tools to improve both facility design and operation in this sector. This study models two freshwater pond-based aquaculture systems using BIM and considers the current environmental and economic impacts associated with their construction and operation. Using the models of the current systems, upgrades to the infrastructure and implementation of new technologies can then be applied to the systems within BIM to determine how the environmental impact varies with the upgrade and investment. This study demonstrates that environmental tools such as LCA and civil engineering tools such as BIM can be combined to enable improvements to infrastructure design and operation.

**Keywords**: aquaculture, building information modelling, life cycle assessment, life cycle costing, sustainable infrastructure

## Smart Technology and Nanotechnology for the Environment (SN)



**SN1 A risk ranking model for prioritising ENPs of human health concern**

Yingzhu Li, Enda Cummins
UCD School of Biosystems and Food Engineering, University College Dublin, Belfield, Dublin 4, Ireland.

Corresponding Author Email Address: li.yingzhu@ucdconnect.ie

As nanotechnology has been introduced into a multitude of industrial sectors, engineered nanoparticles (ENPs) have emerged in many everyday products. Their unique physicochemical characteristics have been shown to be different from bulk forms leading to uncertainties regarding potential hazards to human health. Therefore, it is essential to carry out a comprehensive risk assessment for ENPs to guide risk managers in terms of ENP safety issues. In this study, a risk ranking model is created to prioritise 10 of the most commonly used ENPs. A risk scoring system was developed to characterise quantities used in consumer products, exposure pathways and potential toxicity (dermal, inhalation and oral routes). Nano-TiO2 was ranked as the most critical ENP within Europe, which could be mainly ascribed to potential exposure through large quantities of consumer products. AgNP, as the second most critical type of ENPs, is also of human health concern due to potential exposure through environmental sinks, especially through water sources. Key information in establishing a risk assessment for ENPs is provided by this study, including data gaps, which can pave the way for the further quantification of potential risks. The necessity of risk management for ENPs is emphasised not only during manufacturing, but also during waste disposal processes of nanomaterials.

**Keywords:** engineered nanoparticles, risk ranking, health and safety

## Ecotoxicology (ET)



**ET2 Nematode bioindicators to study the ecological impact of recycling derived fertilisers**

Anna Karpinska, Thomais Kakouli-Duarte
Molecular Ecology and Nematode Research Group, enviroCORE, Department of Science and Health, Institute of Technology Carlow, Kilkenny Road, Carlow.

Corresponding Author Email Address: anna.karpinska@itcarlow.ie

Soil is a major source of nutrients needed for plant growth. The three main such nutrients, nitrogen (N), phosphorus (P) and potassium (K) have been applied so far by farmers via artificial mineral fertilisers whose production, mining and transportation require large amounts of energy. In addition, the global demand for recycled phosphorus is increasing mainly due to a growing human population, food consumption and resource depletion. The ReNu2Farm project is designed to increase the recycling rates of these plant nutrients in the primary food production chain in Northwest Europe (NEW). In this project recycling-derived fertilisers (RDF) are produced from three large waste streams such as sewage sludge, food waste and manure in the form of struvite or ash, aiming in the long-term to replace usage of artificial mineral fertilisers with RDFs in farms. Part of the project involves the investigation of the ecological impact of RDFs by studying their effects on nematodes in single species ecotoxicology experiments and via terrestrial nematode community analyses. The project will thus investigate the effects of RDF on (1) beneficial entomopathogenic nematodes (EPN, Steinernema feltiae) in microcosm experiments looking at nematode infectivity and reproduction, (2) Caenorhabditis elegans in toxicity bioassays observing nematode growth and reproduction, and (3) nematode communities in RDF testing field trials. In the community analyses nematodes will be extracted from soil samples, morphologically identified and assigned to trophic groups. Nematode abundance and biomass will be examined to exclude any adverse effects of RDFs on soil nematode diversity compared to that in control sites.

**Keywords**: recycling derived fertilisers, nematode, toxicity, ecological risk assessment

## Ecotoxicology (ET)



**ET3 Nematology and the environment: a worm's tale**

Thomais Kakouli-Duarte
Molecular Ecology and Nematode Research Group, enviroCORE, Department of Science and Health, Institute of Technology Carlow, Kilkenny Road, Carlow R93 V9690, Ireland.

Corresponding Author Email Address: thomae.kakouli@itcarlow.ie

Nematodes are microscopic (mostly), non-segmented round worms, with great environmental significance, inhabiting nearly every habitat on the planet, terrestrial or aquatic and, in the latter case, marine or freshwater. They can be parasitic to animals and plants or can be free-living in their environment, feeding on bacteria, fungi, or other nematodes. As they occupy intermediate positions in food webs and their communities are sensitive to environmental disturbance, disturbance in these communities reflects disturbance in other ecosystem components. These facts, together with the facts that they are representative of their habitats and are easily extractable from soils and sediments, render them ideal as indicators of environmental change. In addition, certain species are easily culturable and thus easily amenable to laboratory based ecotoxicity experiments. Interest in nematode research, however, is also relevant in the context of food security, particularly in sustainable crop protection practices. Entomopathogenic nematodes (EPN), parasitic to insects, provide effective alternatives for integrated pest management systems against important soil and cryptic insect pests. Plant parasitic nematodes (PPN) pose a global challenge for crop production due to vast crop loses they cause and, at the same time, due to the fact that conventional chemical nematicides are heavily regulated because of environmental health and protection concerns. This presentation will provide an overview on the environmental nematode research carried out by the Molecular Ecology and Nematode Research Group of enviroCORE, IT Carlow, in recent years. Highlights will include the application of nematodes as environmental bioindicators and, specifically, the development of the EPN Steinernema feltiae as a sentinel of heavy metal toxicity, in the context of environmental biomonitoring. In the context of sustainable food security, the presentation will showcase studies on the interactions of nematodes with plant growth promoting bacteria and on sustainable PPN management approaches.

**Keywords:** nematode, environmental change, bioindicator, environmental biomonitoring, entomopathogenic nematodes, Steinernema feltiae, plant parasitic nematodes, sustainable food security, sustainable crop protection

**WM1 Recovery of polyphenols from wine-making residues using colloidal gas aphrons (CGA)**

Paula Jauregi 1, Maria Dermiki 2, Giorgia Spigno 3
[1]University of Reading, UK.
[2]Institute of Technology Sligo, IRELAND.
[3]Università Cattolica del Sacro Cuore, ITALY.

Corresponding Author Email Address: dermiki.maria@itsligo.ie

Although wine production takes place in a small number of countries around the world, it results in the generation of substantial quantities of residues with potential detrimental effects for the environment. Among these residues, grape skins contain significant amounts of bioactive compounds such as phenolic compounds with proven benefits to human health and potential applications as food ingredients. Organic solvents are usually used for the extraction of phenolics from grape skins, however there is a tendency to minimise the use of these solvents in favour of environmentally friendly processes. Colloidal gas aphrons (CGAs), which are surfactant stabilised microbubbles, can be used in separation processes due to their unique characteristics of high interfacial area, high stability compared to conventional foams, ability to be pumped and to separate easily from the liquid phase without mechanical aid, reducing in this way the number of operations for product purification and making them a potential integrated cost- and energy- efficient separation technique. Recovery of compounds is also affected by the type of surfactant used (anionic, cationic or non-ionic). The current study focuses on the use of the non-ionic food grade surfactant Tween 20 in order to recover phenolic compounds from grape skins. A number of operational factors, such as pre-treatment of grape skins with ethanol, concentration of surfactant and ethanol to surfactant ratio, were tested for their effect on the recovery and antioxidant activity of the recovered product. Recoveries up to 52% were achieved at ethanol to surfactant ratio of 1/24. Interestingly, the use of Tween 20 did not affect the antioxidant activity (AOC %), as determined using the ABTS assay. At an ethanol to surfactant ratio of 1/24, the antioxidant activity of the recovered aphron phase was at 60% AOC comparable to 58% AOC at the same total phenolic concentration (200 mg gallic acid/L).

**Keywords:** colloidal gas aphrons, polyphenols, recovery, non-ionic surfactant

**WM2 Investigating the role of bacteria in the performance of duckweed ponds as wastewater bioremediation units**

Bianca Govi1*, Niall O'Leary 2, 3, Marcel A.K. Jansen 1, 3

[1]School of Biological, Earth and Environmental Sciences, University College Cork, Distillery Fields, North Mall, Cork.

[2]School of Microbiology, University College Cork, Cork.

[3]Environmental Research Institute, University College Cork, Lee Road, Cork.

*Corresponding Author Email Address: 114711075@umail.ucc.ie

Duckweed ponds are a promising biotechnological solution for the treatment of dairy processing wastewater due to these plants' ability to uptake nutrients and store them in harvestable form. Duckweeds (family Lemnaceae) are not, however, the only biological agents in wastewater treatment ponds, with microbial processes also playing a major role in water chemistry regulation and nutrient cycling. The present study aims to investigate (1) the microbial diversity found in a commercial dairy processing wastewater treatment facility in Co. Cork and (2) run a laboratory scale experiment to assess the impact of bacterial presence on growth, development and nutrient uptake by Lemna minor. The first objective involved sampling of wastewater and naturally occurring duckweed material from the final polishing tank of the dairy facility. Samples were used to assess the microbial diversity in bulk water, through culture-dependent isolation techniques combined with 16S ribosomal RNA gene amplification, Restriction Fragment Length Polymorphism (RFLP) profiling and sequencing of unique representatives. Additionally, duckweed-associated, and endophytic microbial communities were studied using the same techniques. The second objective required the development of a reliable plant sterilisation protocol. Once axenic duckweed cultures were established, Lemna minor was reinoculated with selected bacteria and growth experiments were run to assess the performance of axenic and re-inoculated plant cultures in terms of growth and water remediation. This research is designed to integrate knowledge about the different processes involved in the bioremediation of wastewaters and help develop next generation integrated systems employing cross-kingdom interactions for optimal remediation and recovery efficiency.

**Keywords:** bioremediation, circular economy, plant science, microbiology

## Waste Management (WM)



**WM3 The GREENER project: Multi-System Approaches to Improving Bioremediation**

Kieran Germaine 1, Xuemei Germaine 2, Mary-Jo Hurley 2, David Dowling 1

[1]enviroCORE, Department of Science and Health, Institute of Technology Carlow, Kilkenny Road, Carlow, Ireland.

[2]MicroGen Biotech Ltd. Unit Enterprise and Research Incubation Centre, Institute of Technology Carlow, Green Road, Carlow, Ireland

Corresponding Author Email Address: David.Dowling@itcarlow.ie

The GREENER project (an acronym for Inte**GR**ated systems for **E**ffective **EN**vironm**E**ntal **R**emediation) involves 17 European and four Chinese partners and has a total budget of just under €7 million. It is part of a flagship EU-China collaboration program designed to stimulate research co-operation between Europe and China. Both Europe and China have serious environmental pollution issues. For example, on the island of Ireland, it is estimated that there are about 2000 sites considered to be polluted by the Environmental Protection Agency (EPA). Traditional methods of treatment such as 'dig and dump' are expensive, destructive to local ecosystems and so not very practical for treating large polluted sites. The GREENER project will investigate the use of bioremediation (using plants, bacteria, and fungi) to remove toxic pollutant from soil, air and water. Bioremediation has been around for decades, and has the advantages of being relatively cheap and environmentally friendly. However, its use in treating environmental pollution is limited due to the fact that it is a slow process and the range of pollutants that it can be used to treat is quite limited. The GREENER project will look at the use of synergistic bioremediation technologies in conjunction with other physical treatment methods (e.g. electrochemistry) to effectively remove pollutants from water and soil/sediments, while generating side products of interest, such as bioelectricity. Fundamental research will be performed at lab-scale, while pilot-tests will be used to prove the feasibility and cost effectiveness for large scale clean-up applications both in Europe and in China.

**Keywords:** Bioremediation, Horizon 2020, Metagenomics, electrochemistry

**WM4 Improving biogas yield by anaerobic co-digestion of chicken litter with grass silage and treating with fungal enzyme cocktail**

Navodita Bhatnagar 1, 2, David Ryan 1, Richard Murphy 2, Anne-Marie Enright 1
[1] enviroCORE, Institute of Technology Carlow, Kilkenny Road, Ireland.
[2]Alltech, Dunboyne, Co. Meath, Ireland.

Corresponding Author Email Address: navodita.bhatnagar@itcarlow.ie

Anaerobic digestion (AD) is a popular technology nowadays as its benefits are threefold viz. mitigating greenhouse gas (GHG) emissions, reduction of waste volume and renewable energy generation. Waste materials which are rich in organic matter can be used as AD feedstocks, for example- agriculture waste like animal manure or crop residues. In particular, the Irish poultry industry is well established and generates large volumes of waste which is currently land spread or used as compost. Approximately 39,519 tonnes of chicken litter (CL) by dry weight is produced annually in Ireland. Direct land spreading which can cause eutrophication due to surface runoff. AD can be a sustainable alternative for disposal of such wastes while also producing gaseous fuel. However, AD of CL as its own challenges, especially, ammonia inhibition and volatile fatty acid (VFA) accumulation. Recently, enzyme supplementation and co-digestion has been shown to enhance biomethane production via AD through improving substrate bioavailability to the microorganisms and improving nutrient balance respectively. In the present study, biomethane potential (BMP) assays were conducted for 22 days in 150 ml serum bottles at 37°C and treated with 6 different enzyme concentrations. Highest specific methane yield (SMY) was obtained for 1% enzyme treatment – 591.7 ml CH4/ g VS which is 26% increase compared to the untreated control and 139% increase compared to untreated single substrates. The combined effect of co-digestion and enzyme treatment is highlighted in these findings.

**Keywords**: anaerobic digestion, specific methane yield, enzyme cocktail, biomethane potential

**WM5 Re-use of decommissioned wind turbine blades and circular economy**

Heloisa Lemmertz 1, 2
[1]Department of Sociology, University College Cork, Western Road, Cork, Ireland.
[2]CPPU, School of Engineering, University College Cork, College Road, Cork, Ireland.

Corresponding Author Email Address: h.lemmertz@umail.ucc.ie

Wind energy is widely considered one of the more sustainable options for energy, due to its potential to produce renewable clean energy in large amounts. This not only avoids the use of fossil fuel resources, but also prevents the generation of associated greenhouse gases. Yet, is this source of renewable energy fully sustainable, when one considers the environmental and social implications of the end-of-life management of the wind turbines and blades? The Re-wind project addresses this challenge for a significant part of the wind turbine – the blade. Our research aims to devise options for the reuse of wind turbines blades, after decommissioning. The project takes an innovative multidisciplinary approach with the objective of finding solutions that are environmentally preferable, economic feasible and socially acceptable. Devising sustainable approaches for the end-of-life management of the large composite blades found in wind turbines poses a significant challenge. The Re-Wind project takes a circular economy view, wherein the objective is retention of value, and minimisation of waste, and waste materials are seen as resources to be used. This concept provides a coherent framework for systems level redesign and as such offers us an opportunity to channel innovation and creativity to enable a positive, restorative economy. In this perspective, today`s goods are tomorrow`s resources, forming a virtuous cycle that fosters prosperity in a world of finite resources. This paper reports on the initial explorations on the circular economy concepts to this interesting and visible waste material, and outlines the work to be undertaken in devising and evaluating reuse options. "Funded under the Re-Wind project (Science Foundation Ireland/National Science Foundation/Department for the Economy of Northern Ireland US/Ireland R&D Partnership Programme, SFI grant no. 16/US/3334".

**Keywords:** circular economy, wind turbine blades, reuse

## Waste Management 2 (L114)



**WM6 An examination of a peer to peer education programme for recycling behaviour in Ireland**

Tadeusz Kirakowski
VOICE Ireland, 9 Upper Mount Street, Dublin 2, Ireland.

Corresponding Author Email Address: tad@voiceireland.org

Through 2018 the Irish government funded a peer to peer social marketing campaign aimed at increasing recycling in the home; the Recycling Ambassador Programme. Historically civil society has not been at the centre of recycling policy in Ireland. Ireland currently suffers from high rates of contamination of recycling waste, the use of a single mixed dry recyclable presents particular issues in this regard. Peer to peer communication has been identified as a key driver of behaviour change rather than top down advertisements. This approach works through building a subject norm within the community. Similar approaches have been taken in other European jurisdictions, successfully applying the theory of planned behaviour model to increase recycling rates and number of households engaged in such behaviours. Through the programme the Recycling Barriers and Behaviours survey was filled out which asked participants about their attitudes towards recycling and the infrastructure in their area. Five thousands surveys were gathered at workshops and events across the country, and of these over 1000 were digitised for analysis. This paper examines the Recycling Ambassador Programme as a method of education on sustainability and uses data gathered through the survey to examine public attitudes towards recycling in Ireland. Finally this paper seeks to examine how future communications on waste and materials could implement similar initiatives.

**Keywords:** recycling, waste, communication, circular economy, theory of planned behaviour

## Marine & Coastal (MC)



**MC1 The SURICATES Project – An approach to beneficial use of dredged sediment for flood protection and erosion control**

*O' Sullivan. R 1, Harrington, J 2.
[1]Department of Civil, Structural and Environmental Engineering and Sustainable Infrastructure Research & Innovation Group, Cork Institute of Technology.
[2]School of Building & Civil Engineering and Sustainable Infrastructure Research & Innovation Group, Cork Institute of Technology.

Corresponding Author Email Address: ross.osullivan@mycit.ie

The EU INTERREG North West Europe SURICATES project aims to increase beneficial sediment use for erosion control and flood protection in coastal and river environments. The project involves the application of pilot projects at selected river and harbour sites supplemented by detailed social, economic and environmental analyses. The aim of the project is to provide local authorities, port and waterway managers and national agencies with new large-scale solutions for sediment use in North West Europe. Dredging, the removal of sediment from the bed in the aquatic environment, is a necessity for national and international maritime transport and the sustainable recovery of dredged sediment to maintain navigable waterways is central to the successful operation of ports and harbours. The significant challenge is to ensure greater beneficial use of dredged sediment and the SURICATES project is targeted at sustainable sediment use to address flood protection and erosion control in the general context of the circular economy. Flood protection and bank erosion control are significant issues in an Irish context and the research work will include investigation of the potential beneficial use of dredged sediments particularly in the context of the internationally-recognised 'Building with Nature' approach. Specific suitable harbour and/or river sites in Ireland will be chosen and their potential assessed for implementation of a range of beneficial use options including bank nourishment and protection, wetland creation and mudflat restoration. This assessment will involve detailed economic and environmental modelling work.

**Keywords:** dredging, sustainable, beneficial use, flood protection, erosion control

## Sustainable Crop Science (SC)



### SC1 Development of new strains of Agaricus bisporus with better biological efficiency for compost utilization

Ankit Singh 1, 2, Brian O'Rourke 1, Helen Grogan 2, Carloalberto Petti 1
[1]enviroCORE, Department of Science and Health, Institute of Technology Carlow, Carlow, Ireland.
[2]Horticulture Development Department, Teagasc Research Center, Ashtown (Dublin).

Corresponding Author Email Address: c00234155@itcarlow.ie

The major region for mushroom production in Ireland is Cavan/Monaghan along with significant contributions from Carlow, Kildare, Mayo, Meath, Westmeath and Tipperary. Mushroom compost is made of straw (60-70%), poultry or horse manure (28-34%), gypsum (2-4.5%), hay and optional ingredients such as corn stover. The process of composting encompasses 35% of entire production cost. In 2017 Ireland produced 69,000 tons of mushroom and for every kilogram of mushroom approximately, 5 kilogram of compost is produced. Substantial amount of nutrients remains trapped in the compost even after three subsequent flushes which is the normal duration of harvest. For an industry driven by narrow profit margins; better utilization of compost by mushroom could lead to higher yield of the crop and better revenues. The productivity of crop decreases with increasing age which makes it less economically feasible to maintain the crop after the third harvest. Improvement in biological efficiency of mushroom strains to absorb nutrients from the compost over three flushes can increase the yield per tonne of compost. The current project aims at characterising new variants of Agaricus bisporus which may differ in their pattern of compost utilization due to differences in lignocellulosic enzyme production. The variants are being analysed for in-vitro growth patterns and for productivity of lignocellulosic enzyme. Correlation studies are establishing rates of growth, enzyme productivity with compost utilization.

**Keywords:** agaricus bisporus, mushroom compost, lignocellulosic enzymes

**SC2 Estimating the potential of Fourier transform infrared spectroscopy as a novel tool for nematode characterisation**

Aoife Egan, Thomais Kakouli-Duarte
Molecular Ecology and Nematode Research Group, enviroCORE, Department of Science and Health Institute of Technology Carlow, Kilkenny Road, Carlow, Ireland.

Corresponding Author Email Address: aoife.egan@itcarlow.ie

Nematodes are diverse complex multicellular organisms that have various life strategies, ranging from free-living to plant parasitic (PPN). PPN are responsible for up to 21% loss of crop yield worldwide with an estimated crop loss of $121 billion globally. Due to this, there is a demand for a rapid and reliable nematode identification system to aid PPN management. Nematodes are one of the most difficult organisms to identify, due to their indistinguishable features and microscopic size. Classical nematode identification techniques are time-consuming and require a high level of expertise and training. Fourier transform infrared (FT-IR) microspectroscopy has been utilised in the identification, classification and characterisation of other organisms. This technique is advantageous as it can rapidly produce the spectra of microorganisms without the need for complex extraction methods or equipment. This technique can also produce results much quicker than traditional identification methods. This study investigated the capacity of FT-IR microspectroscopy to determine unique fingerprint regions between nematode species, with a further aim to develop the technique for nematode identification. The absorption spectra of seven different nematode species from lab reared cultures and from soil extracted samples, were recorded and assessed. The analysis identified specific fingerprint regions for the nematodes Steinernema feltiae, S. carpocapsae, Heterohabditis bacteriophora and Meloidogyne javanica. The results suggest the PPN M. javanica is the most suitable nematode for FT-IR analysis as determined by agglomerative hierarchical clustering and principle component analysis. This technique shows promising potential for further development and could be utilised as a key factor in the decision making for PPN management and the implementation of adequate control measures in the future.

**Keywords:** Fourier transform infrared microspectroscopy, fingerprint region, nematode identification

**SC3 Symbiotic biodiversity in six Irish terrestrial orchids**

Carloalberto Petti
enviroCORE, Department of Science and Health, Institute of Technology Carlow, Kilkenny Road, Carlow, Ireland.

Corresponding Author Email Address: Carloalberto.petti@itcarlow.ie

Orchids are plant species that belong to the Orchidaceae family, the second largest, in order of species abundance, in the plant kingdom with more than 25000 species and a nearly similar number of commercially developed hybrids. The minuteness of seeds, thus the absence of nutrients for the seeds germination and growth, have led to the development of an intricate symbiotic relationship between orchid's roots and fungal species known as mycorrhizae. Ireland's terrestrial orchids diversity is numbered at 30 species amongst which the endemism Dactylorhiza occidentalis, a rare occurring orchid. The Burren is a protected area and a known region rich in plant species including a great diversity of orchids. The project aims at harnessing the potential of orchid's mychorrizal diversity for preservation purposes and for sustainable agriculture. Six different species were collected, from non-protected areas, bearing the subterraneous tubers. The species were Ophrys insectifera, Listera ovata, Dactylorhiza maculata, Orchis mascula, Platanthera bifolia and Dactylorhiza occidentalis. Collected soil and tubers were used to isolate root-associated bacterial and fungal species. Contrary to expectations, a great similarity was shared between all the species with an 80-90% of similarity at bacterial level and 70-80% at fungal level. Fungal diversity showed a surprising number of Fusarium species amongst the fungal isolates. The potential for root colonization, mycorrhizae development and plant growth promoting will be established on selected plant species which will include terrestrial orchids and crop species.

**Keywords:** conservation biology, mycorrhiza, mycorrhizal fungi, microbial population, Orchidaceae sustainable agriculture

## Environmental Management (EM)



**EM1 A geographic information systems approach to mapping and analysing the sources and transmission routes contributing to the dissemination of environmental antibiotic resistance**

Carlos Chique 1, John Cullinan 1, Brigid Hooban 2, 3, Dearbháile Morris 2, 3
[1]Discipline of Economics & Health Economics and Policy Analysis Centre,
National University of Ireland, Galway.
[2]Centre for Health from Environment, Ryan Institute, National University of Ireland, Galway.
[3]Antimicrobial Resistance and Microbial Ecology Group, School of Medicine, National University of Ireland, Galway.

Corresponding Author Email Address: b.hooban1@nuigalway.ie

Antimicrobial resistance (AMR), which stems from the overuse of antimicrobials in both healthcare and agriculture, is one of the leading threats to human health worldwide. The identification of sources of antimicrobial resistant organisms (AROs) and their transmission routes in the environment is important for improving our understanding of AMR dissemination beyond the clinical environment and to inform policy and monitoring systems. Sources of AROs include 'hotspots' of antibiotic usage, such as hospitals and nursing homes, while transmission routes refer to the 'medium' facilitating ARO mobility and expansion in the environment. The purpose of this mapping exercise is to analyse the spatial distribution of AMR sources and transmission routes and to identify potential locations suitable for sampling in the context of the EPA-funded 'AREST' project. The GIS analysis is undertaken for four local authority (LA) areas, namely Fingal Co., Cork Co., Galway Co., and Galway City. A comprehensive review of relevant (spatial) data in each LA, grouped into themes (e.g. healthcare, agriculture), and categorized into sources and transmission routes, was carried out. Spatial datasets were obtained from Irish authorities (e.g. EPA, CSO), or produced through geocoding, with data selection supported by expert knowledge and a literature review. A range of GIS techniques were used to extract, organize and collate the data into the thematic maps through overlaying key spatial datasets. Preliminary results highlight the location of 'clusters' at increased risk of harboring AMR in each LA. They also demonstrate the relevance of aquatic transmission routes for ARO mobility and areas at increased risk of human exposure. In particular, Cork City has a high number of potential sources of AROs. However, potential hotspots of AMR are not necessarily restricted to urban areas. The integration of a GIS approach with expert knowledge of AMR is shown to be a useful tool to gain insights into the spatial dimension of AMR and to guide sampling campaigns. Potential future applications may inform risk analysis and exposure assessment, and also help pinpoint the source and transmission routes of possible outbreaks.

**Keywords:** antimicrobial resistance, sources/transmission routes, environment, geographic information systems


**ESAI ANNUAL REVIEW 2018**

## ESAI Chairpersons Address from Dr. Frances Lucy

The Environmental Sciences Association of Ireland has had a busy year. The highlights are as follows:

- Environ 2018 – 28th Irish Environmental Researchers Colloquium hosted by Cork Institute of Technology, 27th -29th March
- ESAI Postgraduate Researcher of the Year Award
- ESAI Graduate awards at Universities and Institutes of Technology throughout Ireland
- ESAI Grassroots Workshop competition
- Education with Sustainability Conference at IT Sligo, Supported by the ESAI

We had a large attendance at Environ 2018 and this is reported separately. I would like to acknowledge Dr. Joe Harrington and Dr. Niamh Power (joint convenors) and their team of staff and students for hosting Environ 2018 at Cork IT. The colloquium in Cork was a huge success and extremely well organised. Thank you to all the sponsors of the Cork colloquium. The theme for 2018 was 'Arriving at a Sustainable Future'. Congratulations to all the winners in the ESAI Student Presentation competition which featured ten awards this year with a special mention to Cian White, Winner of the Best Oral Presentation at Environ 2018'. Congratulations to Conall Holohan, the winner of the 'ESAI Postgraduate of the Year Award'. He is a postgraduate student at NUI Galway in the final year of his studies. Conall's entry based on his PhD research project on 'The Anaerobic Digestion of Fats: exploring microbial technological solutions' was of an extremely high standard. Thank you to all the entrants for the 'ESAI 2018 Postgraduate of the Year Award' – all entries were of a very high standard. Thanks also to ESAI council members Drs. Liam McCarton and Tasman Crowe for co-ordinating the judging. We encourage MSc and PhD researchers, in the final year of their research study, to apply for the ESAI Postgraduate Award in 2019. Please come along to see Conall present his research during Environ 2019 at the ESAI AGM in the Lecture Theatre L117 Haughton Building on Tuesday April 16th at 5.30pm.

One of our major initiatives in the past few years is to reach out to colleges more than we have done in the past. As part of this, we are fortunate to have an ESAI Liaison in each college. These staff members act as a contact point for ESAI activities and information flow. We are also offering free membership to all undergraduates in relevant courses in each college. The list of third level environmental education programmes on our web site has been updated as part of this process. This year we have recruited 112 new undergraduate members. We see this is a good sign of increased interest in early stage researchers and the growth of the ESAI.

In 2018, ESAI again provided an undergraduate research award to the best graduates in many Environmental programmes in Irish HEIs. This was carried out with the help of the college liaisons who worked with their colleagues to identify the best students within their own environmental courses. Many students throughout Ireland were delighted to get their certificate and prize of ESAI membership. They looked great in their graduation photos holding their awards on the ESAI Twitter feed!

In August 2018, ESAI partnered with CERIS IT Sligo and Mid Sweden University, to host an International Conference entitled 'Education with Sustainability (EwS)'held at IT Sligo. The conference focussed on the challenges facing all aspects of education in teaching for a sustainable future. EwS opened with a lively public Q and A event entitled 'Fake News and Impacts'. Presentation topics at the two-day conference included sustainability aspects at preschool, second level and higher education and outreach initiatives. These were very diverse and ranged from a talk on a Bolivian Andean community to a Swedish case study of sustainability in graphic design education. The conference ended with workshops on Life Cycle Analysis, Corporate Social Responsibility and Design and the provocatively titled, How Unsustainable are the Sustainability Goals. Irish delegates included representatives from eight Higher Education Institutes, highlighting the national importance of the conference.

Please consider the ESAI Grassroots workshop scheme. The Grassroots Workshop Support Scheme was established in 2016 to assist researchers, particularly postgrads and postdocs at hosting specialist workshops. We are grateful to the EPA for providing funds for four more workshops in 2017-2019. This is a great opportunity to organise an event independent of your postgrad research project, which adds to your knowledge, networking and competence in project management.

The ESAI has also signed up to the voluntary Code of Governance. We see this as an important self-assessment of how we carry out our role as an Association, with oversight and fair process.

Where there is no Engineer" is a design initiative funded by the European Union DEAR program and Irish Aid. It is delivered in partnership with DIT, Engineers without Borders Ireland, Habitat for Humanity, Engineers Ireland and the ESAI. ESAI Researchers who think their work may have an application within a developing country are invited to enter the competition. Research is grouped under six global themes; Climate Resilient Infrastructure, Self Supply Water and Sanitation, Health, Off Grid Energy Systems, Food Security and Smart Data in the Community. This year's competition will focus on the scientific and social challenges of forced migration. Selected entrants will be invited to participate in the National Finals where they get the opportunity to pitch their research in a dragons den style format. The winning team will be awarded a "Davies Travel Scholarship" to travel to work with Habitat for Humanity and EWB. Four research concepts will also be selected for funding under our "Arup Trust Innovation Award". This will fund researchers who need to further testing to develop their concept to a practical stage. This is an opportunity for researchers to bring their research into a practical real world environment. Anyone interested to apply can discuss further at the EWB Ireland stand at the environ conference or email liam.mccarton@dit.ie for more information.

## ESAI Chairpersons Address from Dr. Frances Lucy *Cont.*

ESAI depend on the voluntary efforts of our members, so as always, we welcome your input. We are keen to partner with relevant environmental events you may be organising, e.g. conferences, workshops and outreach events. Remember to keep in touch with ESAI through social media on Twitter, Facebook and LinkedIn. We produce a bi-annual newsletter [mail chimp] to keep you up to date with our activities and your participation in ESAI. The ESAI listserver continues to be very effective in terms of spreading news on events and jobs to our network.

On the ESAI Council front, we are actively seeking new members for the council to get involved in a range of new and existing activities. This is a great experience for both early stage [PhD and Post Doc] and more mature researchers and also research supervisors. Please attend the ESAI AGM on if you wish to become involved.

On behalf of the ESAI, I wish to say a sincere thanks to all members of the ESAI Council who are always enthusiastic and willing to get involved in various activities. For example this year we will be revamping our website. I particularly want to thank those who are stepping down from their roles. Many thanks to the ESAI college liaisons each of whom play a pivotal role in promoting Environ and in other activities.

The Council wish to sincerely thank ESAI administrator, Sinead Macken, for her excellent work, dedication and support over the past year with all our diverse activities.

Best wishes to all for research in the year ahead.

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Prof Frances Lucy is Head of Department of Environmental Science at IT Sligo. She has been on ESAI Council since 2013 and was the convenor at the 2015 ENVIRON in IT Sligo.

## ESAI Goals and Objectives 2018

**The ESAI (Environmental Science Association of Ireland), founded in 1995, as a not for profit organisation.** The membership is drawn from all sectors and disciplines, ranging from biology and ecology to engineering, hydrology and management and from professors to amateur naturalists. The goals and objectives of the organisation are to:

- Provide a forum to facilitate exchange of specialist information and advice amongst environmental researchers, policy makers, environmental management practitioners and other stakeholders, within Ireland and elsewhere.
- Promote a fuller awareness of the role that higher-level education institutions may make in finding solutions for the urgent environmental problems confronting contemporary society.
- Provide a forum for networking amongst environmental researchers both at national and international scales.
- Facilitate an annual conference aimed at providing postgraduate and other researchers with an opportunity to learn about each other's work, and for postgraduates to present and publish papers within a supportive community.
- Promote high professional standards amongst environmental researchers and professionals.
- To ensure a platform for science-based research on the environment in Ireland.
- Provide a Code of Ethics for Environmental Professionals in Ireland through its membership.
- To maintain growth in the membership base.

**Lough Gill: Photo Frances Lucy**

## Benefits of Membership

By becoming a member of ESAI, you will also have access to:

- Discounted rates at Environ, the annual Irish Environmental Researchers Colloquium, one of the major activities of the Association. It is now one of the largest national scientific meetings in Ireland attracting over 300 delegates each year.
- Discounted rates for selected workshops, seminars, further education courses and conferences.
- Access to ESAI listserver
- Eligibility to apply for ESAI Postgraduate Researcher of the Year Award
- Eligibility to apply for ESAI Undergraduate of the Year Award
- Eligibility to apply for ESAI Grassroots Workshop Funding
- Learn from others and absorb best practice
- Raise the profile of you and your business
- Stimulate new business opportunities
- Innovate and commercialise new products and services

**Raise your Profile**

- Members of ESAI will receive free-of-charge E-Newsletters, Environews.
- Sponsorship opportunities

## Keeping you informed

The ESAI website (www.esaiweb.org) is kept up to date with the latest news from the association about our upcoming events, competitions and funding opportunities.

We circulate a quarterly newsletter summarising our work throughout the year. We also coordinate an email Listserver, which facilitates a community of over 500 subscribers to exchange information about environmental events and career opportunities in Ireland. To sign up to these services, please visit our website
.
We are also very active on a number of social media platforms including Facebook, Twitter and LinkedIn.


http://twitter.com/esai_environ


http://www.facebook.com/esaiweb


http://www.linkedin.com/in/esaiweb

## Contact details

**ESAI Chairperson**

Dr Frances Lucy, Dept. of Environmental Science, Institute of Technology Sligo, Ash Lane, Sligo.

Email: Chairperson@esaiweb.org Tel: +353 (071) 9155284

Website www.esaiweb.org

**ESAI Administrator**

Ms Sinead Macken, Stonehaven, Moy Road, Kinvara, Co. Galway.

Email: administrator@esaiweb.org Tel: +353 (0) 86 8071498

Website: www.esaiweb.org

## 2018 Events

| Date | Event |
|---|---|
| **January 1st** | **ESAI Grassroots Workshop Support Scheme**<br>Sponsored by EPA – Rolling Call |
| **February 28th** | **ESAI Grassroots Workshop Support Scheme**<br>Sponsored by EPA – Rolling Call |
| **March** | **ESAI Environews Spring Edition available online www.esaiweb.org** |
| **March 26th-28th** | **Annual Conference**<br>Environ 2018 co-hosted by Cork Institute of Technology<br>28th Annual Irish Environmental Researchers Colloquium,<br>Cork Institute of Technology, Cork. |
| **March 26th** | **Field Trip @ Environ 2018**<br>14:00-17:00 Haulbowline Island Remediation Project<br>Haulbowline Island, Cork |
| **March 26th** | **Workshop @ Environ 2018**<br>14:00-17:00 Bringing research to the next level –<br>Commercialisation, Code of Conduct, IP & Technology Transfer<br>Cork Institute of Technology |
| **March 26th** | **Workshop @ Environ 2018**<br>14:00-17:00 Statistical analysis for research – using SPSS statistical software<br>Cork Institute of Technology |
| **March 26th** | **Launch**<br>ESAI Postgraduate Researcher of the Year Award Launch |
| **March 28th** | **ESAI AGM**<br>7:30-18:00, Cork Institute of Technology<br>All members welcome |
| **March 28th** | **ESAI Student Competition Prize Giving Ceremony** |
| **June 30th** | **ESAI Undergraduate of the Year Award Nominations Closes** |
| **August 20th-22nd** | **ESAI Collaboration on 1st International Education with Sustainability (EwS) Conference**<br>20% Discount for members<br>IT Sligo, Sligo |
| **August 31st** | **ESAI Grassroots Workshop Support Scheme for Postgraduate and Postdoctoral Researchers**<br>Sponsored by EPA – Rolling Call |
| **September 1st** | **Undergraduate Membership Offer**<br>Free Membership for all Undergraduate Members Scheme Rolled Out |
| **September 30th** | **ESAI Postgraduate of Year Award**<br>Nominations close |

## 2018 Events *Cont.*

| Date | Event |
|---|---|
| **October 9th-10th** | **ESAI Event Partners ARC2018 – Achieving Resilient Cities & Communities**<br>DIT, Grangegorman, Dublin |
| **October 31st** | **ESAI Grassroots Workshop Support Scheme for Postgraduate and Postdoctoral Researchers**<br>Sponsored by EPA – Rolling Call |
| **October / November** | **ESAI HEI Nominated Undergraduate of the Year Award Winners Graduate**<br>Presentations taking place at HEI's nationwide |
| **December** | **ESAI Postgraduate Researcher of Year Award Winner Announced** |
| **December 7th** | **Annual Conference – Call for Papers**<br>Environ 2019 co-hosted by Institute of Technology Carlow 29th Annual Irish Environmental Researchers Colloquium |
| **December 30th** | **Free Membership for Undergraduate Members**<br>Offer Closes |
| **December 31st** | **ESAI Grassroots Workshop Support Scheme for Postgraduate and Postdoctoral Researchers**<br>Sponsored by EPA – Rolling Call |

## Environ 2018

# Environ 2018

**Public Engagement Event: Mr. Ken Leahy, Ms. Claire Nash, Dr. Joe Harrington, Mr. Ezra MacManamon, Dr. Mary O' Connor, Mr. Jonathan Healy, Professor Frances Lucy**

Two hundred and eighty five delegates registered for the hugely successful three day 28th Irish Environmental Researchers Colloquium, Environ 2018 in Cork Institute of Technology which was organised by Dr. Joe Harrington and Dr. Niamh Power (Conference Joint Convenors), Sinead Macken (Environmental Sciences Association of Ireland – ESAI Liaison) and ESAI council members. The theme of the conference was "Arriving at a Sustainable Future".

88 oral papers and 75 posters were presented at the conference which was divided into seventeen themes:- Water Quality & Resources, Waste Management, Energy, Climate Change, Invasive Change, Invasive Species, Environmental Policy & Communication, Human Health, Ecotoxicology, Environmental Management, Air Quality & Urban Development, Marine & Coastal, The Human Built Environment, Sustainable Infrastructure, Sustainable Land Use & Agriculture, Biodiversity & Ecosystems, Nanotechnology & the Environment and Smart Technology for the Environment.

Delegates from The Netherlands, France, Germany, Belgium, the UK, Northern Ireland and Ireland attended the conference.

Highlights of the conference included a public engagement debate entitled "Flooding in the Cork Region – Impacts and Solutions" which was attended by over 100 people. This public engagement event focused on a matter of local, national and indeed international importance, the debate was lively and informative with very positive feedback on the event. Speakers included from the Office of Public Works (OPW), Arup Consulting Engineers and the local business community. The invited speakers were given eight minutes to outline their position. This was followed by a very vibrant and informative question and answer session that was skilfully chaired by Mr. Jonathan Healy (Newstalk). The different sides of the argument were fully aired and the debate went on past 10pm due to the number of questions from the audience.

## Environ 2018

**Public Engagement Event**

The debate was previewed on the local Evening Echo newspaper and announced on local radio stations.

The public engagement debate was preceded by a cheese and wine reception in the Berkeley Building on the CIT campus.

The conference began on the afternoon of Monday 26th March with three education and training workshops on offer to delegates: 'Field Trip to Haulbowline Island Remediation Project' (Mr Kieran Ruane, CIT and Dr. Cormac O'Suilleabhain, Cork County Council), 'Bringing Research to the next level – Commercialisation, Code of Conduct, IP & Technology Transfer' (Mr. Ronan Coleman, CIT and Mr. Kevin Fitzgibbon, CIT WSSIC) and 'Statistical analysis for research – using SPSS statistical software' (Dr. Catherine Palmer).

**Conference Opening & Plenary: Mr. Michael Loftus, Mr. Eamon Ryan, Dr. Jonathan Derham, Professor Frances Lucy, Dr. Joe Harrington**

At 9.15am Tuesday 28th March, the conference was officially opened with a ceremony held in the CIT Tourism and Catering Building. The speakers included: Michael Loftus, CIT Head of Faculty of Engineering and Science, Dr. Joe Harrington, Conference Co-Convenor and Professor Frances Lucey, ESAI Chairperson. This opening event was following by a plenary session with keynote addresses from Dr. Jonathan Derham, EPA Director and Mr. Eamon Ryan, Green Party. Both speakers gave thought provoking addresses on science and its communication and dissemination.

Over the course of the next two day 88 oral papers were presented in four parallel sessions. 75 academic posters were exhibited in Room T136 of the Tourism and Catering Building. This arrangement worked particularly well as it allowed delegates to mingle with exhibitors/sponsors and to view the posters on display.

## Environ 2018

**Some of the CIT Staff involved at Environ**

**Environ Delegates at the Closing Event**

**Environ Delegates attending Poster Sessions**

The college hosted the Environmental Science Association of Ireland AGM on Tuesday evening which was very well attended and included an oral presentation by Philip Shine the Postgraduate Research of the Year Award Winner for 2017.

Proceedings then moved to the Clayton Hotel Silver Springs for the Environ 2018 conference dinner. The evening began with a drinks reception in the Tivoli Suite with entertainment from a quartet of CIT's very talented School of Music students. A buffet dinner was then served in the Tivoli Suite with music afterwards from Ted Dunne Entertainment, a good night was had by all.

Wednesday began with registration opening at 9.15am. A keynote address was given by Josien Ruijter of NV HVC, The Netherlands at a Plenary Session at 9.30am on the Dutch Experience of Wastewater Sludge Incineration and Phosphorous Recycling. This informative keynote address was very well attended. Ms. Ruijter is a member of the EU Interreg Phos4You Project Team. 9 papers and posters were presented by the Phos4You Partners at the Environ 2018 Conference, the attendance and presentation by the Phos4You partners (CIT is a partner on this EU-funded project) was a feature and a highlight of the Conference. The conference then continued with oral presentations taking place throughout the morning alongside the poster presentations.

This was followed by lunch and then the important business of the day, the Environ 2018 prize giving.

A huge thank you to everyone, both staff and students, who made the conference such a success.

## ESAI INCOME AND EXPENDITURE ACCOUNT 2018

| For the year ended 31 December 2018 | | |
|---|---|---|
| | € | € |
| **Opening balance as 01/01/18** | | **19,916.41** |
| **Income** | | |
| Membership | 3,080.96 | |
| Environ 2017 - Delegate Fee | (140.00) | |
| Environ 2018 - Delegate Fee | 33,061.64 | |
| Environ 2018 - Sponsorship | 18,093.69 | |
| Environ 2018 Prizes | 1,500.00 | |
| Rebates | (100.00) | |
| **Total Income** | **55,496.29** | |
| **Expenditure** | | |
| Environ 2018 (inc prizes) | 37,871.52 | |
| Environ 2019 | 408.00 | |
| Environ 2018 Refunds | 45.00 | |
| Website | 6,046.21 | |
| Administration | 9,852.50 | |
| Travel | 522.28 | |
| Postage/Stationary | 641.23 | |
| Bank Charges (inc. Merchant banking) | 1,452.10 | |
| Insurance | 1,153.17 | |
| Workshop Grassroots | 2,388.62 | |
| Postgrad Prize | 500.00 | |
| Admin | 227.93 | |
| **Total Expenditure** | **61,108.56** | |
| | | -5.612.27 |
| | | **14,304.14** |

## ESAI Council Members 2018

| Chairperson | Regular Members |
|---|---|
| **Dr Frances Lucy** | |
| Email: chairperson@esaiweb.org | Dr Thomas Curran |
| | |
| **Honorary Secretary** | Dr Dorothy Stewart |
| **Dr Kevin Ryan** | |
| Email: secretary@esaiweb.org | Mr Declan Feeney |
| | |
| **Honorary Treasurer** | Prof Tasman Crowe |
| **Mr Liam McCarton** | |
| Email: treasurer@esaiweb.org | Mr Philip Shine |
| | |
| **Communications Officer** | **Membership Officer** |
| **Dr John Gallagher** | c/o Ms Sinead Macken / Administrator |
| Email: communications@esaiweb.org | Email: administrator@esaiweb.org |
| | |
| **Editor** | **Webmaster** |
| **Ms Caroline Wynne** | c/o Dr Adrian Corcoran / Attik Designs |
| Email: lang.yvonne@itsligo.ie | Email: webmaster@esaiweb.org |
| | |
| **Early Stage Researcher Representative** | |
| **Mr Christopher Finnegan** | |
| Email: christopher.finnegan@itcarlow.ie | |
| | |
| **Conference Coordinator 2019** | |
| **Dr Thomae Kakouli-Duarte** | |
| Email: thomae.kakouli@itcarlow.ie | |
| | |
| **Conference Coordinators 2018** | |
| **Dr Joe Harrington & Dr Niamh Power** | |
| Email: conference@esaiweb.org | |

## Notes

## Notes

## ESAI Postgraduate Researcher of the Year 2019

**Applications are invited from postgraduate students doing either a PhD or a Masters degree by research in an environmental topic.**

**Winner receives €500.**
**Closing date is Sept 30th, 2019.**

**Think outside the box.**

Details of both schemes at
**www.esaiweb.org/news**

esai
Environmental Sciences Association of Ireland


## Grassroots Workshop Support Scheme

**ESAI and the EPA are delighted to announce the continuation of the Workshop Support Scheme with awards to assist early stage researchers with the delivery of stand alone workshops.**

**Open to postgraduate & postdoctoral researchers.**
**Awards of up to €600 per event.**
**Offered on a rolling call basis.**