Environ 2020

Ireland's Water, Energy & Environment in a Climate & Biodiversity Emergency

20th – 22nd October 2020

Online

30TH IRISH ENVIRONMENTAL RESEARCHERS COLLOQUIUM

DCU Institiúid Uisce DCU DCU Water Institute

esai Environmental Sciences Association of Ireland


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DCU Convenor's Welcome to ENVIRON 2020

Dear Delegate,

The ENVIRON 2020 Organising Committee welcomes you to the 30th Irish Environmental Researchers' Colloquium (ENVIRON 2020) hosted by the Dublin City University Water Institute. The ENVIRON colloquium is the largest gathering of environmental researchers in Ireland with almost 300 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.

As has been the case for many years now, the world in 2020 is at an even more critical juncture regarding issues such as climate change, global food security, waste at an unprecedented scale, access to clean water, biodiversity loss, soil degradation, loss of wild habitats and, associated to all the above, socioeconomic and geopolitical issues. In recognition of the United Nations Intergovernmental Panel on Climate Change report and the publication of Irelands climate action plan which declared a Climate and Biodiversity Emergency, this year's colloquium overarching theme of ***"Ireland's Water, Energy & Environment in a Climate and Biodiversity Emergency"*** aims to focus on what key researchers in Ireland are doing to tackle this emergency, while also stimulating important discussions and actions to address this emergency. It is no coincidence that the world is in the midst of a global pandemic due to COVID19 at a time when the world is beginning to recognise that humans cannot keep depleting the planets resources without catastrophic consequences.

The colloquium was formally opened on Tuesday 20th October by Professor Daire Keogh (President, Dublin City University), Professor Fiona Regan (Water Institute, DCU), and Dr Liam McCarton (ESAI Chairperson) followed by a Keynote Address by Gilles Gantalet from DG Environment. Three concurrent sessions followed over the course of the next three days, at which over seventy papers and 80 posters were presented under the following thematic areas: Biodiversity and Ecosystems Water Quality and Resources, Climate Change, Marine and Coastal, Waste Management, Energy, Wastewater and Water Reuse, Environmental Policy and Communication, Sustainable Infrastructure & The Built Environment, Urban Development & Air Quality, Human Health, Ecotoxicology, Sustainable Land Use and Agriculture and Technology and the Environment. These parallel sessions were interspersed with 6 poster sessions, a panel discussion on Wednesday at 12pm and a workshop on Thursday morning to stimulate discussion on the United Nations Sustainability Goals.

A unique feature of this year's event is that it was the first time Environ was delivered totally online, with speakers, poster presenters and plenary sessions all happening virtually. We have also introduced a conference app, WHOVA (whova.com) which we hope helped people network online in our virtual coffee breaks as well as having direct access to abstracts and presentations online. Access to the Whova App remains live until April 2021, so I hope you will continue to network with fellow researchers online.
We hope that you found ENVIRON 2020 stimulating for your own research and interests and left the conference with a vision of how you can play your part in addressing this climate and biodiversity emergency.

Dr Anne Morrissey

ENVIRON 2020 Convenor

On behalf of the ENVIRON 2020 Organising Committee

ESAI Welcome to ENVIRON 2020 Delegates

The ESAI Council wish to extend to you a warm welcome to the 30th Irish Environmental Researchers Colloquium (ENVIRON) hosted in collaboration between the ESAI and the Dublin City University (DCU) Water Institute. The theme of this year's conference is 'Ireland's Water, Energy & Environment in a Climate and Biodiversity Emergency.'

Like most organisations, the ESAI and our members have been impacted by the global pandemic. This year's Environ conference was originally planned for April. This is the first "virtual" Environ and we would like to thank all sponsors and members who have registered for their patience and continued support.

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. Although this year's Environ was delivered online, we hope it continued to provide a platform for informed debate and networking. Environ opened on Tuesday 20th October with a Keynote address by Gilles Gantelet the Director of the Directorate "Policy, Coordination, Life Governance and resources" within the Directorate General for the Environment at the European Commission. A number of events ran over the three days, including a variety of oral and poster presentations, plenary speakers, Q & A panel discussions and an social evening environmental quiz night.

We 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. We also acknowledge excellence in environmental research across several levels including the Level 7 and 8 Undergraduate Awards Scheme, the prestigious Postgraduate Researcher of the Year Award and the ESAI / EPA Grassroots Workshop Award. Further information can be found at www.esaiweb.org

The ESAI wishes to sincerely thank Environ Convenor 2020 Dr Anne Morrissey and the DCU 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 virtually meeting you over the course of the colloquium and hope you enjoy your online visit to DCU" to "We hope you enjoyed your online visit to DCU.

Liam McCarton
ESAI Chairperson

Environ 2020 Organising Committee

Conference Convenors

Dr Anne Morrissey
Dr. James Carton
Dr. Jenny Lawler

Dublin City University Planning & Scientific Committee

Ms Caoimhe O Broin
Ms Ruth Clinton
Ms Aine Nolan
Professor Fiona Regan
Professor Barry McMullin
Professor Pat Brereton
Ms Samantha Fahy
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Dr. Goran Dominioni
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Mr. Kelvin Martins
Dr. David Kinahan
Mr. Keith Hickey

Environmental Sciences Association of Ireland (ESAI)

Ms. Sinead Macken — ESAI Administrator
Dr. Liam McCarton — ESAI Chairperson
ESAI Council

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Environ 2020

Dublin City University Water Institute

October 20th – 22nd 2020

Ireland's Water, Energy & Environment in a Climate and Biodiversity Emergency

30th Irish Environmental Research Colloquium

DELEGATE INFORMATION

ENVIRON 2020 Conference Programme

All activities took place through the conference App Whova, where delegates found a copy of the abstracts, conference schedule and links to the live streamed events. You will find a recording of the opening plenary session on Tuesday morning and the panel discussion on Wednesday morning on the App and on the Environ website.

	Conference Programme Tuesday 20th October 2020		
10:00 - 11:00	**Conference Opening & Plenary Session** featuring keynote speakers DCU President Daire Keogh & Gilles Gantelet, Director of the 'Directorate A – Policy, Coordination, Life Governance and Resources' within the Directorate General for the Environment at the European Commission		
11:00 - 11.30	**Break for Coffee,** Virtual Coffee Networking Option for Sessions 1, 2, 3		
11:30 - 12:45	**Session 1** Biodiversity & Ecosystems	**Session 2** Water Quality & Resources 1	**Session 3** Climate Change 1
13.00 - 14.00	**Lunch**		
14.00 - 15.15	**Session 4** Water Quality & Resources 2	**Session 5** Climate Change 2	**Session 6** Marine & Coastal
15.15 - 15.45	**Break for Coffee,** Virtual Coffee Networking Option for Sessions 4, 5, 6		
15.45 - 16.15	**Poster Session 1 & 2 featuring 1 min poster presentations & poster Q&A**		
	Poster Session 1: Water Quality & Resources	**Poster Session 2:** Sustainable Land-Use Agriculture & Food, Biodiversity & Ecosystems	
16:15 - 17:45	**Where Could Ecology Take You?** *CIEEM lead Careers Q&A session with experts working in ecology & environmental management*		

ENVIRON 2020 Conference Programme

	Conference Programme Wednesday 21st October 2020		
10:00 - 11:15	**Session 7** WasteWater & Water ReUse	**Session 8** Intereg Atlantic Area Special Session: Agriculture & Climate Change	**Session 9** Environmental Management, Policy & Communications
11:15 - 11.45	**Break for Coffee,** Virtual Coffee Networking Option for Sessions 7, 8, 9		
12:00 - 13:30	**Q&A Panel Debate & Public Engagement Event** *'Ireland's Water, Energy and Environment in a Climate and Biodiversity Emergency'* **Discussion Panellists:** Vincent Cleary (CEO, Glenisk), Tara Shine (Environmental Scientist), Henry Smyth (Head of Market Development, Ervia)		
13.30 - 14.00	**Environmental Sciences Association of Ireland AGM** with guest speaker ESAI Postgraduate Researcher 2019 Molly-Ann Williams All welcome		
14.00 - 15.15	**Session 10** Marine & Coastal	**Session 11** Energy	**Session 12** Sustainable Infrastructure & The Built Environment, Urban Development & Air Quality
15.15 - 15.45	**Break for Coffee,** Virtual Coffee Networking Option for Sessions 10, 11, 12		
15.45 - 16.15	**Poster Session 3 & 4 featuring 1 min poster presentations & poster Q&A**		
	Poster Session 3: Marine & Coastal, WasteWater & Water ReUse, Food-Water-Energy Nexus	**Poster Session 4:** Sustainable Transport, Energy, Climate Change, Air Quality	
19:00 - 20:30	**Environmental Quiz Night** *All Welcome*		

ENVIRON 2020 Conference Programme

	Conference Programme Thursday 22nd October 2020		
10:00 - 11:00	**SDG Interactive Workshop** "How Unsustainable are the Sustainable Development Goals" **with Guest Speakers** Riccardo Mastini, a policy advisor for the Green New Deal for Europe, and Liam McCarton, Chair of ESAI and Director of Engineers Without Border Ireland challenging participants to question if the SDGs really are a blueprint to meet the needs of the present generation without compromising the ability of future generations to meet their own needs.		
11:00 - 11.30	**Break for Coffee,** Virtual Coffee Networking Option for Sessions 13, 14, 15		
11:30 - 12:45	**Session 13** Human Health & Environment	**Session 14** Ecotoxicology	**Session 15** Sustainable Land-Use Agriculture and Food Industry
12:45 - 13:30	**Lunch**		
13:30 - 14.45	**Session 16** Technology & The Environment	**Session 17** Waste Management	
14.45 - 15.15	**Break for Coffee,** Virtual Coffee Networking Option for Sessions 16 & 17		
15.15 - 15.45	**Poster Session 5 & 6 featuring 1 min poster presentations & poster Q&A**		
	Poster Session 5: Technology & Environment, Ireland 2050, Waste Management	**Poster Session 6:** Human Health, Ecotoxicology	
15:45 - 16:30	**Student Best in Conference Prizegiving** **Environ 30th Anniversary Honours List** **Close of Conference**		

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Environ 2020

Dublin City University Water Institute

October 20th – 22nd 2020

Ireland's Water, Energy & Environment in a Climate and Biodiversity Emergency
30th Irish Environmental Research Colloquium

BIOGRAPHIES

DCU Water Institute Conference Convenors

Dr Anne Morrissey is Associate Professor in the Department of Mechanical & Manufacturing Engineering at DCU. A past (BE) Chemical Engineering graduate from UCD and receiving her PhD from NUI Galway, Anne has been worked in and been carrying out research in the area of environmental protection since 1996. She previously worked with one of the world's leading packaging manufacturers, a link she still maintains through her involvement with the Irish Packaging Society and as a Fellow of the Chartered Institution of Wastes Management. Anne's area of research interest at DCU focuses on sustainability, with a particular emphasis on water and wastewater treatment and waste management.

Dr James Carton is Assistant Professor in Energy Sustainability in the School of Mechanical and Manufacturing Engineering, DCU a member of the DCU's Sustainability Council & the Water Institute, and also a member of FEL-100 programme of the World Energy Council. Following several years of industrial manufacturing experience, James was awarded PhD in 2011 at DCU having focused his research on hydrogen technology design and development. He is co-founder of Hydrogen Ireland Association and is the foremost academic in Ireland with a deep sectoral network in hydrogen and energy storage technologies, with his research focus is Energy sustainability through innovative technology development.

Dr Jenny Lawler is the Senior Research Director of the Water Center at Qatar Environment and Energy Research Institute (QEERI). She graduated in Ireland with a Bachelor's Degree in Chemical Engineering and a PhD in membrane separations. She joined QEERI in December 2019, coming from Dublin City University Water Institute. She is passionate about the provision of safe water for all, as a basic human right; and believes that research in this area can have a positive impact on policy development to assist in protection of human health. She is particularly interested in the targeting of contaminants of emerging concern in the environment, especially those that impact on human health such as plasticizers, agricultural pesticides, pharmaceuticals, microplastics and nanomaterials.

Opening Event: Tuesday 20th October 2020

Speaker 1: Director DCU Water Institute

Prof Fiona Regan is founder and Director of the DCU Water Institute and is Full professor in Chemistry at the School of Chemical Sciences in Dublin City University. Fiona's research focuses on analytical chemistry in the field of environmental monitoring and she has special interest in priority and emerging chemicals as well as the establishment of decision support tools for environmental monitoring using novel technologies and data management tools. Fiona recently established a citizen science programme at the Water institute for monitoring catchments to assess sources of nutrients in Irish freshwaters. She is an associate editor with Royal Society of Chemistry's Analytical Methods, a member of the Water JPI Scientific and Technological Board, and a member of the Royal Irish Academy (RIA) Environment and Climate Change committee. Fiona is a regular contributor to TV programmes such as EcoEye, Nationwide, RTE's What Planet are you on? and to Newstalk, RTE 1 Drivetime, Morning Ireland on radio.

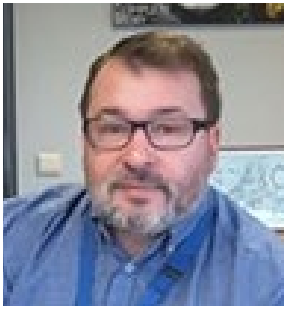
Speaker 2: ESAI Chairperosn

Liam McCarton is a Chartered Civil Engineer and lecturer in TU Dublin, leading the Development Technology in the Community Research Group. He previously worked in International Development managing major infrastructure projects in Ireland, Africa, South America and Asia. His current research focus is integrating Nature Based Solutions for resilient cities and communities, and is a member of the NatureWat (EIP) and Water in Industry and Green Infrastructure (WSSTP) working groups. Liam has co-authored on a Springer book 'A Technology Portfolio of Nature Based Solutions for Innovations in Water Management'. He is also a Director of Engineers Without Borders Ireland and leads their Innovation Academy and Development Education programs.

Opening Event: Tuesday 20th October 2020

Speaker 3: DCU College President

Professor Daire Keogh began his term as President of DCU in July 2020. He previously served as Deputy President of the University (2016-2020). Prior to that, he was President of St Patrick's College, Drumcondra (2012-2016), and played a key role in its incorporation with DCU. Daire has published extensively, on the history of popular politics, religion and education in Ireland. A former Government of Ireland Senior Research Fellow, he is currently Principal Investigator of an Irish Research Council funded project to publish the extensive correspondence of Cardinal Paul Cullen. He is a founding member of the European Quality Assurance Register Committee, the body charged by EU Governments with monitoring quality assurance in higher education across the continent. He is a Chartered Director and is a member of several Boards including Women for Election. Daire is also a member of the Irish Association of the Order of Malta, and he recently completed a term as a Council member of the National Council for Curriculum and Assessment, and a Board member of the Centre for Cross Border Studies (2012-2017). Daire is a graduate of the National University of Ireland (BA), the Gregorian University Rome (BPh), the University of Glasgow (MTh) and the University of Dublin (PhD).



Keynote Speaker: Director of the Directorate A

Gilles Gantelet is the Director of the Directorate A "Policy, Coordination, Life Governance and resources" within the Directorate General for the Environment at the European Commission since May 2017. He joined DG Environment in 2015 as Head of the "Life, Nature" unit and as adviser of the Director General. He started his career in the European Commission back in 1994 working as Assistant of the Director General, Spokesperson of different Commissioners, deputy head of unit and Head of unit in different directorates' generals of the European Commission.

Workshop @ Environ Tuesday 20th October

Where Could Ecology Take You? Join professionals from the Chartered Institute for Ecology and Environmental Management (CIEEM) at this networking event

Facilitator: CIEEM Project Officer Elizabeth O'Reilly

Elizabeth O'Reilly is the Project Officer for the Irish Section of the Chartered Institute of Ecology and Environmental Management (CIEEM) and is delighted to organise this session and participate in the ENVIRON conference this year.

Speaker 1: Public sector

Maeve Flynn, a senior ecologist for An Bord Pleanála

Speaker 2: Environmental NGO sector

Niamh Roach who works part time for Bat Conservation Ireland.

Speaker 3: Academia

Dr. David Kelleghan is a Fulbright TechImpact Scholar and currently works as a postdoctoral researcher in Teagasc.

Speaker 4: Private sector

Niamh Burke a principle ecologist for JBA for over 14 years, who is currently setting up her own Environmental consultancy.

Wednesday October 21st

Q&A Panel Debate 'Ireland's Water, Energy and Environment in a Climate and Biodiversity Emergency'

Chairperson: DCU Environ Conference Co-Convenor, Dr James Carton

Dr James Carton is Assistant Professor in Energy Sustainability in the School of Mechanical and Manufacturing Engineering, DCU a member of the DCU's Sustainability Council & the Water Institute, and also a member of FEL-100 programme of the World Energy Council. Following several years of industrial manufacturing experience, James was awarded PhD in 2011 at DCU having focused his research on hydrogen technology design and development. He is co-founder of Hydrogen Ireland Association and is the foremost academic in Ireland with a deep sectoral network in hydrogen and energy storage technologies, with his research focus is Energy sustainability through innovative technology development.

Speaker 1: Vincent Cleary

A native of Killeigh, Co Offaly, **Vincent Cleary** is Managing Director of Glenisk. The business was established in 1987 and in 1995 Vincent, along with his siblings, transitioned Glenisk to be one of Ireland's best known and most sustainable food brands, through the championing of organic ingredients. Glenisk has a vision of an Organic Ireland, where the future health and wellbeing of our children is assured – predicated on the belief that healthy soil grows healthy food to help raise healthy families. This philosophy drives the business's commitment to organic agriculture, reduced waste and sustainable practices. Glenisk was one of the first verified members of Origin Green in 2013. Glenisk continues to work with its pool of Organic farmers to encourage biodiversity by introducing beehives on the farm and providing introductory training for farmers.

Wednesday October 21st

Q&A Panel Debate 'Ireland's Water, Energy and Environment in a Climate and Biodiversity Emergency'

Speaker 2: Henry Smyth

Henry Smyth is Head of Market Development in Ervia. Over the past 20 years Henry has worked in senior management roles across the organisation's gas networks, energy retail and water / wastewater businesses. In his current role Henry is leading development of carbon capture and storage and hydrogen within Ervia. Prior to joining Ervia Henry spent a number of years working internationally in engineering and energy consultancy.

Photo credit John Allen

Speaker 3: Dr Tara Shine

Dr Tara Shine has spent 20 years as an international climate change negotiator and adviser to governments and world leaders on environmental policy. She was Special Adviser to the Mary Robinson Foundation-Climate Justice and The Elders before setting up Change by Degrees, a sustainability consultancy based in Kinsale, Co. Cork. Tara is Chair of the Board of the International Institute of Environment and Development (IIED) and a member of faculty and lead facilitator for the visibility stream of Homeward Bound, a global leadership programme for women in science. Tara is a science communicator and TV presenter. She is author of 'How to Save Your Planet One Object At A Time' published in April 2020 by Simon and Schuster. In September this year Tara was appointed co-facilitator of the Structured Expert Dialogue under the UN Framework Convention on Climate Change, a process which will monitor progress and enhance delivery on Paris Agreement goals.

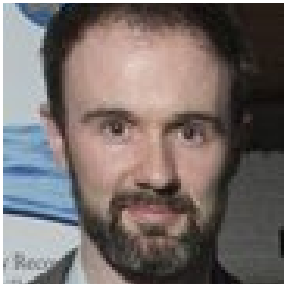
Wednesday October 21st

ESAI AGM Guest Speaker
Postgraduate Researcher of the Year 2019

Molly-Ann Williams is a third year PhD student currently studying under the supervision of Prof. Anne Parle-McDermott and Prof. Fiona Regan at Dublin City University. She has a first class BSc honours degree in Biological Sciences from the University of Warwick and an MSc in Forensic Science from King's College London. Her current research combines her passions for DNA and conservation through the study of environmental DNA. During her PhD, she has developed a novel, alternative method of eDNA detection by combining isothermal amplification of DNA with CRISPR-Cas detection. Molly-Ann thrives to share her passion for science through teaching on the CTYI program, organising outreach activities whilst chair of the Biological Research Society and presenting at international conferences.

Environmental Quiz Night

Dr. Niamh Power is a Lecturer in Civil, Structural & Environmental Engineering, in Cork Institute of Technology. After her Civil & Structural Engineering degree, she was awarded the Irish Research Scholarship to pursue her PhD in the area of biogas. Niamh is an active member of the Sustainable Infrastructure Research & Innovation Group at CIT. Her research interests include biogas, anaerobic digestion, renewable energy from wastes & crops, transport & CHP, LCA and policies & drivers for change.



Dr. John Gallagher is Assistant Professor in Energy & Environmental Systems Modelling in the School of Engineering at Trinity College Dublin. His research interests lie in delivering innovative solutions to current environmental and energy challenges, and adopting a circular economy approach in the life cycle of measurement, modelling and mitigation. He's currently Co-PI on several European projects, and is actively involved in research dissemination, outreach and doctoral education

Thursday 22nd October 2020

SDG Interactive Workshop
"How Unsustainable are the Sustainable Development Goals"

Facilitated by ESAI Chairperson, Liam McCarton

Liam McCarton is a Chartered Civil Engineer and lecturer in TU Dublin, leading the Development Technology in the Community Research Group. He previously worked in International Development managing major infrastructure projects in Ireland, Africa, South America and Asia. His current research focus is integrating Nature Based Solutions for resilient cities and communities, and is a member of the NatureWat (EIP) and Water in Industry and Green Infrastructure (WSSTP) working groups. Liam has co-authored on a Springer book 'A Technology Portfolio of Nature Based Solutions for Innovations in Water Management'. He is also a Director of Engineers Without Borders Ireland and leads their Innovation Academy and Development Education programs.

Guest Speaker

Riccardo Mastini is a PhD candidate in Political Ecology at the Institute of Environmental Science and Technology at the Autonomous University of Barcelona. He is a policy advisor for the international campaign Green New Deal for Europe. He previously worked as a campaigner at Friends of the Earth Europe and as a consultant advising international environmental organizations and governmental agencies. You can follow him on Twitter / Facebook and visit his website.

Thursday 22nd October 2020

ESAI Prizegiving & Close of Conference

ESAI Chairperson, Liam McCarton

Liam McCarton is a Chartered Civil Engineer and lecturer in TU Dublin, leading the Development Technology in the Community Research Group. He previously worked in International Development managing major infrastructure projects in Ireland, Africa, South America and Asia. His current research focus is integrating Nature Based Solutions for resilient cities and communities, and is a member of the NatureWat (EIP) and Water in Industry and Green Infrastructure (WSSTP) working groups. Liam has co-authored on a Springer book 'A Technology Portfolio of Nature Based Solutions for Innovations in Water Management'. He is also a Director of Engineers Without Borders Ireland and leads their Innovation Academy and Development Education programs.

Closing Address: DCU Environ Conference Co-Convenor: Dr. Anne Morrissey

Dr Anne Morrissey is Associate Professor in the Department of Mechanical & Manufacturing Engineering at DCU. A past (BE) Chemical Engineering graduate from UCD and receiving her PhD from NUI Galway, Anne has been worked in and been carrying out research in the area of environmental protection since 1996. She previously worked with one of the world's leading packaging manufacturers, a link she still maintains through her involvement with the Irish Packaging Society and as a Fellow of the Chartered Institution of Wastes Management. Anne's area of research interest at DCU focuses on sustainability, with a particular emphasis on water and wastewater treatment and waste management.

Environ 2021 Conference Co-Convenor

Dr. Jean O'Dwyer is a Lecturer of Environmental Science in the School of Biological, Earth and Environmental Sciences at University College Cork. Jean is a PI in the Environmental Research Institute and leads the Environment and Health research lab, which is involved with several nationally funded projects ranging from the epidemiology of infectious disease to antimicrobial resistant bacteria in drinking water. Jean is an active science communicator, and is currently the organiser of Soapbox Science Cork and runs 'The Earth Story' an award winning science education blog.

Keynote Speakers

Biodiversity & Ecosystems Session:
Dr Victor Beumer, Earthwatch Europe

Dr Victor Beumer obtained his PhD in 2009 on Landscape Ecology and is an expert on urban water management and green infrastructure. He has been working with many cities across Europe to improve their climate adaption strategy and to implement nature-based solutions. From 2008 to 2018 he has been working at Deltares in the Netherlands as an expert on green water infrastructures. He has initiated the Nature-based Solutions working group in the Water Europe platform and is now active member of the Hybrid Green & Grey Infrastructure vision group of this platform. In 2018 he started his own company focusing on climate adaptation through nature-based solutions in cities and has been working with Earthwatch Europe for 1.5 years as the senior research lead for Climate-Proof cities. Victor initiated the UK movement for Tiny Forest: a fast-growing, native, urban forest with the engagement of citizens.

Water Quality & Resources Session:
Dr Susan Hegarty, DCU Water Institute

Dr Susan Hegarty is a geographer and a member of the School of History and Geography and the DCU Water Institute. Her research focuses on citizen science for monitoring water quality and on the evolution and our use of the Irish landscape. She has researched the role of the Quaternary ice-sheets on this landscape and the role Quaternary sediments play in the vulnerability of water sources to pollutants. She is also interested in the exploitation of Irish mineral resources in the nineteenth century. She is enthusiastic about transmitting the importance of Geography and environmental science to the wider public, and to this end has taken part in a number of documentary series on both Irish and British television channels and is involved in a number of citizen science projects looking at water quality in Ireland.

Keynote Speakers

Water Quality and Resources 2:
Angela Ryan, Irish Water

Angela Ryan is a chartered civil engineer and water resources planner for with the asset management section of Irish Water. Angela is currently the project lead for the National Water Resources Plan, the 25-year strategic plan for water services, which will set out how the company will meet the present and future challenges of water supply.

Climate Change Session: Session Chair:
Yvonne Cannon, CARO

Yvonne Cannon has 20 years' professional experience working across the private and public sectors in the areas of environmental impact assessment, water resources, water quality and project management. She holds a B.A. in Science from Trinity College Dublin (2000) and an MSc. in Environmental Engineering from Queens University Belfast (2002). Yvonne joined the multi-disciplinary Dublin CARO team as a scientist on the establishment of the office in 2018 where her work has focused on supporting the four Dublin local authorities in the preparation and implementation of their Climate Change Action Plans. She has also collaborated with the other CARO offices across the state to increase awareness and to build capacity within local authorities in the area of climate action via training, education and citizen engagement. Yvonne has represented CARO on the National Climate Research Coordination Group as CARO are mandated to participate in climate action research projects and to liaise with third level institutions and the climate research community.

Keynote Speakers

Climate Change Session:
Prof Barry McMullin

Prof Barry McMullin graduated with a BE (Electrical Engineering) degree from UCD in 1980. He worked in diverse roles in the energy and manufacturing industries before joining DCU (then NIHED) in 1987. He received a PhD in Computer Science in 1993 from NUI. He has served in diverse academic roles, including as Executive Dean of the Faculty of Engineering and Computing from 2013-2017. In recent years he has focussed particularly on responses to large scale societal challenges including climate change. His current research is on approaches to rapid society-wide phase out of fossil energy use, and the potential early need for large scale draw down of carbon dioxide from the atmosphere.

Marine & Coastal Session:
Dr Brendan McHugh, Marine Institute

Dr Brendan McHugh is a marine scientist in Marine Institute (MI) chemistry team with over 20 years of experience in persistent organic pollutants and their impacts in the marine environment. He is currently responsible for delivery of primarily legislative led marine water quality assessments and associated research as well as being active in many applied national and international research projects. Research interests include passive sampling, contaminant monitoring in higher trophic level species including marine mammals, contaminants in sea bird eggs as an indicator of offshore pollution and in contaminant induced biological effects. Irish representative on OSPAR Working Groups on Monitoring and on Trends and Effects of Substances in the Marine Environment and on ICES Working Groups on Marine Chemistry and Marine Sediments. Is an author/co-author to over 25 publications and reports.

Keynote Speakers

Wastewater and Water Reuse:
Dr Pilar Fernandez-Ibanez, University of Ulster

Dr Pilar Fernandez-Ibanez is a lecturer in Engineering Science at Ulster University. Previously Head of Group at Plataforma Solar de Almería of CIEMAT (Spain). Her research focuses on solar driven technologies for water purification, advanced oxidation processes for the removal of microbiological pathogens and hazardous chemical contaminants from water, and low-cost technologies for water disinfection in developing communities. Published 151 peer-reviewed papers (H= 52, total citations> 8,300). She has participated in 19 EU-funded research projects including the H2020-WATERSPOUTT, REWATERGY and RPANIWATER projects, and a Royal Society International Collaboration Award with the University of Sao Paulo (Brazil). She is a Fellow of the Institute of Physics, member of the Climate Change and Environmental Sciences Committee of the Royal Irish Academy. Associate Editor for Europe of the Journal of Photochemistry & Photobiology, A: Chemistry and editor of the Process Safety and Environmental Protection, both from Elsevier.

Intereg Atlantic Area Special Session:
Agriculture & Climate Change: Dr Edel Doherty, NUI Galway

Dr Edel Doherty is the chair of this special session. Edel is a lecturer in Economics at the J.E. Cairnes School of Business and Economics, NUI Galway and she is a partner in the RiskAquaSoil project. Her research is focused on the application of discrete choice experiments, economic evaluation and econometrics in Health and Environmental Economics. In environmental economics, Edel has mainly used non-market valuation methods to examine preferences in areas such as recreation, water quality and agri-environment schemes. Her work to date has been published in a number of leading international peer-reviewed journals such as the Journal of Economic Behaviour and Organisation, Health Affairs, Economics and Human Biology, European Review of Agricultural Economics and the Journal of Agricultural Economics.

Keynote Speakers

Environmental Management, Policy & Communication: UCD Earth Institute Keynote Chairperson Dr Finbarr Brereton, UCD Earth Institute

Dr Finbarr Brereton is a Lecturer in Environmental Policy with UCD Planning and Environmental Policy. He is an Environmental Economist with a PhD (Environmental Policy) on the topics of Quality of Life and the Economics of Happiness. Finbarr's research interests focus on exploring the determinants of subjective well-being, specifically the spatial environmental determinants. More recently, his research has focused on people's perceptions of, and behavioural responses to, environmental externalities caused by natural hazards and human activities. His work has been published in journals such as Ecological Economics, Risk Analysis, Environmental Hazards and Natural Hazards. He is a member of the UCD Earth Institute. He is / was involved in a number of research projects including, inter alia, FloodPAP exploring flood risk perceptions, Energy for Well-being examining the influence of energy mix on well-being in Europe, and HAPPINESS (HAPpiness, Political Institutions, Natural Environment and Space). He has a keen interest in all areas of survey design and implementation, and with Prof. Peter Clinch, was the National Coordinator of the European Social Survey (ESS) Rounds 6 and 7 in Ireland, funded by the Irish Research Council.

Keynote Speakers

Environmental Management, Policy & Communication: Keynote Speaker: Samantha Fahy, DCU Water Institute

Samantha Fahy started her career in plasma physics and gained over twenty years of experience in the management and administration of high technology complex multi-stakeholder national and EU funded research projects. In 2012, Samantha was appointed to 'Sustainability DCU' and working with internal and external stakeholders she was charged with delivering a holistic cross institutional sustainability solution for Dublin City University. Focusing on embedding an ethos of sustainability from operations & research to curriculum development, Samantha has led DCU in a series of initiatives including the establishment of the DCU Sustainability Council and the annual DCU Climate Action plan delivering novel and innovative initiatives. These interventions have gained DCU 12th position in the International UI Green Metrics rankings and have also successfully gained and retained DCU's Green Campus Status under the An Taisce/ International Foundation for Environmental Education programme for the past six years. Samantha has been the DCU representative on the European Consortium of Innovative Universities Sustainability Sub Committee (2012-2018) and is the current chair of the Irish Universities Associations (IUA) Sustainability Working Group, she also sits on the Green Broadcaster Advisory Group with RTÉ and has recently (June 2020) been appointed to the European Commission Expert Group on Greening the Marie Skłodowska-Curie Action (MSCA).

Energy Session: Dr Emer Dennehy, SEAI

Dr. Emer Dennehy is a senior energy analyst currently responsible for Ireland's national energy projections at the Sustainable Energy Authority of Ireland (SEAI). Emer has both national and international experience working as an energy analyst in the energy statistics and modelling groups in SEAI, as well as in the Energy Technology Perspectives Division in the International Energy Agency (IEA).

Keynote Speakers

Sustainable Infrastructure & The Built Environment:
Brian Gilmore, Cement Manufacturing Industry

Brian Gilmore has been in the cement industry for 13 years primarily working with communities, local officials, regulators and the media to engage people as the industry transitions away from fossil fuel and tackles its climate action commitments. In addition to making cement, the industry has much to offer in terms of resource recovery and the circular economy. The high temperature manufacturing process offers potential to provide solutions for many of societies waste challenges. Prior to that he spent 11 years working in a hazardous waste management company innovating and problem solving for a diverse range of customers. After his primary degree in Natural Sciences in Trinity he completed a two-year research project on fossil fish poo (coprolites), leading to an MSc and a published paper.

Human Health & Environment:
Dr Ian Marnane, EPA

Dr Ian Murnane currently works in the Environmental Protection Agency in Dublin and is responsible for a number of work areas including chemicals in the environment, ecosystems impact assessment related to air pollution and developing linkages between the environment and health. Ian also worked at the European Environment Agency in Copenhagen where he co-authored a recently published EEA report 'Healthy environment, healthy lives, how the environment influences health and well-being across Europe'.

Keynote Speakers

Sustainable Land-Use, Agriculture & The Food Industry:
Dr Marcus Chadha, Agilent Technologies

Dr Marcus Chadha has worked for Agilent for more than four years as a LC-MS Field Application Specialist. His role involves collaborating with Environmental and Food customers, developing new methods and workflows using LC-QQQ and LC-QTOF instruments. He also works with Agilent's sales team providing technical advice and conducting customer demonstrations. Previously Marcus was as a Laboratory Manager for a CRO, heading their LC-MS department. He has a Ph.D. in Analytical Biochemistry where he used LC-MS and 2D-NMR to characterise novel macromolecules"

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ESAI Student Competition 2020

The ESAI held competition for all student oral and poster presentations who presented at Environ 2020. Winners will be invited to submit an article on their research project to the ESAI Website and the ESAI E-Zine 'Environews. Results were announced at the prize giving ceremony at the close of conference at 15:45, Thursday 22nd October.

The prizes and winers this year are:

- **ESAI Best Oral Presentation (€500) sponsored by Environmental Sciences Association of Ireland**
  Merissa Cullen, NUI Maynooth - Comparison of active ingredient and commercial formulated glyphosate on the brain and digestive tract of the bumblebee Bombus terrestris

- **ESAI Best Poster Presentation (€250) sponsored by Environmental Sciences Association of Ireland**
  Tristan Nolan, UCD – Antibiotic resistance genes in bacteria and bacteriophages: A land use study of rivers

- **Best Social Engagement Presentation (€250) sponsored by Environmental Services Ireland**
  Eithne Davis, IT Sligo – Horizon scan of invasive alien species - Predicting the next invasions for the island of Ireland

- **Best Analytical Chemistry Poster (€250) sponsored by Eurachem Ireland**
  Stuart McMichael, University of Ulster – Evaluation of a photoelectrocatalytic reactor for water remediation

- **Best Natural History Presentation sponsored by Irish Naturalists Journal (€250 & 12 month subscription to the Irish Naturalists Journal)**
  Kerry Ryan, Teagasc Research Centre & NUI Galway – Understanding the effects of multi-species grasslands on the diversity and function of the soil microbiome for improving resource use efficiency and mitigating the effects of climate change

- **Best Water Related Presentation (€250) sponsored by Chartered Institution of Water and Environmental Management (CIWEM)**
  Ruben De la Torre Cerro, UCC – Quantifying phenological mismatches: Climate change drivers and their impacts on biotic interactions through different trophic levels in Ireland

- **Best Wastes & Resources Management Presentation (€250 & 12 month CIWM student membership) sponsored by Chartered Institution of Wastes Management (CIWM)**
  Ross O'Sullivan, CIT – The Challenges of Beneficially using Dredged Sediment in Ireland

- **Richard Fitzgerald Prize for Best Aquatic Environment Poster (€250) sponsored by AquaTT**
  Jayne Stephens, UCD – Tide: A driver of faecal indicator bacteria levels in bathing waters

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.

Environ 2020

Dublin City University Water Institute

October 20th – 22nd 2020

Ireland's Water, Energy & Environment in a Climate and Biodiversity Emergency

30th Irish Environmental Research Colloquium

ORAL AND POSTER PRESENTATION SCHEDULE

ENVIRON 2020 CONFERENCE PROGRAMME

	ORAL PRESENTATIONS SESSIONS **Tuesday October 20th 11:00 – 12:45**		
	Session 1 **Biodiversity & Ecosystems**	**Session 2** **Water Quality & Resources 1**	**Session 3** **Climate Change 1**
11:00 - 11.30	Chair: **Dr Thomae Kakouli-Duarte** IT Carlow & ESAI Council Virtual Coffee Break & Networking with delegates interested in Biodiversity & Ecosystems Research	Chair: **Dr Greg McNamara** DCU Virtual Coffee Break & Networking with delegates interested in Water Quality & Resources Research	Chair: **Prof Barry McMullin** Virtual Coffee Break & Networking Session with delegates interested in Climate Change Research
11:30 - 1145	Chair: **Dr Thomae Kakouli-Duarte** IT Carlow & ESAI Council **Keynote Speaker** **Dr Victor Beumer** Earthwatch Europe The implementation of natural solutions in cities for a variety of benefits.	Chair: **Dr Greg McNamara** DCU **Keynote Speaker** **Dr Susan Hegarty** DCU Water Institute Using citizen science to assess freshwater quality	Chair: **Prof Barry McMullin** Environmental literacy and deliberative democracy: A content analysis of written submissions to the Irish Citizens' Assembly on climate change **Diarmuid Torney**
11:45 - 12.00	Examining the effects of farmers' participation in an agri-environment scheme on the quality and quantity of semi-natural habitats' **Andreas Tsakiridis** Teagasc	Effect based monitoring for pharmaceutical pollution in Ireland (EMPIRE project) **Areez Yusuf** DCU	Organisational greenhouse gas emissions reporting: The significance of Scope 3 emissions **Grainne McIvor** DCU
12.00 - 12.15	Biodiversity of aquatic insects in urban environments: The role of man-made ponds in promoting diversity in urban landscapes **Eva Freeney** UCD	Environmental water treatment using electrochemically assisted photocatalysis **Stuart McMichael** UU	Cockles Molly Malone would be proud of? Irish cockle (Cerastoderma edule) growth and potential climate impacts **Kate Mahony** UCC
12:15 - 12:30	Development and application of a rapid high-throughput microfluidics tool for bivalve and crustacean eDNA screening in Irish marine coastal areas **Dennis van der Pouw Kraan** GMIT	Effects of consecutive extreme weather events on a temperate dystrophic lake: a detailed insight into physical, chemical and biological responses **Maria Caldero Pascal** Dundalk IT	The influence of extreme weather events on soils and the role of climate change in soil quality **Vivien Pohl** TU Dublin
12:30 - 12:45			Understanding the effect of multi-species grasslands on the diversity and function of the soil microbiome for improving resource use efficiency and mitigating the effects of climate change **Kerry Ryan** Teagasc Research Centre/NUI Galway

ENVIRON 2020 CONFERENCE PROGRAMME

	ORAL PRESENTATIONS SESSIONS **Tuesday October 20th 14:00 – 15:45**		
	Session 4 **Water Quality & Resources 2**	**Session 5** **Climate Change 2**	**Session 6** **Marine & Coastal 1**
14:00 - 14:15	Keynote Chair: **Yvonne Cannon** Climate Action Region Office (CARO) Dublin Metropolitan **Keynote Speaker Professor Barry McMullin** DCU "Carbon Budgets" and effective climate governance: a brief HOWTO guide	Keynote Chair: **Yvonne Cannon** Climate Action Region Office (CARO) Dublin Metropolitan **Keynote Speaker Professor Barry McMullin** DCU "Carbon Budgets" and effective climate governance: a brief HOWTO guide	Chair: **Dr Burcu Gunes** DCU **Keynote Speaker** **Dr Brendan McHugh** Marine Institute From seabird eggs to sea snails: alternative perspectives on marine monitoring
14:15 - 14:30	In-Situ validation of Sentinel-2 Data for Irish lakes and Transitional and Coastal (TRAC) waters (INFER project) **Valerie McCarthy** DKIT	Assessing society-wide national climate change mitigation scenarios using a warming-equivalent model to aggregate greenhouse gases including methane **Paul Price** DCU	Examining the perceptions of tourists of sustainability pressure indicators on the Wild Atlantic Way **Daniel Norton** SEMRU, NUI Galway
14:30 - 14:45	The issue of microbial contamination within private wells in Ireland **Luisa Andrade** UCC	Paris aligned open energy system model for Ireland **Iftekhar Hussain** DCU	Quantification of persistent organic pollutants in killer whales stranded in Ireland **Moira Schlingermann** GMIT
14:45 - 15:00	Vertical migration of microplastic in agricultural soils. A risk to groundwater? **Linda Heery** UCD	Quantifying phenological mismatches: Climate change drivers and their impacts on biotic interactions through different trophic levels in Ireland **Ruben De la Torres** UCC	
15:00 - 15:15		Quantifying carbon stock of north Bull Island, Dublin **Ruben De la Torres** UCC	
15:15 - 15:45	Chair: **Jenny Lawler** QEERI Virtual Coffee Break & Networking with delegates interested in Water Quality & Resources Research	Chair: **Samantha Fahy** DCU Virtual Coffee Break & Networking Session with delegates interested in Climate Change Research	Chair: **Dr. Burcu Gunes** DCU Virtual Coffee Break & Networking Session with delegates interested in Marine & Coastal Research

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	POSTER PRESENTATIONS SESSION **Tuesday October 20th 15:45 – 16:15**	
	Poster Session 1	**Poster Session 2**
15:45 - 16:15	Chair: **Dr Caroline Wynne** EPA & ESAI Council Featured Research Areas: Water Quality & Resources (WQ	Chair: **Dr. Liam McCarton** TU Dublin and ESAI Council Featured Research Areas: Sustainable Land-Use, Agriculture & Food (SLAF), Biodiversity & Ecosystems (BE)
	Poster with 1 Minute Presentations: WQ1/ Nutrient Sensor for monitoring phosphate in natural waters **Akshay Sinde** DCU WQ2/ Spatial and temporal distribution of lead in drinking water of different water supply zones in Dublin **Jasmine Kaur** UCD WQ3/ Phosphate sensing using a novel and near real-time microfluidic portable sensor **Joyce O'Grady** DCU WQ4/ Using data analytics to predict water level in catchments **Asma Slaimi** DCU WQ5/ Irish peatlands and their connection to water quality **Lisa Geoghan** LIT WQ6/ Socio-economic assessment of water governance and management legislations in the Republic of Ireland **Sarpong Hammond Antwi** DKIT WQ7/ Citizen science investigations in river environmental stewardship: The Maigue river catchment **Donna Weiner** Mary Immaculate College & UL WQ8/ Acclimatize: A Resilient Model for Bathing Water Quality **Niamh Martin** UCD WQ9/ Tide: A driver of faecal indicator bacteria levels in bathing waters **Jayne Stephens** UCD **Meet the Poster Presenters:** WQ10/ HoliFab: Precise flow control using photo actuated hydrogel valves and PI controlled LED actuation for microfluidic MEMS **Ashkay Shinde** DCU WQ11/ A study of temporal variations in pyrethroid pesticide occurrence in Irish surface water environments **Imogen Hands** DCU WQ12/ An Investigation of microplastics in clean water systems **Alice Liddell** QUB WQ13/ Occurrence, sources and fate of pharmaceuticals present in Irish surface waters **Dylan O'Flynn** DCU	**Poster with 1 Minute Presentations:** SLAF1/ Contaminated land - effectiveness of surfactants on heavy metal removal **Ada Szymanska** CDE Global SLAF2/ Disaggregated N2O emission factors associated with deposition of sheep excreta in temperate grasslands **Aude Mancia** Teagasc SLAF3/ Development of a mathematical model for permeability requirements of a bioplastic film for use in modified atmosphere packaging of red meat **Natasha Hutchings** QUB BE1/ The application of CRISPR-Cas to Salmo salar detection from environmental DNA **Molly-Ann Williams** DCU BE2/ Investigation of littoral zone carbon flux in a humic lake in the west of Ireland **Emma Drohan** DKIT **Meet the Poster Presenters:** SLAF4/ STAT5A and STAT3 gene variants in six breeds of Irish beef cattle: implications for milk production and fertility traits **Lyndsey O'Kane** AIT SLAF5/ Estimating the frequencies of meat quality gene variants in Irish beef cattle **Katie Quigley** AIT SLAF6/ Using reconstructed soil microbiomes for improving soil bioremediation **Robert Conlon** IT Carlow SLAF7/ Improving the efficiency of a petroleum degrading bacterial consortia to bioremediation soil contaminated with heavy fuel oil at the former Irish Sugar factory site in Carlow **Mutain Wang** IT Carlow BE3/ Lough Arrow - Conservation status assessment and collaborative actions for the Natura network **Darren Garland** IT Sligo

ENVIRON 2020 CONFERENCE PROGRAMME

	ORAL PRESENTATIONS SESSIONS **Wednesday October 21st 10:00 – 11:45**		
	Session 7 **WasteWater & Water Reuse**	**Session 8** **Interreg Atlantic Area Special Session: Agriculture & Climate Change**	**Session 9** **Environmental Management, Policy & Communication**
10:00 - 10:15	Chair: **Dr Jenny Lawler** QEERI **Keynote Speaker Dr Pilar Fernandez-Ibañez** UU Large solar reactors for rainwater disinfection in Sub-Saharan Africa	Keynote Speaker & Chair: **Dr Edel Doherty** Economics Department, NUI Galway Understanding farmers' attitudes towards climate change adaptation	Chair: **Dr Finbar Brereton** UCD Earth Institute **Keynote Speaker** **Samantha Fahy** DCU Carbon Footprinting as a valuable communication tool
10:15 - 10:30		Water and soil management in a changing climate **Adrian Dowding** Westcountry River Trust, UK	The effectiveness of environmental enforcement instruments to produce increased compliance outcomes and/or sustainability-based outcomes **Ellen O'Connor** UCC
10:30 - 10:45	SAFEWATER: Providing safe drinking water to rural communities in Colombia and Mexico **Tony Byrne** UU	Climate change; Communication; Media; Coastal threats; Communities adaptation **Neide Areia** Centre for Social Studies, University of Coimbra, Portugal	The Irish Climate Action Plan 2019: A case study in multi-level and cross-sectoral policy implementation **Diarmuid Torney** DCU
10:45 - 11:00	Characteristics of wastewater associated with dental practice **Timothy Sullivan** UCC	Remote sensing and territorial analysis to adapt in face of climate change: assessing the risk, exchanging views and connecting actors for a better resilience **Julia James** Association Climatologique De La Moyenne-Garonne et Du Sud-Ouest, France	Horizon scan of invasive alien species - Predicting the next invasions for the island of Ireland **Eithne Davis** IT Sligo
11:00 - 11:15		Can advisory services help bridge the behaviour gap to sustainable farming practices? **Denis O'Hora** Dept. of Psychology, NUI Galway	
11:15 - 11:45	Chair: **Dr Jenny Lawler** QEERI Virtual Coffee Break & Networking Session with delegates interested in WasteWater & Water Reuse	**Group Discussion**	Chair: **Dr Jenny Lawler** Virtual Coffee Break & Networking Session with delegates interested in Environmental Management, Policy & Communications Research

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	ORAL PRESENTATIONS SESSIONS **Wednesday October 21st 14:00 – 15:45**		
	Session 10 **Marine & Coastal 2**	**Session 11** **Energy**	**Session 12** **Sustainable Infrastructure & The Built Environment**
14:00 - 14:15	Chair: **Professor Pat Brereton** DCU Investigation of biogeochemical cycling of nutrients, elements, and carbon in Irish marine transitional zones **Nadeeka Rathnayake** NUI Galway	Chair: **Dr James Carton** DCU **Keynote Speaker** **Emer Dennehy** Data & Insights - Energy Analyst, SEAI Energy modelling for the national energy and climate plan	Chair: **Dr Dorothy Stewart** EPA & ESAI Council **Keynote Speaker** **Brian Gilmore** Cement Manufacturers Ireland Cement, Concrete and the Sustainable Development Goals
14:15 - 14:30	Legacy organic pollutants and pollutants of emerging concern in Irish fishery products **Jenny Smith** Marine Institute	Optimising the installation of solar PV systems on Irish dairy farms **Philip Shine** CIT	An Analysis of the Factors Determining the Use of Solid Fuel as a Supplementary Fuel for Home Heating **John Eakins** UCC
14:30 - 14:45	Shifting larval phenology of the Dublin Bay prawn (Nephrops norvegicus) in a warming ocean **Ryan McGeady** NUI Galway	High levels of renewable energy enabling 'Green Hydrogen' production in Ireland by 2030 **Conor Forde** DCU	Analysing the dry weather influent volumes as a function of maximum tidal water level in Galway, Ireland **Sukanya Sakia** NUI Galway
14:45 - 15:00	Establishing a winter pCO2 baseline in Irish coastal waters **Aedín McAleer** NUI Galway	Sensitivity of net-zero greenhouse gas emission pathways on social discount rate assumptions in an energy system optimization model **Jason Maguire** MaREI, UCC	The Challenges of Beneficially using Dredge Sediment in Ireland **Ross O'Sullivan** CIT
15:00 - 15:15	A critical analysis of enforcement of sea-fisheries law in Ireland **Laurie O'Keeffe** UCC		
15:15 - 15:45	Chair: **Prof Pat Brereton** Virtual Coffee Break & Networking Session with delegates interested in Marine & Coastal Research	Chair: **Dr James Carton** Virtual Coffee Break & Networking Session with delegates interested in Energy Research	Chair: **Dr Dorothy Stewart** EPA & ESAI Council Virtual Coffee Break & Networking Session with delegates interested in Sustainable Infrastructure & The Built Environment, Urban Development & Air Quality Research

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	POSTER PRESENTATIONS SESSION **Wednesday October 21st 15:45 – 16:15**	
	Poster Session 3	**Poster Session 4**
15:45 - 16:15	Chair: **Dr. Joe Harrington** CIT & ESAI Council Featured Research Areas: Marine & Coastal, (MC) WasteWater & Water Reuse (WW), Food-Water-Energy Nexus (FWE)	Chair: **Dr. Niamh Power** CIT & ESAI Council Featured Research Areas: Sustainable Transport (ST), Energy (E), Climate Change (CC), Air Quality (AQ)
	Poster with 1 Minute Presentations: MC1/ Co-occurrence of complex parasite assemblages in the cockle Cerastoderma edule in the Irish coast **Sara Albuixech Marti** UCC MC2/ Impact of biofouling on membranes of diffusive gradient in thin film passive sampling devices for priority metals **Martin Nolan** DCU MC3/ The Impact of electromagnetic fields and chemicals from the subsea power cables on marine species **John Ohuneye** TCD WW1/ A Statistical Monitoring Approach for Non-residential Water Distribution Systems **Hafiz Hashim** NUI Galway **Meet the Poster Presenters:** MC4/ An investigation and visualisation of the stratification of abiotic properties of Irish coastal and estuarine waters **Philippa Wilkes** IT Carlow MC5/ Investigations of the performance of a marine antifouling material inspired by Scophthalmus rhombus **Chloe Richards** DCU MC6/ Application of PDMS Passive Sampling for the Analysis and Quantification of Dissolved Water Concentration of Priority Contaminants in Water Bodies in Support of Compliance Monitoring **Denis Crowley** Marine Institute WW2/ Evaluating novel PMMA SODIS reactors for leachables in South Africa **Paloma Ozores Diez** DCU WW3/ Development of an in-house rig for measuring bubble velocity for validating computational simulation results of UASB reactors **Ramon Santos** TU Dublin WW4/ Microbial acclimation to salinity in the anaerobic digestion process **Claribel Buenano** NUI Galway FWE1/ Photoelectrochemical oxidation of nitrogen compounds in wastewater and hydrogen production **Adriana Rioja Cabanillas** UU	**Poster with 1 Minute Presentations:** AQ1/ The Integration of Scientific Evidence into the Formulation of Environmental Law and Policy **Rhoda Jennings** UCC AQ2/ Emissions from and fuel consumption associated with off-road vehicles and other machinery **Rita Hagan** TU Dublin E1/ Innovative Energy Tracking; Changing the way we use energy **Odhran Casey** DCU E2/ Co-digestion of cattle slurry and Lolium perenne silage for butyric acid production **Fabiana Maria Coelho** NUI Galway CC1/ Exploring dragonflies and damselflies as indicators of climate change **Dave Wall** National Biodiversity Data Centre CC2/ ENERGE - Energizing Education to Reduce Greenhouse Gas Emissions **Raquel de Castro Rodirgues** Lima, NUI Galway ST1/ Modelling climate policy success: Applying a car stock model to an ex-post analysis of climate taxation Regime **Vera O'Riordain** MaREI, UCC ST2/ Developing sustainable scenarios for passenger light-duty vehicles in Ireland **Vahid Aryanpur** MaREI, UCC **Meet the Poster Presenters:** E3/ Developing an understanding for the role of hydrogen in Ireland's decarbonisation strategy **Kelvin Martins** DCU AQ3/ Development of an algorithm to predict pollution levels in cities caused by vehicles **Keer Xu** TU Dublin

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	ORAL PRESENTATIONS SESSIONS **Thursday October 22nd 11:00 – 12:45**		
	Session 13 **Human Health & Environment**	**Session 14** **Ecotoxicology**	**Session 15** **Sustainable Land-Use, Agriculture & The Food Industry**
11:00 - 11:30	Chair: **Dr Jean O'Dwyer** UCC & ESAI Council Virtual Coffee Break & Networking Session with delegates interested in Human Health & Environment	Chair: **Prof Frances Lucy** IT Sligo & ESAI Council Virtual Coffee Break & Networking Session with delegates interested in Ecotoxicology Research	Chair: **Dr Tom Curran** UCD & ESAI Council Virtual Coffee Break & Networking with delegates interested in Sustainable Land-Use, Agriculture & The Food Industry Research
11:30 - 11:45	Chair: **Dr Jean O'Dwyer** UCC & ESAI Council **Keynote Speaker:** **Dr Ian Marnane** Inspector, Environmental Protection Agency Egotistical environmentalism: looking after number one	Chair: **Prof Frances Lucy** IT Sligo & ESAI Council Persistent organic pollutants and heavy metal concentrations in Northen Gannet (Morus bossanus) eggs in two island colonies in Ireland **Andrew Power** GMIT	Chair: **Dr Tom Curran** UCD & ESAI Council **Keynote Speaker:** **Marcus Chadha** LC-MS Field Application Specialist, Agilent Technologies Combating PFAS 'The Forever Chemical' contamination
11:45 - 12:00	Bathing waters - a transmission route for antimicrobial resistance **Kelly Fitzhenry** NUI Galway	An investigation of mycotoxin induced DNA damage in porcine intestinal cells. **Asmita Thapa** DCU	Irish farmers' willingness to use recycled derived fertiliser products **Aoife Egan** CIT
12:00 - 12:15	A Point Prevalence Survey of Antimicrobial Resistance in the Aquatic Environment, Ireland 2018-2019 **Brigid Hooban** NUI Galway	A study on the ecological impact of recycling derived fertilisers (RDFs) using nematodes as environmental bioindicators **Ana Karpinska** IT Carlow	Using the life cycle assessment approach to contribute to a sustainable seafood sector **Sinead Mellett** AIT
12:15 - 12:30	What lurks beneath the PIER - are recreational water users at risk from superbugs? **Maeve Louise Farrell** NUI Galway	Comparison of active ingredient and commercial formulated glyphosate on the brain and digestive tract of the bumblebee Bombus terrestris **Merissa Cullen** NUI Maynooth	Analysis of data submitted under NECD across Europe **Katie Wyer** UCD
11:30 - 11:45			Day length perception in perennial ryegrass **Michael Richards** UCC

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	ORAL PRESENTATIONS SESSIONS **Thursday October 22nd 13:30 – 14:45**	
	Session 16 **Technology & The Environment**	**Session 17** **Waste Management**
13:30 - 13:45	Chair: **Dr John Gallagher** TCD & ESAI Council Distributed Ledger Technologies to Globally Coordinate Grass-Roots Driven Actions on Climate, Biodiversity and the Environment **Jens Ducrée** DCU	Chair: **Dr Liam McCarton** TU Dublin & ESAI Council Developing a plastic reduction programme for Irish households and schools **Abigail O'Callaghan** VOICE Ireland
13:45 - 14:00	The dairy biorefinery: integrating biological, physical and electrochemical processes for cheese whey valorisation **Paolo Dessi** NUI Galway	The use of MSW-compost on land, a study of metal and nutrient leaching **Jessica Graca** DCU
14:00 - 14:15	LimerickAir - a distributed network of low cost monitors mapping particulate air pollution **Brendán Anraoi MacGabhann** Mary Immaculate College, UL	The drivers and advancement of a phosphorus deficient growing medium, for the testing of recovered phosphorus fertilisers. **Ciaran O'Donnell** CI
14:15 - 14:30	Customisable Benchtop Platform for the detection of Nitrite and Nitrate utilising Colorimetric Chemistries **Andrew Donohoe** DCU	Physio-chemical characterisation and ecotoxicology risk assessment of starch and gelatine blend bioplastics **Marta Mroczkowska** IT Carlow
14:30 - 14:45	Electrochemically assisted cheese whey fermentation for CO2-free volatile fatty acids production **Marco Isipato** University of Cagliari, Italy	
14:45 - 15:15	Chair: **Dr John Gallagher** TCD & ESAI Council Virtual Coffee Break & Networking Session with delegates interested in Technology & The Environment Research	Chair: **Liam McCarton** TU Dublin & ESAI Council Virtual Coffee Break & Networking Session with delegates interested in Waste Management Research

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	POSTER PRESENTATIONS SESSION **Thursday October 22nd 15:15 – 15:45**	
	Poster Session 5	**Poster Session 6**
15:15 - 15:45	Chair: **Dr. John Gallagher** TCD & ESAI Council Featured Research Areas: Technology & The Environment (TE), Ireland 2050 (IRL2050), Waste Management (WM)	Chair: **Dr Jean O'Dwyer** UCC & ESAI Council Featured Research Areas: Human Health (HH), Ecotoxicology (ETox)
	Poster with 1 Minute Presentations: WM1/ Enhancing anaerobic digestion of oleate by conductive materials **Yuchen Liu** NUI Galway WM2/ Towards circularity in the supply chain: An exploration into the opportunities and challenges of implementing new sustainable business models in fashion **Stephen King** TU Dublin TE1/ Development of multi-parameter system sensing for environmental monitoring **Ibthihaj Albalawi** UCC TE2/ Determination of NSAID drugs using Micellar Electrokinetic Chromatography with UV detection **Hanan Alatawi** UCC TE3/ Thermal analysis of an indoor office room using smart window for improved physiological and responses on inhabitants and workers **Yona Arike Samuel** IT Carlow IRL2050/ Qualifying and quantifying the Reuse sector in Ireland **Keelin Tobin** Clean Technology Centre **Meet the Poster Presenters:** WM3/ An economic evaluation of the treatment of piggery waste through small-scale anaerobic digestion **Sean O'Connor** IT Sligo TE4/ Evaluation of a photoelectrocatalytic reactor for water remediation **Stuart McMichael** UU TE5/ Microbes and the Environment: establishing the broader impact **Huili He** IT Carlow	**Poster with 1 Minute Presentations:** ETox1/ Modelling the effect of moulting on metallic pollutant accumulation in freshwater macroinvertebrates **Irene O'Callaghan** UCC HH1/ Detection of Verotoxigenic Escherichia coli (VTEC) in Irish private groundwater wells **Liam Burke** NUI Galway HH2/ Antibiotic resistance genes in bacteria and bacteriophages: A land use study of rivers **Tristan Nolan** UCD HH3/ Development of lab-on-a-chip detection system for environmental monitoring of Polychlorinated Biphenyls (PCBs) in soil **Samia Alsefri** UCC HH4/ Balancing conservation of the natural environment with outdoor recreation: An investigation of stakeholder perceptions **Maura Kiely** NUI Galway HH5/ Investigating the presence of microplastics in rivers flowing into Dundalk Bay **Stephen Kneel** DKIT HH6/ Is water quality a determinant of beach choice? A survey of bathing water users in the West of Ireland Maeve **Louise Farrell** NUI Galway HH7/ Environmental factors modulating Lyme disease risk in Ireland **Riona Walsh** NUI Galway **Meet the Poster Presenters:** ETox2/ The impact of algal food on phenotypic endpoints of daphniids **Allan McGivern** DCU HH9/ The impact of environment on micro and macronutrients in meat **Sofia Skoumpa** IT Carlow HH10/ The human health risk of exposure to the microplastics in daily life **Luming Yang** TCD HH11/ The Impact of climate change on healthcare **Naayema Hussaini** Association of Medical Students, TCD

Environ 2020

Dublin City University Water Institute

October 20th – 22nd 2020

Ireland's Water, Energy & Environment in a Climate and Biodiversity Emergency

30th Irish Environmental Research Colloquium

ORAL PRESENTATION ABSTRACTS

Assessing the Impact of Farmers' Participation in Agri-environmental Schemes on the Ecological Quality of Semi-natural Habitats

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Agri-environmental schemes (AESs) have been developed by governments as a response to farmland biodiversity declines mainly caused by agricultural intensification. Despite the substantial amount of money spent by governments on designing, implementing, and monitoring these schemes, the environmental effectiveness of AESs is ambiguous. A variety of studies have been undertaken to evaluate the environmental effects of AESs through the examination of specific environmental measures or geographical areas. However, studies examining the effectiveness of AESs at national scale are scarce. We aim to fill this gap in the literature by combining habitat and socio-economic survey data from approximately 200 nationally representative Irish farms in 2012, and quantitatively assessing the ecological impact of farmers' participation in AES on on-farm habitats. Results from propensity score matching analysis highlight the absence of statistically significant effect of participation on habitats' ecological quality.

Keywords: Policy impact evaluation, Agri-environmental schemes, Propensity score matching, Ireland

Biodiversity of Aquatic Insects in Urban Environments:
The Role of Man-made Ponds in Promoting Diversity in Urban Landscapes

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Urbanisation has caused a decline in freshwater biodiversity by contributing to the loss, fragmentation and pollution of natural habitats. Ponds are known to support a rich diversity relative to their size, contributing significantly to regional aquatic species diversity. In urban environments ponds are common water features but few studies have assessed how these habitats are supporting aquatic biodiversity in Ireland. This study sampled eight aesthetic, drainage and nature reserve ponds in the greater South East Dublin urban environment. Coleoptera and Hemiptera were sampled using a cluster of 6 horizontal activity traps (combined trap entrance area of 0.034m^2 per cluster) deployed for 144hrs, at six sampling points on the edge of each pond. The macroinvertebrates collected were identified to species level, where possible. A total of 27 Coleoptera taxa (mostly *Dytiscidae*) and 15 Hemiptera taxa (mostly *Corixidae*) were recorded in this study. There was significant difference in the species richness, species abundance, and community composition between ponds. The results indicate that most ponds contribute uniquely to urban aquatic diversity, and the level of rare taxa (%) present at each pond was high. Well vegetated ponds, although this included alien invasive species, presented a diversity of habitats and seemed to support a greater species richness of both Coleoptera and Hemiptera. Ponds in urban environments have complex catchments that present a real challenge for management. This study shows that these habitats seem to support a unique, large set of insect species and careful management is required to maintain and enhance aquatic diversity in our cities.

Keywords: Urban environment, Biodiversity, Ponds, Aquatic insects

Development and application of a rapid high-throughput microfluidics tool for bivalve and crustacean eDNA screening in Irish marine coastal areas

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Bivalves and crustaceans are key taxonomic groups that play pivotal roles in ecosystems and comprise a significant component of fisheries and the aquaculture industry. Understanding factors that affect habitat preference and recruitment patterns in the wild can be a key component of effective management strategies and requires effective and rapid monitoring tools. Using genomic DNA of target organisms, a multi-species panel of molecular assays was developed and validated on a microfluidic platform to detect 15 ecologically and economically important bivalve and crustacean species in heterogeneous environmental samples. The newly developed tool was then tested on zooplankton samples that were collected fortnightly (between July and November 2019) in eight locations around the Irish coast (n = 67). Results displayed distinctive patterns in molecular signal across locations and time points for species. Number of species detected per site per time point ranged from seven to three, with commercial species such as *Mytilus spp,* and *Crassostrea gigas* being detected across time series. Other target species detected in the tested locations were *Cerastoderma edule*, *Pecten maximus*, *Aequipecten opercularis*, *Cancer pagurus*, *Paelemon serratus*, *Necora puber*, *Mya brachydactyla* and *Spisula solida*. Further work will aim to determine limits of detection, as well as applicability to detect spawning events and relative biomass estimation. Such novel method showed to be an effective and rapid screening tool for detecting a range of bivalve and crustacean species in plankton samples, with the potential to revolutionise marine biodiversity monitoring. The development and application of such tools will play a critical role in the effective management of natural resources and hence enable national sustainable growth strategies and international policy.

Keywords: Environmental DNA, marine zooplankton, biodiversity, ecosystem monitoring, high throughput microfluidics

Biodiversity and Ecosystems

A genomic assessment of the genetic integrity of Irish *Bombus terrestris* (ssp. *audax*)

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Bombus terrestris (L.) is an important species of bumblebee pollinator that is both native to Ireland and commercially imported for fruit pollination. Historically, non-native continental European subspecies were used for crop pollination in Ireland. However, in recent years, only colonies of the Irish and British subspecies (*B. terrestris audax*) are imported into the country. The importation of commercial colonies poses several risks to native pollinator populations, including hybridisation with locally adapted species. Evaluating the genetic diversity and distinctness of the Irish *B. terrestris* population is essential to understand and protect the integrity of our genetic resources. Individual-based, whole genome sequencing (WGS) is an unbiased approach for assessing huge quantities of biomarkers across the bumblebee genome. The genomes of 32 wild, Irish male *B. t. audax* bumblebees from 27 sites across Ireland were selected for sequencing, as well as some German, Turkish and commercial representatives. After WGS on the Illumina NovaSeq6000, sequence data were quality-assessed, filtered and aligned. Variant calling was performed to assess biallelic single nucleotide polymorphisms (SNPs). A principal component analysis (PCA) and ADMIXTURE analyses were used to assess population structure between Irish and non-Irish bumblebees while F_{ST} estimates were calculated to identify divergent alleles among Irish and non-Irish bees. Genetic diversity within the Irish population was evaluated using PopGenome. Both PCA and ADMIXTURE analyses indicate a single Irish *B. terrestris* population on the island of Ireland and a separate non-Irish population. Evidence of admixture with non-Irish bees was found, mainly in the Eastern counties of Ireland. Contrary to nuclear SNP data, numerous mitochondrial haplotypes were identified in the Irish population, perhaps ancestral or a result of recent hybridisation events. This study's findings will have implications for future policy development and the management of commercial bumblebee imports in Ireland.

Keywords: Bumblebee, pollinators, genome, population genetics, hybridisation

Effect Based Monitoring for Pharmaceutical Pollution in Ireland (EMPIRE project)

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Pharmaceutical pollution has been a source of global concern in the last two decades due to increased consumption especially in OECD countries. Pharmaceuticals are developed to be effective even at low concentration and leaching of these drugs into surface waters can occur. The presence of low dose pharmaceuticals in surface waters could have potential toxic effects to both humans and aquatic organisms. For instance, there are reports linking increased pharmaceutical pollution of surface water to rising antibiotic resistance and abnormal reproductive behaviours in aquatic animals. The unavailability of effect based bioassays to test for the presence of pharmaceuticals in surface waters hinders water quality assessment. The EPA funded project, EMPIRE, aims to develop an effect based monitoring system using a combination of *in vitro* and *in vivo* bioassays for determination of pharmaceutical pollution in Irish surface water. A list of thirteen chemicals including diclofenac, EE2, erythromycin, azithromycin, amoxicillin, and ciprofloxacin have been identified from EPA watch list and priority list. Trimethoprim, sulfamethoxazole and carbamazepine have also been selected from NORMAN list of Emerging Substances as they are commonly found in European surface waters with low elimination efficiency from wastewater treatment plants. Based on the reports from the literature review and NORMAN recommendations, a list of seven mode of actions (MOAs) including estrogenicity, androgenicity, oxidative stress response, genotoxicity and activation of aryl hydrocarbon receptors have been mapped for testing. We will also look at the effect of the pharmaceuticals on life cycle and global gene expression of *Daphnia magna* as well as on growth of specific algae. It is hoped that the findings of this study will serve as a proof of concept and validation of effect based monitoring tools in addition to generation of data on environmental impact of the selected pharmaceuticals.

Keywords: Emerging pollutants; EPA watch list; effect based monitoring

Environmental water treatment using electrochemically assisted photocatalysis

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Electrochemically assisted photocatalysis (EAP) is an advanced oxidation process i.e. produces hydroxyl radicals, these radicals can degrade a range of chemicals, bacteria or viruses. The technology can therefore be used for various environmental water treatment solutions. This work examined the treatment of rainwater by analysing the inactivation of environmental strains of *Escherichia coli* (*E. coli*) and *Pseudomonas aeruginosa* (*P. aeruginosa*) using culture-based and EMA-qPCR methods. The EAP system used consisted of a TiO_2 nanotube photoelectrode, with a carbon felt counter electrode. A second system was tested in tandem to assess only solar irradiation. During testing, the natural solar irradiation had a maximum intensity of 13 Wm^{-2}, to increase the solar irradiation into the systems a compound parabolic collector was used. The disinfection results showed that the EAP system was more effective, achieving a 5.5-log_{10} reduction for *E. coli* and a 5.8-log_{10} reduction for *P. aeruginosa* when using culture-based analysis. The EMA-qPCR showed a 2.4-log_{10} reduction in gene copies for *E. coli* and 3.0-log10 for *P. aeruginosa*.

Keywords: TiO2 Nanotubes, Solar disinfection, EMA-qPCR, Electrochemically assisted photocatalysis, *Pseudomonas aeruginosa*

Water Quality and Resources 1

Effects of consecutive extreme weather events on a temperate dystrophic lake: a detailed insight into physical, chemical and biological responses

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Between May and July 2018, Ireland experienced an exceptional heat wave, which broke long-term temperature and drought records. These calm, stable conditions were abruptly interrupted by a second extreme weather event, Atlantic Storm Hector, in late June. Using high-frequency monitoring data, coupled with fortnightly biological sampling, we show that the storm directly affected the stratification pattern of Lough Feeagh, resulting in an intense mixing event. The lake restabilised quickly after the storm as the heatwave continued. During the storm there was a three-fold reduction in Schmidt stability, with a mixed layer deepening of 9.5 m coinciding with a two-fold reduction in chlorophyll *a* but a three-fold increase in total zooplankton biomass. Epilimnetic respiration increased and net ecosystem productivity decreased. The ratio of total nitrogen:total phosphorus from in-lake versus inflow rivers was decoupled, leading to a cascade effect on higher trophic levels. A step change in nitrogen:phosphorus imbalances suggested that the zooplankton community shifted from phosphorus to nitrogen nutrient constraints. Such characterisations of both lake thermal and ecological responses to extreme weather events are relatively rare but are crucial to our understanding of how lakes are changing as the impacts of global climate change accelerate.

Keywords: Heat waves, summer storms, mixed layer deepening, nutrient imbalances, temperate dystrophic lakes

Water Quality and Resources 1

Association of potential human pathogens with microplastics in freshwater systems

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Microplastics (MPs) have been known as long lasting anthropogenic contaminants and as a global environmental concern. As persistent pollutants, MPs have been recognised as vectors for human pathogens. MPs are rapidly colonised by microbial communities due to their high surface area to volume ratio and hydrophobicity. Studies show that MPs not only interact with microorganisms directly, but also play a major role as vectors for other pollutants, which interact indirectly with microorganisms. However, there are a limited number of studies on bacterial colonization of MPs in freshwater. In the present research a bacterial colonization experiment was conducted with polyethylene MP particles exposed to water in the River Barrow, Carlow, Ireland. MP beads were placed *in-situ* in the river and in *ex-situ* river water samples in the laboratory, for a duration of 14 days. Results from high throughput 16S rDNA sequencing revealed that bacterial communities colonising the MP incubated in the river or in the laboratory, differed in both abundance and diversity. Potentially pathogenic species, such as *Enterobacter* sp., *Campylobacter* sp., *Enterococcus* sp., *Helicobacter* sp., *Clostridium perfringens,* and *Escherichia coli* were identified. This could indicate that MPs act as a distinct habitat for bacteria, and increase the risks associated with their entrance in the food chain.

Keywords: Microplastics (MPs), microbial community, pathogens, freshwater, 16S rDNA, polyethylene

Climate Change 1

Environmental Literacy and Deliberative Democracy: A content analysis of written submissions to the Irish Citizens' Assembly on climate change

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Amid pressure for climate action worldwide, processes of deliberative democracy are being called upon to address public policy complexities, include citizens in decision-making, restore faith in public institutions and enhance governance processes. The citizens' assembly model is lauded internationally for the much-needed structure it provides to support bottom-up governance efforts as well as the potential for effective citizen engagement on complex topics. The Irish Citizens' Assembly, which took place from 2016 to 2018, is heralded as an example of best practice in design and execution. Yet, there is a dearth in analysis of its form, structure, impact and content, particularly in the climate crisis context. This paper examines one element of the deliberative democracy process that aimed to include a wider breadth of publics beyond the 99 citizens randomly selected to take part: the public submissions invited as part of the Citizens' Assembly process. In total, 1,185 submissions were received on the topic of climate change. Our study undertakes a comprehensive content analysis of these submissions. Specifically, we explore 1) the content and concerns foregrounded within the submissions; 2) the frames and rhetorical strategies employed; and 3) the stakeholders and scales called upon for climate action. The study identifies trends, preoccupations, and salience within the corpus of written submissions and expands our understanding of citizen perceptions of climate science and policy. We offer both operational lessons for others aiming to enact similar deliberative forums as well as communications lessons for wider efforts to deepen public engagement on the climate crisis.

Keywords: Climate Change, Irish citizens' assembly, deliberative democracy

Climate Change 1

Organisational Greenhouse Gas Emissions Reporting: The Significance of Scope 3 Emissions

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Higher Education Institutes often exclude Scope 3 emission sources from their carbon footprint (CF) calculations due to lack of technical knowledge on how to do this or because they are viewed as insignificant compared to Scope 1 & 2 emissions. To investigate the validity of this approach, a study conducted at Dublin City University for the 2018 calendar year, investigated the significance of Scope 3 emissions for a Higher Education Institute (HEI) using the Greenhouse Gas Protocol Corporate Accounting and Reporting standard (The GHG Protocol standard). Emissions (including indirect emissions) were quantified using emission factors, a real time management tool and a spend based Environmentally Extended Input Output (EEIO) system to calculate the procurement related emissions. This study found that emissions from Purchased Goods & Services (Scope 3 emissions) were the largest contributor of overall university emissions at 48%, with construction related procurement the largest percentage of this. As a result, Scope 3 emissions should be included in all CF's calculations for an effective future mitigation strategy. The methodology used in this project can also be used by other national Higher Education Institutes (HEI's) to calculate a CF, although it is recommended future CF calculation move toward a hybrid method rather than a spend based method to quantify procurement related emissions.

Keywords: Carbon footprint; scope 3 emissions; university mitigation

Cockles Molly Malone would be proud of? Irish cockle (*Cerastoderma edule*) growth and potential climate impacts

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The common cockle is culturally, economically and ecologically important in Ireland and across Europe. Previous studies indicated a faster growth rate in cockles at Dundalk Bay, Co. Louth compared to other sites in Ireland and the UK. This study looked at the influence of latitude and environmental parameters on cockle growth rates in fished (F) and non-fished (NF) populations at a range of Irish and Atlantic Area European sites. Approximately 30 cockles were sampled bimonthly from April 2018 to October 2019 from sites in Ireland, Wales and France. The morphometric data of 2,133 cockles were measured, allowing the estimation of Von Bertalannfy growth parameter estimates. Biotic and abiotic were included in a mixed effects model to determine if they impacted growth. Results confirmed that Dundalk cockles grew fastest until year three, when growth slowed, possibly due to fishing activity. Cockles at Carlingford (impacted by trematodes and reduced salinity) exhibited the slowest initial growth upon examination of growth curves. Cockles at the Dee attained smaller maximum sizes more slowly than the latitudinally equivalent Dundalk, possibly due to higher population density. Cockles at Cork, achieved the largest sizes, likely due to their non-fished status. Cockles at Arcachon, the warmest site, grew more slowly in their initial life stages, potentially due to increased energy allocation to reproduction. With the possibility for these parameters to vary as a result of climate change, in particular for increased water temperatures, reduced salinity due to predicted increased precipitation, greater freshwater loadings into near shore ecosystems and increased trematode transmission, cockle growth in Dundalk may be negatively impacted, thus threatening the Irish fishery.

Keywords: Climate change, growth rates, fisheries

Climate Change 1

The influence of extreme weather events on soils and the role of climate change in soil quality

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Increasing global temperature has acted as a driver for change in the climate system at both a local and global level. Extreme weather events such as heavier precipitation and windstorms have become more apparent and are more frequent in recent years in Ireland and across Europe. These extreme weather events influence various sectors of the socio-economic system. One of the most notable and vulnerable sectors is agriculture which is primarily affected through impacts on crop productivity. Agriculture also plays a major role in regulating climate systems and has contributed to the global alteration of the nitrogen (N) cycle through the emission of reactive N species. Rainfall is a key driver in the transport of environmental pollutants, as well as leaching of nutrients from soils and inducing physical changes. Using ion chromatography, X-ray fluorescence (XRF) and inductively coupled plasma mass spectrometry (ICP-MS), the initial structure and the changes occurring due to extreme precipitation were analysed in agricultural soils from two sites in Fingal County Council, Ireland. The experimental setup explored soil structure and dynamics under low and high temperatures simulating field measurements (-5°C and 35°C respectively). The biggest physico-chemical changes were observed in the initial cycles. However, the changes occurring in each case showed unique site specificity, due to associated differences in soil structure. Recognizing the impact of extreme precipitation events on soil physico-chemical character and the associated emission of reactive N species is a prerequisite to the development of effective adaptation and mitigation strategies for the preservation of soil quality in response to increasing global temperatures and the more extreme weather conditions induced by climate change.

Keywords: Soil, soil quality, nitrogen, agriculture, climate change

Climate Change 1

Understanding the effect of multi-species grasslands on the diversity and function of the soil microbiome for improving resource use efficiency and mitigating the effects of climate change

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Population growth is leading to the intensification of agricultural systems globally, driving the need for more efficient agricultural production systems that enable increased, climate-resilient food production, while minimising environmental impacts. Multi-species grasslands have been shown to be more productive and have greater nitrogen use efficiency than less species-diverse grasslands. However, it is less understood how the greater aboveground pasture species-diversity affects belowground microbial communities and the underlying mechanisms of nutrient cycling. This study aimed to provide a better understanding of how 1) diverse forage plant communities and 2) climatic stress, affect the diversity and function of the soil microbiome. Soil samples were taken from 86 plots in an established experimental grassland site; before and during a drought treatment, 24 hours after re-wetting and 6 weeks after re-wetting. Molecular assays assessed the abundance of phylogenetic and functional N-cycling microbial communities across treatments, and sequencing approaches were used to assess microbial community composition. Community function was found to be primarily affected by plant species. Plantain monocultures were found to have the lowest potential denitrification rates while leguminous monocultures had the highest rates of biological nitrogen mineralisation. The 16S *rRNA* bacteria gene was most abundant in chicory monocultures, whereas there was no difference in the abundance of the 16S *rRNA* archaea gene between monocultures. This work provides an enhanced understanding of the impact of above-ground diversity on below-ground diversity and function, and of the potential use of diverse forage mixtures to enhance the resistance/resilience of soil microbial communities in response to climate related stresses.

Keywords: Soil microbiome, multi-species grasslands, climate change

Water Quality and Resources 2

In-Situ Validation of Sentinel-2 Data for Irish Lakes and Transitional and Coastal (TRAC) waters (INFER project)

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Aquatic ecosystems are crucial for human well-being and have important functions in the environment. Management of these waterbodies needs an integrative and adaptive approach that can provide a comprehensive and reliable overview of current status. Conventional monitoring is often time consuming, labour intensive and costly. In many cases, this means waterbodies are often sampled infrequently and at relatively few sampling points. Low spatial and temporal resolution only provides a snapshot in time and does not allow for detailed studies of changes and temporal trends, and does not consider short-term extreme changes. The use of 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. With the launch of the MSI onboard Sentinel-2 there are greater opportunities to study smaller inland waterbodies with more frequent return times over a geographic location. Data from satellites are derived using algorithms that estimate the atmospheric properties and reflectance of the waterbody. To improve on these estimations the INFER Project (EPA Strive Funding Project Code: 2017-W-MS-30) aims to measure reflectance *in situ* across various lake and TRAC waterbodies using a two hyperspectral radiometer setup with a sun glint removal method. We are collecting water quality data to compare data derived from the satellite as it passes over the sampling area. The collection of reflectance measurements will inform algorithms with the goal of increasing the reliability of data extracted from satellite imagery, which could be used alongside more traditional methods to increase the coverage of waterbodies monitored and fill the current gap in water quality monitoring programmes.

Keywords: Remote Sensing, Earth observation, Water Quality, Monitoring, Lakes, Coastal water

The Issue of microbial contamination within private wells in Ireland

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In Ireland, as in much of the world, lack of regulation in small-scale groundwater extractions leads to a higher risk of microbial contamination, leaving consumers vulnerable to adverse health impacts. For example, Irish private wells are associated with the transmission of Verotoxigenic *Escherichia coli* (VTEC), a waterborne infectious disease, for which Ireland has the highest incidence rate in Europe. As such, and in line with the United Nations Sustainable Development Goal 6, this research aims to identify significant threats leading to microbial contamination within private groundwater supplies (servicing 16% of the Irish population. In total, 132 private wells from 21/26 Irish counties were assessed for the presence of *Escherichia coli*, a well-established faecal indicator, as well as *Pseudomonas aeruginosa*, an opportunistic soil/water resident. Analytical results highlight the prevalence of bacterial contamination, with 35 (26.5%) and 8 (6%) of the 132 wells analysed (September-November 2019) testing positive for *E. coli* and *P. aeruginosa*, respectively. While *P. aeruginosa* were only found in supplies from high (H=6.5%) and extreme (E=6.5%; X=14.3%) groundwater vulnerability, *E. coli* were found across all vulnerability categories. Site survey results also demonstrate that nearly 60% of supplies lack basic protective features, and that 14% of wells were located within 30m of a septic tank and 55% within 25m of animal grazing/slurry spreading fields, conflicting with existing guidelines. These preliminary results seem to indicate that a combination of local hydrogeology and lack of well stewardship practices may be triggering the persistent issue of microbial groundwater contamination in Ireland.

Keywords: Microbial contamination, groundwater, private wells, *Escherichia coli, Pseudomonas aeruginosa*

Vertical migration of microplastic in agricultural soils. A risk to groundwater?

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The prevalence of microplastic (MP), polymeric particles (1 µm - 5 mm), is an increasing concern in our marine and freshwater systems. International research efforts have mainly focused on the abundance, characteristics and implications of plastic pollution in marine settings, with the transport and fate of plastics in terrestrial and freshwater systems being less well understood. The pathway from land to sea is significant in the Irish context given the widespread use of MP rich biosolids for soil conditioning in agricultural lands. To investigate the potential vertical movement of MP through agricultural soil, a laboratory drainage experiment was initially conducted using homogenously packed vertical sand columns. Polymer types (PVC, PET and LDPE), size (<150 µm, 150-300 µm) and physical condition (virgin and weathered states) were examined. Each test, conducted in triplicate, investigated the vertical movement of MP that was seeded on the surface of the columns and subjected to simulated rainfall of varying intensity for different durations (up to 20 hours). The results indicate limited MP mobility as all seeded MPs were recovered within the top 5 cm. To confirm these findings, a further investigation involving the extraction of 2 m deep cores from a down-slope transect of an agricultural field was undertaken. This field had been treated with thermally dried wastewater treatment plant sludge annually for ~20 years. The dispersion and depth of MPs were observed through laboratory testing. Results indicate that most MPs were retained in the upper c. 30 cm (plough zone) of each core with penetration of biosolid MPs to depths below this being considerably more limited. Concentrations of MPs found within the plough zone were lower than expected (0.14 to 0.03 MP per gram of soil), suggesting that vertical migration through the soil matrix of biosolid MPs is not a significant hydrological transport pathway.

Keywords: Microplastic, freshwater, soil, pathways, environmental fate

Climate Change 2

Assessing society-wide national climate change mitigation scenarios using a warming-equivalent model to aggregate greenhouse gases including methane

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Estimated CO_2-only global carbon budgets (GCBs) critically depend on achieving reductions in nitrous oxide (N_2O) and in short-lived methane (CH_4). Therefore, a nation's "low carbon transition" needs to be completed within its 'fair share' quota of the aggregate global greenhouse gas (GHG) budget. For Ireland, assessing climate action including these non-CO_2 gases is important because a comparatively large fraction of reported emissions is due to N_2O and CH_4, arising primarily from ruminant agriculture. However, the warming commitment of mitigation scenarios that include CH_4 have been difficult to evaluate as the standard GHG equivalence metric, GWP_{100}, fails to reflect the physical reality that sustained reductions in CH_4 *flow* can result in a substantial reduction in its total warming-equivalent contribution within 10 to 20 years. A new metric, called GWP*, approximates changes in the warming-equivalent (CO_2-we) contribution of short-lived climate pollutants such as CH_4. Incorporating the GWP* methodology, we have developed an open source model to project GHG warming-equivalent commitments (by gas and in aggregate) of policy-relevant national mitigation scenarios to 2100. Complex but critical trade-offs between GHGs and sectors are clarified and scenarios for effective climate change mitigation compared. Supplementing the primary requirement for radical CO_2 mitigation, substantial and sustained reduction in total national methane emissions appears to be critical to the feasibility of achieving net zero CO_2-we by 2050. In addition to radically limiting fossil fuel usage, reducing total usage of reactive nitrogen in agricultural and biogas production is argued to have a key role in overall climate mitigation for Ireland.

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Keywords: Climate action, Paris Agreement, transition, climate modelling, methane, GWP*

Paris Aligned Open Energy System Model for Ireland

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According to the stringent requirement implied by the Paris temperature goals, an accelerated pace of CO_2 mitigation, well beyond current targets at national and EU level is required to limit anthropogenic global warming to "well below 2 °C" over pre-industrial; and to make efforts toward a lower limit of 1.5 °C. In the case of Ireland specifically, relevant research suggests an aggressive deployment of variable renewable electricity (VRE: wind, solar, etc.) to address the national and regional demand constraints. However, the deployment of VRE required must be thoroughly evaluated to identify the most technically feasible and cost-effective approach for the necessary deep decarbonisation of the energy system. As modelling increasingly contributes to energy policy-making, the transparency and openness of tools, models and datasets all become matters of important public interest. Python for Power System Analysis (PyPSA) is a recently developed open energy system modelling platform. It supports conventional electricity networks including thermal generation and variable wind and solar generation; energy flows with alternative carriers (hydrocarbon fuels, hydrogen, and heat); heterogenous energy storage; and coupling between end use sectors (electricity, heating and transport). In the work, we present Open Energy System Model for Ireland (OESM-IE), a baseline open energy system model for Ireland, using PyPSA. It includes electricity, heating and transport sectors, and represents: total primary energy requirement, total final consumption, energy carrier stocks, CO_2 emissions, and internal and external energy flows. The model has been calibrated against recent SEAI and EirGrid datasets.

Keywords: OESM-IE, PyPSA, VRE.

Climate Change 2

Quantifying phenological mismatches: Climate change drivers and their impacts on biotic interactions through different trophic levels in Ireland

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Phenology is the study of cyclic and seasonal phenomena in organisms, such as leaf unfolding and senescence, flowering of plants, and migration events that have a great influence on the functioning of ecosystems and their services. Climate change is responsible for disruptions in phenological events which are taking place earlier, later or for longer periods. Responses differ at intra- and inter-species levels but also at a community level. Even though ecosystems are governed by many complex interactions, there is very little known about the role of phenological shifts in species interactions in the functioning and persistence of ecosystems. Our aim is to identify phenological mismatches for several taxa linked through the trophic network and to determine the importance of multiple climate change drivers across scales. Moreover, we aim to quantify the effect of phenological mismatches on the biotic interactions among different species. Citizen science datasets from 2009-2019 (eBird, MothIreland, Butterfly Monitoring Scheme) were used to implement a novel approach to document phenology by analysing trends in phenological changes through regression analyses to identify significant advances or delays but also their responsible factors. Further a trophic phenology mismatch index (TPMI) among interactor partners was created and tested in order to determine significant mismatches that are relevant for biotic interactions. Results identify a shift in the phenological responses of species and should foster discussion on the importance of phenology modulating biotic interactions and the role of climate change drivers on phenological mismatches. Our findings will be of use to elaborate predictions of phenological change and the risk for biotic interactions to potentially be compromised throughout Ireland.

Keywords: Phenology, climate change, phenological mismatch, biotic interactions, trophic network

Climate Change 2

Quantifying Carbon Stock of North Bull Island, Dublin

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Carbon sequestration and storage is a process for mitigating anthropogenically caused climate change. Many habitats naturally sequester carbon through their above- and belowground biomass, and sediment accumulation. Wetlands are one of the best examples of these habitats as they sequester more carbon per unit area than terrestrial forests; yet do not receive the same level of protection, restoration, and management. Two of the three classified saltmarsh habitats in Ireland are listed as inadequate by the National Parks and Wildlife Service and are not fulfilling their ecological service. North Bull Island in Dublin, Ireland, is home to an approximately 200 years old saltmarsh and is currently in a favourable condition. Carbon stocks of North Bull Island were quantified to encourage the implementation of legislation to protect, manage and restore these ecosystems. In order to quantify carbon, we used methods outlined by the Coastal Blue Carbon handbook; this involved soil cores to calculate root biomass and carbon mineral content, and clip plots to calculate aboveground biomass. Due to Ireland's long growing season, a large carbon stock in soil and plant biomass is expected as well as high levels of sediment accretion; thus, indicating the vast ability of Irish wetlands to sequester and store carbon. We will present details on the total carbon stock of individual components of the saltmarsh habitat on North Bull Island. It is important for Ireland to acknowledge the ability of this ecosystem service to aid the battle of mitigating climate change. As an island, Ireland is susceptible to many severe changes in its ecosystem, and as one of the worst ranked EU countries in terms of greenhouse gas emissions, maintaining and protecting these natural carbon sinks is crucial to sustaining our environment.

Keywords: Carbon, blue carbon, carbon sequestration, tidal saltmarsh, coastal wetlands, wetlands, coastal vegetated habitats

Examining the perceptions of tourists of sustainability pressure indicators on the Wild Atlantic Way

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The Wild Atlantic Way (WAW) is a coastal touring route intended to increase visitor numbers and promote tourism in the coastal parts of the West of Ireland particularly to an international audience. Any increase in tourist numbers may bring economic benefits to the region but it may also bring increased pressures on the region or parts of the region. This raises issues regarding the sustainability of the route and its effect on the region's environment including on the beaches and coastal waters near the route. Environmental pressures from increased tourism may include more pollution or litter, or possible erosion of sensitive coastal habitats. Increased traffic related to tourism may also be affecting residents of the WAW and overcrowding at certain locations may detract from the 'wild' or remote image that the route aims to promote. This endogenous pressure from tourists themselves may affect their experience of the WAW and its long term viability. To help assess the level of endogenous pressure from tourists of the WAW, the Maritime, Ocean Sector and Ecosystem Sustainability (MOSES) project undertook a survey of tourists at six locations on the WAW focused on perceptions of tourists of sustainability pressure indicators related to traffic levels, tourist numbers and quality of infrastructure. In addition, both international and domestic tourists were surveyed on their spending, activities and attitudes towards the WAW. Initial results suggested that the pressures from tourists are perceived to be higher at the southern end of the WAW route.

Keywords: Sustainability indicators; Coastal tourism; Wild Atlantic Way; Sustainable tourism

Quantification of persistent organic pollutants in killer whales stranded in Ireland

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Apex marine predators such as killer whales are at particular risk to the bio-accumulation of harmful anthropogenic contaminants including poly-chlorinated biphenyls (PCBs), poly-brominated diphenyl ethers (PBDEs) and organochlorine (OC) pesticides. These persistent organic pollutants (POPs) have been found to adsorb to sediments, as well as accumulate in waterways and aquatic systems. Blubber samples from an adult female, an adult male and a mother-foetus pair stranded between 2010 and 2017 were analysed for a suite of contaminants including 16 PCBs and 7 PBDEs. Samples underwent total lipid extraction with green solvents including cyclohexane, hexane and isopropanol using an Ultra Turrax homogeniser. The lipid portion was concentrated via turbo-evaporation and was subjected to a column chromatography clean-up phase. Subsequently contaminants in each sample were quantified by gas-chromatography-mass spectrometry (GC-MS) using isotopically labelled internal standards. Concentrations ranged from 1.5 mg/kg to 49.3 mg/kg lipid weight and 0.04 to 1.2 mg/kg lipid weight for Σ16PCBs and Σ7PBDEs respectively. The adult male killer whale was found to contain a Σ19OC concentration of 49.4 mg/kg lipid weight. The suggested toxicity threshold of 17 mg/kg lipid weight was exceeded in one sample, the adult female that was discovered with a near-term foetus. The results of this research reaffirms the necessity of continual monitoring and reporting of pollutant concentrations across the entirety of the species.

Keywords: Killer whales, PCBs, OCs, PBDEs, Ireland

Marine and Coastal 1

The impact of UVR on Pacific oyster *Crassostrea gigas* pathogen development

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Solar ultraviolet radiation (UVR), an important element of all ecosystems, can have both positive and negative impacts on aquatic invertebrates. In recent years, European oyster cultivation sites have experienced increasing 'mass mortality events' (up to 80%) during the summer months. Both *Vibrio aestuarianus* and *ostreid herpesvirus* microVar-1 (OsHV-1 mVar) have been associated with these mortality events. In this study, laboratory and field experiments were carried out to assess the impact of UVR on *C. gigas* and the development of *V. aestuarianus* and OsHV-1mVar. In initial lab trials, oyster seed were exposed (n = 880) to 0.7 kJ/m^2 of UV-B for three days – levels similar to those experienced at low tide during summer, and recovery was monitored for four days. Oyster mortality was quantified daily and gill tissue samples were collected for pathogen detection. Field based trials to validate laboratory results, were conducted in 2018. *C. gigas* seed (n = 3000) were relayed at 'low' and 'high' shore points, with ~2 hrs of aerial exposure differential. Oysters were sampled for mortality and pathogen infection weekly during the summer months and environmental conditions were recorded from Met Éireann. Exposure to UVR was found to increase mortality in oyster seed but also to reduce prevalence and intensity of *V. aestuarianus* infection. OsHV-1mVar was only detected in the 2018 field trial when the prevalence of infection was highest in high shore oysters. These results show that pathogen partitioning exists between different tidal zones and that UV is an important factor to consider in disease transmission.

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Keywords: Aquaculture, Solar radiation, Pacific oyster, Pathogens, Vibrio *aestuarianus*, *Osterid herpesvirus*-1

Large solar reactors for rainwater disinfection in Sub-Saharan Africa

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Two billion people rely on fresh water sources that are faecal contaminated and half a million people die every year due to water and sanitation-related diseases. Therefore, the development of household water treatment and safe storage technologies (HWTS) to deliver safe potable water at household level is important. These technologies should be effective, available, affordable, and acceptable to the communities. In this paper, a V-trough solar pilot plant, a new design of solar disinfection reactor, with a treatment capacity of 150 liters per day, has been conceptualized to reduce complexity and manufacturing and installation costs associated with CPC reflectors, as well as evaluating the disinfection efficiency. The inactivation of *Escherichia coli* K-12 (CECT 4624), *Enterococcus faecalis* (CECT 5143), *Salmonella sub enteritidis* (CECT 4155) and *Pseudomonas aeruginosa* (CECT 110) in synthetic rainwater has been assessed under natural solar conditions. Results showed similar inactivation profiles between the CPC and V-trough mirror solar photo-reactors. This paper shows that the best option for disinfecting large volumes of water, considering an easy design and low-cost of manufacturing, is the new design V-trough mirror working on a static mode operation using long path-length transparent tubes. This reactor has been tested for the disinfection of harvested rainwater in South Africa and Uganda with the aim of providing treated water to over 500 pupils in two primary schools in Uganda, and to 54 people in two South African communities.

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Keywords: Solar reactor, water disinfection, *Escherichia coli*, *Enterococcus faecalis*, *Salmonella sub enteritidis*, *Pseudomonas aeruginosa*

Wastewater and water reuse

SAFEWATER: Providing safe drinking water to rural communities in Colombia and Mexico

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In 2010 the United Nations declared safe and clean drinking water and sanitation a human right essential to the full enjoyment of life and all other human rights. This means that water should be safe, sufficient, accessible, affordable, and acceptable. Still, it remains that at least 1.8 billion people globally use a source of drinking water that is faecally contaminated and thus likely to lead to diarrheal illness. Sadly, nearly 1,000 children die each day due to preventable water and sanitation-related diarrhoeal diseases. SAFEWATER is a transdisciplinary research project aimed at developing technologies to deliver safe drinking water to rural communities in Colombia and Mexico. Working with our partners in Brazil, Mexico and Colombia, we have developed water treatment prototypes that are a combination of filtration and UVC disinfection which can deliver up to 250 L of water per day for individual households. To test the systems, we followed the guidance from the WHO Guidelines on household based water treatment and storage. To achieve comprehensive protection (three star) the water treatment system must give a 4 log reduction in bacteria, a 5 log reduction in viruses, and a 4 log reduction in protozoa. We have tested our systems for bacterial removal and for virus removal (using MS2 as a surrogate). Initial results from pilot tests in rural Mexico and Colombia demonstrate the systems are working well and the householders are very happy to have an ample supply of potable water. Based on the initial testing we are revaluating the design and we aim to field test at least 160 prototypes in households of Colombia and Mexico in the coming year. The development of systems to deliver large volumes is a paradigm shift in household based water treatment intervention.

We acknowledge the funding of SAFEWATER from the Global Challenges Research Fund UKRI (Grant Ref: EP/P032427/1).

Keywords: Drinking water, UVC disinfection, filtration, field trials

Characteristics of wastewater associated with dental practice

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Materials such as amalgam (Hg/Ag-based) have been in use in dentistry worldwide for nearly 150 years. However, Ireland's recent ratification of the Minamata Convention, has seen a move towards mercury-free dental materials. Amalgam is now largely prohibited for dental treatment in certain patient categories unless deemed strictly necessary by the dental practitioner and the discharge of mercury waste is strictly regulated. However, there is a knowledge gap in terms of waste streams associated with materials that have replaced amalgam. These materials contain a variety of nanoparticle and microparticle fillers and a range of other chemical constituents (e.g. acrylates for photocuring). It is unclear as to whether the wastewater separation techniques already in situ in dental practices, which were largely designed for the separation of amalgam and particles >100μm^2, are appropriate for new dental materials. Here, we examine the dental wastewater (DWW) resulting from the application and removal of mercury-free dental materials. We report the results of DWW analyses, including total suspended solids, and other physicochemical data, as well as micro and nanoparticle size distributions that can potentially be discharged to the environment from DWW, despite filtering technologies in place. Our results indicate that DWW streams can often contain high concentrations of micro- and nanoparticles, including Al and Zn nano-fillers arising from glass ionomers, ceramic fillers and other metal oxides in use, and are potential entry routes for engineered nanomaterials into the environment. Preliminary toxicity testing of DWW samples using OECD 202 and 211 *Daphnia magna* acute immobilisation tests indicated that samples were toxic at low concentrations. This study has the potential to aid dental guidelines, future policymaking and make recommendations for dental wastewater treatment before release into the environment.

Keywords: Dental, Wastewater, Materials, toxicology

Understanding farmers' attitudes towards climate change adaptation'

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Climate change has both direct and indirect effects on agricultural productivity, including due to changing rainfall patterns, drought, flooding and the geographical redistribution of pest and diseases. Extreme weather events are projected to increase in the coming decades; however, uncertainties remain in relation to the scale and extent of the impact on farming. Using the discrete choice experiment (DCE) method from a representative sample of Irish farmers, this paper analyses farmers' economic value associated with insurance against extreme weather events, including flooding events. We find that farmers have a slight but significant preference for index-based insurance and prefer longer insurance contracts. Approximately 30 percent of farmers indicated that they are concerned with flooding events and a larger majority of farmer' are concerned with storm damage. In additional analyses, we find that approximately 40 percent of farmers would be willing to allow some flooding on their land to reduce the risk of downstream flooding to local communities.

Keywords: Sustainable agriculture; flooding; risk

Water and soil management in a changing climate

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Working in an applied capacity with rural stakeholders to build better water and soil management for a resilient future, the Risk AquaSoil project is a European collaboration looking at the implications of climate change on our land and water. We aim to develop and improve early warning or prediction of risk in order that rural areas can adapt to a changing environment in a proactive way through developing good land management practices and working towards the old adage of "prevention is better than cure" rather than "out of sight out of mind" where the river is concerned.

Keywords: Water, soil, climate change

Climate change media communication in coastal threatened countries: Dismissing communities of coastal adaptation processes?

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Among other threats, climate change is posing profound challenges to coastal countries and communities, mainly due to the rising sea-levels. Ireland and Portugal, for instance, are especially prone to the effect of global warming on the countries' coastlines such as an increased frequency of storm surges. Coastal communities are called to adopt new resilient sustainable practices in order to mitigate and adapt to climate change consequences. The adoption of new practices is influenced by individuals' understanding of climate change and risk perceptions. As media is critical in shaping individuals' understandings, perceptions and actions, it may serve as an important mediator of a sustainable behavioural change. For such, the aim of this study is to analyse the climate change media coverage in two coastal countries and to ascertain to what extent coastal threats are properly covered. A total of 638 news items published in Ireland and Portugal in 2017 and 2018 were selected and in-depth quantitatively content analysed. Results show that the scientific discourse is privileged in the Irish and Portuguese media. A non-resilient narrative prevails, with the communities' and individuals' role in adapting to climate change hardly mentioned in both Irish and Portuguese news. The coastal sector and related hazardous processes, such as coastal flooding, are rarely mentioned in the two countries' media coverage. The disproportionate salience given to scientific debates, distant and non-resilient narratives, given by Irish and Portuguese media, may be contributing to the widespread of the social climate apathy and the disengagement of individuals regarding climate change in general, and its effects in the coastlines in particular.

Keywords: Climate change; Communication; Media; Coastal threats; Communities adaptation

Remote sensing and territorial analysis to adapt in face of climate change: assessing the risk, exchanging views and connecting actors for a better resilience

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Faced with climate change impacts, ACMG has taken part in *Risk-AquaSoil,* an Interreg Atlantic project, alongside European partners to improve our adaptation to climate change, mitigate the impacts and ensure a future for rural and peri-urban areas. Extreme climatic events happen with multiple impacts. How are these events impacting on the future of farming? What are the local levers that can be activated to improve resilience for actors? Farmers of *Lot et Garonne* were surveyed about their visions of climate change, the obstacles encountered and their needs. Once the report on farmers was written and disseminated, the Mayors were questioned. What emerges is an absence of a common risk culture, climate change is not considered as an element, in the same way as water or air, but rather as a personal, political or economic commitment. To make the risks visible is necessary to share a common culture. Maps of the risk of erosion at large scale are helping to find zones where actions shall be intended. ACMG has developed a method using Sentinel 1 Radar satellite imagery providing categories of soil occupation: active vegetation, vines, trees and bare soil. The bare soils are divided into 3 classes: slope less than 2° → low risk, slope between 2° and 6° → moderate risk, slope greater than 6° → high risk. The objective is to provide ways to reposition each individual as an actor and make the risk visible in order to adapt to climate change in a sustainable and viable way.

Keywords: Erosion, climatic hazards, agriculture, climate

Can advisory services help bridge the behaviour gap to sustainable farming practices?

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The effects of climate change in Ireland will most likely see the seasonal hydrological cycle become more extreme, driven by increased winter precipitation, decreased summer precipitation and increased temperature. Farming practices that have been sustainable may not be in the future. In addition, some farming practices that have not been sustainable persist and the impact of these practices is increasing as farming activity increases to satisfy greater and greater demand. Adapting farm practices for the coming reality faces a number of difficult challenges. First, there is considerable heterogeneity among the farm population in particular in terms of system, productivity and farmer knowledge and attitudes. Sustainable farm practices may be particular to farm systems, intensity of production or may be particular to local hydrological circumstances and bespoke solutions are time-consuming to develop. They also raise risks of perceived unfairness, since some farmers have to do more than others to adapt, and confusion, since informal transfer of practices may lead to practices being adopted that are inappropriate to the local context. Second, there are a number of features of sustainable farming practices that make generating these behaviour changes difficult. Typically, current practices have been in place for an extended time, the incentives for change are uncertain and the costs of not changing may not be felt by those who fail to change. We discuss the foregoing challenges and the potential role for advisory services in gathering relevant data on farm and farmer characteristics to inform intervention and in co-developing interventions with farmers. This work forms part of the Interreg project, RISKAQUASOIL, and the EPA and DAFM funded project, WaterMARKE.

Keywords: Sustainable farming; advisory services

The effectiveness of environmental enforcement instruments to produce increased compliance outcomes and/or sustainability-based outcomes

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Results-based frameworks, such as the OECD framework for environmental enforcement, focus on sustainability and environmental outcomes rather than on compliance per se i.e. 'beyond compliance'. Internationally, there has been much emphasis placed on a more collaborative approach in the hope that this will encourage companies to go 'beyond compliance' and make environmental outcomes central to their decision-making. It is expected that the more cooperative approach will appeal to different motivations for good behaviour e.g. reputation. However, these collaborative approaches are difficult to measure and evidence on the effectiveness of environmental promotion activities is scarce and results are mixed. We examine the effectiveness of traditional enforcement instruments of monitoring (inspections, surveillance, etc.) and enforcement (prosecutions, fines, etc.) to produce increased compliance outcomes and/or sustainability-based outcomes. The findings of this study show that different enforcement instruments have different effectiveness on compliance-based and sustainability-based outcomes. Briefly, the number of prosecutions in a sector leads to increased sector compliance but the magnitude of the financial penalty involved in prosecutions is the aspect that drives investment in clean technology. There are spillover effects indicating an advantage for sector and regional approaches. The biggest spillover effect is sectoral. Policy-makers and regulators can use the results to guide enforcement activities.

Keywords: Environmental regulation; Enforcement; Compliance; Sustainability-based outcomes

The Irish Climate Action Plan 2019: A Case Study in Multi-levelled and Cross-sectoral Policy Implementation

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Addressing climate change requires the involvement and the coordination of local, national, regional and international actors from the public, private and third sectors. Ireland's Climate Action Plan 2019 is an example of a policy that attempts to take such an approach. There is no consensus in the literature on how to evaluate such a plan. However, four common questions that cover governance, structural and process indicators of effectiveness can be identified: i) What is its purpose? ii) How is it governed? iii) What is its membership? iv) What are its processes? This paper takes a network approach to address these questions and to offer an evaluation of the plan. Our analysis shows that the network is centralized around a powerful government actor that is responsible for directing, brokering and enabling the interactions and activities of most of the other actors in the network. They and other national level actors are responsible or co-responsible for most of the actions in the plan, whereas local, regional and international level actors have much weaker roles. Scientific organisations are the only actor type involved in the delivery of actions with actors from multiple other sectors, suggesting an attempt by the plan's designers to organise a scientifically informed response to climate change. The level of cross-sectoral collaboration between government actors and those involved in Ireland's energy sector is much more extensive than between any other two sectors, indicating the importance placed on decarbonising Irish society.

Keywords: Climate action plan, policy, decarbonisation

Horizon scan of invasive alien species – predicting the next invasions for the island of ireland

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A Horizon scanning workshop for potential Invasive alien species establishment on the island of Ireland was held in April 2017, using a consensus-based approach and involving experts on invasive species and biodiversity. The main aim of the workshop was to come up with an ordinated list of species most likely to arrive, establish and cause impacts to biodiversity in terrestrial, freshwater and marine biomes on the island of Ireland within the decade 2017-2027. Freshwater species dominated the top ten species (six out of ten), with crayfish (*Pacifastacus leniusculus*) highlighted as the most likely species to arrive, establish and create impacts on biodiversity in Ireland's freshwater systems. The list of 40 included eighteen freshwater invaders, fifteen terrestrial IAS and seven marine species. Crustacean species (freshwater and marine) were taxonomically dominant (ten out of forty); this relates to multiple pathways of introduction, their ability to adapt as ecosystem engineers and the resulting high impacts on biodiversity. This evidence-based list provides key information to the competent agencies in both jurisdictions to prioritise the prevention of the most likely invaders and fulfil commitments to their respective legislation and to the EU Regulation on Invasive Species (EU1143/2014). Particular consideration on managing pathways of arrival by introducing targeted biosecurity in both jurisdictions is vital to maintaining native biodiversity on the island of Ireland.

Keywords: Biodiversity; biosecurity; risk assessment; regulations; pathways

Investigation of biogeochemical cycling of nutrients, elements, and carbon in Irish marine transitional zones

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Marine transitional zones (MTZs), such as coastal lagoons, tidal inlets, estuaries, and bays form an interface between marine and terrestrial environments. MTZs are often highly dynamic and variable systems, where complex physical and biogeochemical processes from marine and freshwater environments interact. Mixing of nutrients and contaminants-rich freshwater discharge with sea water results a continuum in salinity and a gradient of chemical, physical, and biological components in the water column. Therefore, MTZs are important zones for nutrient and elemental cycling, primary productivity, fisheries recruitment and human wellbeing. However MTZs are also now vulnerable to multiple stressors like global warming, sea level rise, eutrophication, deoxygenation, increasing concentrations of atmospheric CO_2 etc. that can act in different ways on ecosystems requiring careful assessment of the action of each stressor on the key biogeochemical processes occurring in MTZs. EPA and Marine Institute funded project Nuts&Bolts (2019-2023) addresses knowledge gaps with regard to the impact of multiple environmental stressors on the biogeochemical cycling of nutrients, elements (trace metals and rare earth elements (REEs)), and carbon in Ireland's marine transitional waters. Surface and deep water samples were collected from selected MTZs mainly in west coast of Ireland; Kinvarra Bay, Corrib River, Lough Furnace, Shannon Estuary, Wexford, and Sligo Harbour and tested for nutrients (Nitrate, Nitrite, Phosphate, Silicate, ammonia, and urea), FDOM/CDOM, trace metals and REEs, picoplankton abundance (flow cytometry), and climate relevant dissolved gases (O_2, N_2, Ar, CO_2, DMS by Membrane Inlet Mass Spectrometry) in transitional waters. Recent results are presented.

Keywords: Marine transitional zones, biogeochemical cycling, nutrients, trace metals and rare earth elements

Legacy organic pollutants and pollutants of emerging concern in Irish fishery products

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Seafood is one of the primary sources of a number of environmental contaminants in the human diet. The Marine Institute has over twenty years of data on the concentrations of heavy metals, certain persistent organic pollutants including certain pesticides, industrial chemicals such as polychlorinated biphenyls (PCBs), and unintentionally produced substances such as dioxins in finfish, crustaceans, shellfish and bivalve molluscs. There are a number of different regulations and conventions which share the aim of reducing levels of these contaminants in the marine environment and ensuring seafood is safe for human consumption. These, and other service level agreements, guide the Marine Institute's monitoring programmes for contaminants in seafood. Samples of commercially important fish species landed at the major Irish fishing ports are collected annually, as are samples of bivalve molluscs from designated shellfish growing waters. Farmed finfish are sampled under the National Residues Control Plan. The results of testing of the edible portion of species sampled between 2012 to 2017 for trace metals, organochlorine compounds (OCs), indicator PCB, polychlorinated dibenzodioxins and furans (PCDD/Fs), dioxin-like PCBs (dl-PCBs) and selected brominated flame retardants (primarily polybrominated diphenyl ether congeners - PBDEs) are discussed, along with the implications for consumers. A retrospective review of concentrations over a 20-year period, particularly of legacy organic pollutants, in a number of these species is also presented.

Keywords: Organic pollutants, metals, seafood, dioxins

Shifting larval phenology of the Dublin Bay prawn (*Nephrops norvegicus*) in a warming ocean

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The Dublin Bay prawn/Norway lobster (*Nephrops norvegicus*) is the most valuable commercial fishery in Irish waters. Embryonic and larval development of ectothermic species such as *N. norvegicus* is coupled to sea temperature. Changes in phenology, the seasonal timing of biological events, due to ocean warming have been documented in marine habitats worldwide. A number of historical zooplankton datasets from the Irish Sea were used to examine the timing of *N. norvegicus* larval release from 1982 - 2010. We report an earlier shift in larval phenology by 19 days between two time series, 1982 – 1995 and 2000 – 2010, due to an increase in average temperature during embryo incubation leading to faster embryo development and earlier hatching of larvae. In addition, oceanographic models were used to simulate larval transport and examine the effect of larval phenology and interannual and spatial variability on larval retention and dispersal distance. Larvae released late in the season had a higher likelihood of retention (32%) than those released early (17%) as a result of a shorter larval duration due to warmer temperatures, limiting dispersal potential. Average retention was quite high (24%) across simulated years, although it was subject to considerable interannual variability. Retention was influenced by the location of release, larvae originating from the eastern section of the grounds had lower retention as they were more likely to be transported north by strong currents through the North Channel. The western Irish Sea grounds consistently provided larval donations to nearby grounds, particularly to grounds off the west coast of Scotland. The ground may act as an important source of larvae particularly to isolated grounds that rely on donations to sustain their population.

Keywords: Phenology, *Nephrops norvegicus*, Larvae, Ocean warming, Larval transport

Establishing a winter pCO_2 baseline in Irish coastal waters

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While uptake and cycling of CO_2 in the open ocean has been well studied, CO_2 in coastal waters is much less understood. Irish coastal waters have the potential to act as both a source and a sink of CO_2, switching between them at different seasons. Underway pCO_2 systems were installed on two Irish research vessels to collect data and to compare these data with pre-existing open source SOCAT data from ships of opportunity travelling through Irish waters. pCO_2 data are corrected for non-ideal behaviour of the gas to give fCO2 during post-processing, leading to a difference of 1-2ppm. SOCAT has over 66179 fCO_2 data points in Irish coastal and shelf waters from 1991 to 2019. Data before 2012 are limited and show no visible trends. However, from 2012 onwards seasonal trends begin to show as more data are available. A cyclic trend can be seen with the lowest fCO_2 recorded in spring of 220 – 250 ppm, gradually increasing in summer then peaking in autumn around 450 ppm. Very little data are available in the winter months making it hard to establish a winter trend. In January 2020, the *RV Celtic Voyager* completed a passage from Killybegs, Donegal around the north east and south coast of Ireland, ending in Galway, with the underway pCO_2 system autonomously sampling the seawater every 2.5 minutes. In general, the pCO_2 stayed close to equilibrium with the atmospheric pCO_2 of 400-460 ppm throughout the survey with the exception of 4 locations Dun Laoghaire (507ppm), Waterford harbour (744 ppm), inside the mouth of the Shannon Estuary (500 pmm) and Galway harbour (638 ppm). This for the first time gives a winter baseline in Irish coastal waters with which the variability generated by biological activity in other seasons can be compared, as further data are collected.

Keywords: Coastal waters, Ireland, pCO_2, fCO_2, SOCAT

A Critical Analysis of Enforcement of Sea-Fisheries Law in Ireland

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The Irish government has stated its intention to significantly grow the "blue economy" in Ireland, including sea-fisheries, over the next number of years. However, it is estimated that a large proportion of fish stocks are already overfished. If the marine economy is to grow successfully into the future, then conservation and sustainable exploitation must be prioritised. Effective regulation of the sea-fishing industry goes hand in hand with a normatively effective enforcement regime to ensure conservation. There is little to no academic literature in the area of enforcement of sea-fisheries law in Ireland. The objective of this research is to critically assess whether sea-fisheries law and its enforcement in Ireland is fit for purpose which is crucial to long-term sustainability of fish stocks and economic expansion in the area. To the author's knowledge, this research is the first root and branch analysis of sea-fisheries law and its enforcement in Ireland. The research has concluded that a system based primarily on the criminal law is inappropriate for dealing with breaches of sea-fisheries law. It recommends introduction of a system of administrative sanctions for the majority of sea-fisheries offences. More specifically, the reintroduction of warning letters and the introduction of a fixed penalty notice scheme and variable monetary penalty scheme. The courts should retain an oversight role in the application of administrative sanctions with criminal prosecution reserved for more serious cases. Licence revocation is possible under the legislation but is never invoked in practice. This should be available as a top tier sanction for repeat serious offenders. This would align with other EU Member States and would more easily satisfy the obligation under EU law that penalties should be "effective, proportionate and dissuasive".

Keywords: Fisheries, enforcement, sanctions

From waste to sustainable "green" fuel production and organic synthesis via artificial photosynthesis

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Photoreforming of lignocellulose is a promising approach for sustainable and "green" H_2 production. The process is traditionally carried out with UV-absorbing TiO_2 colloids combined with expensive noble Pt and RuO_2 co-catalysts.[1,2] Advances in the field involve the use of visible light-absorbing but toxic CdS photocatalysts in strongly alkaline media (pH 15)[3] or toxic organic solvents (CH_3CN).[4] Herein, we report for the first time the photoreforming of lignocellulose into H_2 using an activated cyanamide-functionalized carbon nitride ($^{NCN}CN_x$) in aqueous media over a broad pH range (2-15) including benign conditions.[5] This photocatalyst which is non-toxic, scalable and inexpensive oxidizes biomass in the presence of various co-catalysts including heterogeneous Pt, or MoS_2 and the molecular Ni bis(diphosphine) (**NiP**) cocatalyst. The $^{NCN}CN_x$/**NiP** system shows a benchmark activity of 39 310 ± 1970 μmol H_2 (g $^{NCN}CN_x)^{-1}$ h^{-1} for 4-methylbenzyl alcohol (4-MBA) photoreforming. It also establishes precious metal-free, non-toxic, and visible-light-promoted photoreforming of both purified and raw biomass in KP_i (pH 4.5). Activated $^{NCN}CN_x$ photoreforms lignocellulose with molecular and heterogeneous co-catalysts in a broad pH range. However, in alkaline media the highest efficiencies and thus conversion yields (22 %) are observed.

Keywords: Waste utilization, biomass, artificial photosynthesis, "green" fuels, organic synthesis

Optimising the installation of solar PV systems on Irish dairy farms

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Agricultural activities are responsible for 33% of overall greenhouse gas (GHG) emissions in Ireland, forecasted to increase due to ambitious production increases targets and an 85% increase in exports by 2025. This increased agricultural production must be met with consideration regarding GHG emissions to ensure compliance with EU GHG emission allowances. However, it is projected that Ireland's 2030 GHG emissions will be far below the targeted 30% reduction. As no immediate solution is available to reduce methane production from livestock, increasing the utilisation of solar PV systems on dairy farms may serve as an effective measure to offset GHG emissions, while also aligning with Ireland's National Renewable Energy Action Plan. However, in order to maximise the impact of solar PV systems, installations must be managed and sized correctly, as overall return on investment will be impacted by factors such as: grant aid, availability of a feed-in-tariff, on-farm electrical demand profile as well as farm location. Thus, the Agricultural Energy Optimisation Platform (AEOP) was developed to aid with the proliferation of solar PV systems on Irish dairy farms. AEOP combines optimisation functionality and the state-of-the-art in dairy energy modelling to autonomously identify the optimum milking times, solar PV system size, solar water heating system and optimum water heating time to either maximise return on investment or minimise energy related CO_2 emissions on a farm-to-farm basis and unique user inputted investment conditions. AEOP will help maximise the impact of solar PV systems on Irish dairy farms and in turn, the probability of Ireland achieving its strict EU targets by: 1) reducing energy related CO_2 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.

Keywords: Decision support; dairy; energy; optimisation; solar PV; agriculture

High Levels of renewable energy enabling "Green Hydrogen" production in Ireland by 2030

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The 2019 Irish Government Climate Action plan includes the ambitious target of increasing the installed capacity of renewable generation to meet 70% of electricity demand by 2030. High levels of dispatch down will be a substantial barrier to achieving high levels of renewable energy on the Irish system. Currently, there are many regions in Ireland in which there are significant network constraints and high dispatch down levels of renewable generators. These areas may be considered favourable for electrolyser deployment, where excess electricity may be converted into hydrogen for use in heat and transport sectors. Hydrogen produced from renewables is referred to as 'Green Hydrogen' and provides an opportunity to decarbonise the entire energy system. The viability of 'Green Hydrogen' production from wind energy is examined for a number of scenarios and regions of Ireland and an emissions and cost comparison is made with hydrogen produced from natural gas through Steam Methane Reforming (SMR). Multiple revenue streams for hydrogen in the transport and heat sectors have been considered. A number of vehicle types have been evaluated on an emissions and cost basis and vehicle deployment projections for 2030 are in line with Hydrogen mobility Ireland projections. The potential for hydrogen injection into the gas grid is also explored which can aid the decarbonisation of the gas grid and heat sector.

Keywords: Energy, renewables, hydrogen, electrolysis

Sensitivity of net-zero greenhouse gas emission pathways on social discount rate assumptions in an energy system optimization model

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Ireland published a Climate Action Plan (CAP) in 2019 this is expected to save 58.4 $MtCO_2eq$ compared to BaU in 2030. Notably from CAP 2019 is the change in GHG target description, from percentage reduction compared to a base year, to the quantity of saved GHG emissions, this target description has set in motion the introduction of legally enforced, 5-year carbon budgets from 2021. This research informs the process of setting intertemporal and inter-sectoral carbon budgets by applying an energy system optimisation model (ESOM), in this research – TIMES will be used, which has been used extensively in the past for GHG mitigation studies of the Irish energy system. The main novelty of this research is a sensitivity analysis to understand the impact of social discount rates (SDR) and technology-specific hurdle rates (TSHR) on Ireland's long term decarbonisation pathways. The SDR sensitivity analysis results show that the SDR is of great importance to the overall carbon budgets and decarbonisation trajectory. The TSHR has much less of an effect on the final carbon budgets and decarbonisation trajectory, the TSHR may, therefore, be more appropriately used as a fine-tuning exercise. Further and deeper analysis is required to understand the change in the proportion of each economic sector with varying SDRs and TSHRs.

Keywords: Ireland, Carbon Budgets, TIMES, Social Discount Rate, Hurdle Rate, decarbonisation pathway

An Analysis of the Factors Determining the Use of Solid Fuel as a Supplementary Fuel for Home Heating

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The burning of solid fuels for home heating purposes is cited as a contributing factor to the estimated 1,100 premature deaths occurring annually in Ireland due to poor air quality. While existing data sources show that 16% of households use solid fuels as the main heating fuel, 47% of households use it for supplementary heating (e.g. to heat a single room). The transition away from solid fuel use for space heating purposes is thus a key priority in the development of Ireland's first National Clean Air Strategy. Previous research explaining the choice of solid fuel as a home heating fuel has focused predominantly on its use as the main heating fuel. In contrast, the factors determining the choice of solid fuel for supplementary heating have not been examined in detail. This paper applies a multinomial logit (MNL) modelling approach to data from the CSO's QNHS Module on Household Environmental Behaviours to address this gap in the literature. Our analysis reveals that supplementary solid fuel use generally occurs among affluent households such as those with higher education, a better employment status and residing in larger dwellings. Conversely, the use of solid fuel as the main heating fuel tends to be associated with less affluent households such as those living in smaller or rented dwellings or in homes without an energy efficient rating. Interestingly, pro-environmental households are found to be more inclined to use solid fuel for supplementary heating but less likely to use it as the main fuel. Any design of policy to promote a transition away from solid fuel use needs to be cognisant of these differences for its effective implementation.

Keywords: Air pollution, home heating, solid fuel

Analysing the dry weather influent volumes as a function of maximum tidal water level in Galway, Ireland

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The design and operation of wastewater treatment plants (WWTPs) is dependent on precipitation events characterised by high intensity rainfall and dry days. Normal dry weather flow determines the dry weather flow design of wastewater infrastructure which is crucial for civil engineers and architects. DWF, if not designed appropriately, results in lower flow velocities impacting the pipes within a sewerage system. In events of high tides, tidal inflow enters the sewer systems via combined sewer overflow outfall pipes resulting in the variation in normal DWF. This research aims to assess the normal DWF and tides as a contributing factor to changing DWF using an urban area case-study in Ireland. Daily data of tide water level, precipitation and influent volume for a relatively large municipal wastewater treatment plant in Ireland for the period of 2011-2018 was used for this study. The dry weather flow was estimated by averaging the flow of consecutive zero rainfall days excluding the flow values of the first two dry days of such an event to eliminate the effects of any preceding rainy days. This research investigated the relationship between daily maximum tidal water level and dry weather influent volume. Daily maximum tidal water level was obtained from the raw 6-minute interval tidal data. It was observed that, the relationship between daily values of influent volume and maximum tidal water level showed significant linear trends for all the years except 2012 and 2018. This analysis gave insight to other factors such as demographic changes due to tourism or population growth on dry weather influent wastewater volumes.

Keywords: Wastewater treatment plants; Dry weather flow; Tidal Inflow; Sewerage system; Combined sewer overflow

The Challenges of Beneficially using Dredge Sediment in Ireland

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Dredging in Ireland is primarily required to maintain the access, navigability and operation of Irish ports and harbours. The importance of the main ports in Ireland to economic growth and development is critical with over a 30% increase in goods handled over the past decade from 41.8 million tonnes in 2009 to 55.1 million tonnes in 2018. The potential impact of Brexit will further increase Ireland's dependence on Port-related movement of goods. Dredge sediment management practice involves a wide range of different management approaches. There are a wide range of potential beneficial uses of sediment as alternatives to the more traditional method of disposal (primarily at sea). The challenge is to implement such beneficial use alternatives as an integral part of an overall dredge sediment strategy at a national level and this paper presents this challenge in an Irish context. Dredge sediment volumes generated for Ireland vary by year and are project dependent; the average annual dredging amount generated over the past two decades is approximately 1.5million dry tonnes, based on an extensive analysis of dredge sediment data gathered. The proportion beneficially reused has been less than 10% and the proportion contaminated is very small. Over 50% of the dredged sediment may be classed as fine grained silts and clays but a significant proportion is coarser sediment with potential for beneficial use. The paper reviews the legislative aspects relevant to dredge sediment management including the Disposal at Sea' licensing system and its influence on practice and the EU Waste Framework Directive and the current approach to implementation and limitations related to 'end of waste' designation. The paper also outlines current dredge sediment management practice and provides recommendations for a sustainable increase in the beneficial use of dredged sediment.

Keywords: Dredging, beneficial use, legislation, challenges, waste, ports

Bathing waters - a transmission route for antimicrobial resistance

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Seawaters are frequently used for recreational purposes and may represent a previously unrecognized risk for transmission of antimicrobial (AMR) to humans. The aim of this study was to examine recreational waters for the presence of antimicrobial resistant bacteria (ARBs), namely extended spectrum beta-lactamase producing *Enterobacterales* (ESBL-PE) and carbapenemase-producing *Enterobacterales* (CPE) during the Irish bathing season. Twenty-four samples (30L) of seawater were collected between May and September during 2018 and 2019 at two beaches (Beach A and Beach B) in Ireland. Results showed four CPE Two NDM-producing *E. coli* were isolated from individual samples collected at both Beach A and Beach B, one KPC-producing *Klebsiella pneumoniae* was isolated at Beach B in 2019 and one OXA-48-producing *Klebsiella pneumoniae was isolated at Beach B in 2018*. Forty-four ESBL-PE were identified from 13 out of 14 samples collected in 2018. Whole Genome Sequencing (WGS) results illustrated sequence type (ST) 131 to be the most commonly detected isolate (n=8) at Beach A across both sampling seasons. In contrast, sequence types varied to a much higher degree at Beach B with no repetition of STs. Results of WGS analysis also outlined strong similarities between isolates collected at both Beach A and Beach B to isolates collected in previous studies at the same locations. These findings highlight major limitations of current EU bathing water regulations as the seawaters at the locations at which CPE and ESBL-PE were detected were consistently designated as of good/excellent quality. The isolation of CPE from four samples is also of particular concern. Moreover, WGS sequencing data also suggests the potential persistence of clinically relevant CPE in recreational waters over a period of time. This analysis demonstrates the potential importance of seawater as a transmission route for AMR to humans.

Keywords: Antimicrobial resistance; bathing waters; aquatic environment; transmission route

A Point Prevalence Survey of Antimicrobial Resistance in the Aquatic Environment, Ireland 2018-2019

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Antimicrobial resistance (AMR) is a global public health concern across healthcare and agricultural sectors. The aim of this study was to perform a nationwide point prevalence survey of contaminating sewage sources and receiving water bodies for the presence of AMR. A total of 39 water (30L) and 25 sewage (250mL) samples were collected across Ireland between November 2018 and July 2019. Water samples were filtered using the CapE method [1] followed by enrichment. CHROMagar mSuperCARBA™ and Brilliance ESBL agars were used to screen for carbapenemase-producing *Enterobacterales* (CPE) and extended spectrum beta-lactamase producing *Enterobacterales* (ESBL-PE), respectively. Sewage samples were directly cultured on to these agars. Colonies were identified by MALDI-TOF and antimicrobial susceptibility testing was performed using EUCAST criteria. Selected isolates were examined for $bla_{\text{CTX-M}}$, bla_{VIM}, bla_{IMP}, $bla_{\text{OXA-48}}$, bla_{NDM}, and bla_{KPC} by real time PCR. Whole genome sequencing was performed on 60 isolates. A total of 9/64 samples (5 water, 4 sewage) harbored one or more CPE (Table 1). The most commonly detected carbapenemase gene was $bla_{\text{OXA-48}}$ (n=6), followed by bla_{NDM} (n=2), bla_{KPC} (n=2) and bla_{IMP} (n=1). Real time PCR revealed the presence of 99 ESBL-PE from 38/64 samples (26 water, 12 sewage), including $bla_{\text{CTX-M-group1}}$ (n=83) and $bla_{\text{CTX-M-group9}}$ (n=16) detection. Of the sequenced isolates, *E.coli* ST131 (n=8) was the most common sequence type followed by ST38 (n=8) and ST10 (n=4). Plasmids were identified in 56/60 isolates with IncFIB (n=45), IncFII (n=39) and IncFIA (n=29) featuring most frequently. Core genome MLST comparisons revealed greater than 98% similarity between three *Klebsiella* isolates originating from hospital sewage, a nearby estuary and seawater. This study highlights the link between sewage sources and the aquatic environment in terms of AMR. The detection of CPE in waters is particularly concerning as a potential transmission route for AMR. A longitudinal study is ongoing to better understand the sources, persistence and transmission of AMR in the environment as part of the EPA/ HSE-funded AREST project.

Keywords: Antimicrobial resistance, extended spectrum beta-lactamase producing *Enterobacterales*, carbapenemase-producing *Enterobacterales,* aquatic environment

What lurks beneath the PIER - are recreational water users at risk from superbugs?

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Antimicrobial resistance (AMR) is one of the greatest threats to human health globally. The role of the environment in transmission of AMR is poorly understood. Exposure to AMR in recreational water could represent a substantial public health risk, through gut colonisation and onward dissemination of AMR bacteria. The EPA-funded PIER project: "Public health Impact of Exposure to antibiotic Resistance in recreational water" will compare the carriage of AMR bacteria in regular water users to that of non-water users. Human faecal samples will be screened for extended spectrum beta-lactamase-producing *Enterobacteriaceae* (ESBL-PE) and carbapenemase-producing *Enterobacteriaceae* (CPE) using selective chromogenic agars. Identification and antibiotic susceptibility testing will be performed using standard clinical laboratory methods. Cross sectional point prevalence and longitudinal cohort studies will examine the incidence of colonisation with CPE/ESBL-PE and examine the persistence of carriage over a two-year-period. Ethical approval for the study has been granted by the National University of Ireland, Galway Ethics Committee. A pilot survey at three beaches gauged attitudes towards recreational water quality and AMR, identifying suitable terminology to be used in the PIER survey. A stakeholder analysis is underway to identify water user groups in the West of Ireland for recruitment. The PIER project will inform development of environmental policies for the protection of public health.

Keywords: Recreational water, bathing water, antibiotic resistant bacteria, antibiotic resistance, public health and wellbeing, systems thinking

Ecotoxicology

PCBS, PBDEs, OCs and heavy metals in Gannet eggs: a comparison between Irish colonies

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The Northern Gannet *Morus bossanus* is an avian sentinel; the largest breeding seabird in Ireland and an obligate piscivore. Gannet eggs (n = 10-20) were collected from two island colonies off the east coast of Ireland, approximately 150km from each other, in locations with divergent history of industrialization. Levels of potentially harmful contaminants including Polychlorinated biphenyls (PCBs), Polybrominated diphenyl ethers (PBDEs), Organochlorine pesticides (OCs), heavy metals and mercury were measured and differences in contaminant concentrations between colonies compared. Stable isotopes of carbon (d13C) and nitrogen (d15N) were measured in each egg to understand the influence of diet in contaminant levels detected. Significantly higher levels of PCBs, PBDEs and mercury were detected near Dublin (Ireland's industrialized capital city and location of its largest port) compared to Wexford. No differences were observed in levels of OCs and heavy metals between the two colonies. Stable isotope analysis demonstrated that Gannets in both locations occupy the same dietary niche excluding a difference in diet as the driver of differing contaminant levels in the two feeding areas. Though Gannets travel significant distances when foraging for food (~200km) tracking studies in Ireland and the UK have shown that birds from breeding colonies maintain exclusive feeding areas with little overlap between neighbouring colonies. Spatially separated foraging behaviour may explain differences of contaminant levels detected between the colonies in this study, despite their close proximity and the high dispersal ability of Gannets. These results are in concurrence with elevated levels of contaminants in lower trophic level organisms that have been found in Dublin Bay compared to the rest of Ireland, indicating potential for Gannets as a higher trophic level indicator - though variability in their diet, including feeding on fishing discards, may lead to unacceptable levels of variability for an indicator species.

Keywords: Gannet, seabirds, POPS, Persistent Organic Pollutants, heavy metals, mercury, stable isotope analysis, pcbs, ddt

Ecotoxicology

An investigation of mycotoxin induced DNA damage in porcine intestinal cells

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Mycotoxins are toxic compounds, and are naturally occurring secondary metabolites produced by fungal species. They are mostly found in wheat, barley and corn. Deoxynivalenol (DON) is one of the most frequently occurring mycotoxins. Pigs are particularly susceptible to toxicity induced by DON and consumption of contaminated wheat, barley and corn based feed can result in vomiting, diarrhoea and reduced growth. This study shows that incubation with DON for 24 hours had a toxic effect on porcine gut epithelial (IPEC-J2) cells at levels below the European Food Safety Authority (EFSA) recommendation of 0.9 ppm. Alltech's selenium-enriched yeast (Sel-Plex) is an organic selenium product that is used as an animal feed supplement as it has a positive impact on animal health. Mycosorb A$^+$ is a mycotoxin binder produced by Alltech that reduces the amount of mycotoxin absorbed by animals and is therefore, also used as supplement to animal feeds. The protective effect of these two supplements on the IPEC-J2 porcine intestinal cells was investigated. It was shown by TUNEL assay that a 48 h pre-incubation of IPEC-J2 cells with Se-Y and My-A+ resulted in lower levels of DON associated DNA damage when compared to cells with no pre-treatment, although the extent to which this is associated with decreased cell viability remains unclear. Further studies on DON will include investigating its effects in conjunction with other co-occurring mycotoxins.

Keywords: Mycotoxins, deoxynivalenol, DNA damage

Ecotoxicology

A study on the ecological impact of recycling derived fertilisers (RDFs) using nematodes as environmental bioindicators

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Soil is the main source of nutrients needed for plant growth. The three main such nutrients, nitrogen(N), phosphorous (P) and potassium (K), are routinely applied by farmers via artificial mineral fertilisers, whose production, mining and transportation pollute the environment. Nutrient recovery technologies are employed to produce recycling derived fertilisers (RDF) from three large waste streams, sewage sludge, food waste and manure, that can replace usage of conventional mineral fertilisers in farms. However, before these RDF are applied to the soil, they need to undergo an ecological risk assessment. Nematodes are the most abundant and widespread soil roundworms, sensitive to pollutants and environmental disturbance and therefore ideal as biological indicators of environmental change. This project is an investigation on the ecological impact of RDF by studying their effects on nematodes in single species ecotoxicology experiments and terrestrial nematode community analyses via the following approaches: investigating the effects of RDF on (1) beneficial entomopathogenic nematodes (*Steinernema feltiae*) in microcosm experiments looking at nematode infectivity and reproduction, (2) *Caenorhabditis elegans* in toxicity bioassays observing nematode mortality and (3) nematode communities in RDF testing field trials in Ireland, Belgium and France, as part of the INTERREG_NWE Project called ReNu2Farm (www.nweurope.eu/renu2farm). For community analyses nematode DNA was extracted from soil samples, and the 18S rRNA gene was analysed, using suitable primers from Bhadury et al. (2006), via subsequent sequencing and further bioinformatic analysis. Absolute nematode abundance expressed in Molecular Operational Taxonomical Units (MOTUs) is currently examined using Nematode INdicator Joint Analysis (NINJA) to exclude any adverse effects of RDF on soil nematode diversity compared to that in control plots.

Keywords: Nematode, ecological risk assessment, RDFs

Comparison of active ingredient and commercial formulated glyphosate on the brain and digestive tract of the bumblebee *Bombus terrestris*

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Food crop production and ecosystem functioning are vital services provided by pollinating insects; however, many species are in decline around the globe. Several factors are associated with pollinator decline, including habitat loss, disease and pesticide use. Currently, little is known about the potential effects that non-insecticidal pesticides, such as herbicides and fungicides, could have on pollinating insects. To address these gaps, the PROTECTS (Protecting Terrestrial Ecosystems Through Sustainable Pesticide Use) project was established to provide baseline information on understanding and mitigating the effects of pesticide use on terrestrial ecosystem services, focusing on *Bombus terrestris* as a model insect pollinator. Using mass-spectrometry based proteomics, we characterized glyphosate effects on the neuronal and digestive systems of *B. terrestris*, to determine whether cellular and physiological processes are altered at the molecular level. We also investigated similarities and differences between the effects of glyphosate alone (active ingredient; AI) or as part of a commercial formulation (hereafter CF-A). After five days of chronic exposure, both AI and CF-A resulted in the differential expression of core sets of proteins highlighting a glyphosate specific response/effect regardless of source. However, key differences were also identified suggesting that the adjuvants found in commercial formulations may also alter the bumblebee proteome. Gene Ontology analysis resolved proteins associated with metabolism that were affected by both AI and CF-A exposure in the brain. In the digestive tract, metabolism, cellular organization and stress-responses are most affected in AI-exposed bees compared to metabolism and some stress-responses in CF-A exposed bees. This study demonstrates the potential for proteomics to assess pesticide effects on non-target organisms where no mode of action has been established. Furthermore, we highlight potential issues with using AI pesticides alone when assessing potential effects, as many pesticides are applied as part of commercial formulations which contain other ingredients potentially toxic to insects.

Keywords: Glyphosate, bees, pesticides, proteomics

Irish Farmers' Willingness to use Recycled Derived Fertiliser Products

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Mineral fertilisers are widely used for crop production; however, they are a finite resource. Therefore, more sustainable options need to be implemented and utilised. Recycling derived fertilisers (RDFs) are renewable products derived from several different sustainable sources. These products have great potential for replacing mineral fertilisers. They are safe to use, have high nutrient value and are readily available. The farmers' willingness to utilise these products was investigated. A farmers' survey was compiled to determine, but not limited to, the farmers' attitude towards using RDFs, their experience of using these products and their willingness to pay for these recycled products. Farmers in North-West Europe (NWE), from seven different countries, were surveyed, and the results were collated, assessed and statistically analysed. Over 1220 farmers and stakeholders responded to the survey. Overall, respondents in Ireland were the most willing to utilise RDF products compared to the other participating NWE countries. In particular, participants from Ireland were more willing to utilise household waste (57%) and food industry waste (72%). However, respondents in Ireland currently use ash the most, compared to the other NWE countries. The survey results also indicated that participants in Ireland have used RDF products the least (23%) compared to the other participating NWE countries (59%). Yet, respondents in Ireland have had the highest very/positive experience (84%) compared to the NWE countries with 75%. In addition, participants in Ireland were the most willing to pay the same for RDF products (28%) as mineral fertilisers in comparison to the other participating NWE countries (16%). To increase the use and uptake of these products, it is important to inform farmers that these products are safe to use and their nutrient content can be known, so the farmer can have confidence in their performance. Using RDFs is an example of the circular economy in action.

Keywords: Recycling derived fertilisers, farmers survey, sustainability, compost, sewage sludge

Using the life cycle assessment approach to contribute to a sustainable seafood sector in Ireland

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The seafood sector in Ireland is important from an economic and social perspective worth an estimated €275 million for the Irish fishing industry. In 2019 Ireland had 2,022 registered fishing vessels in 2019, 278 aquaculture production units and 164 seafood processors. It is important to the economy in particular the rural coastal communities, in 2019 it accounted for 16,000 jobs directly and indirectly. However, the seafood sector faces many challenges, including waste management, water pollution, challenges and carbon dioxide (CO_2) emissions associated with demanding energy and fuel use for the transportation of goods. These challenges are forcing all stakeholders, from policy-makers to consumers and industries, to move to more sustainable policies, practices and processes. Life cycle assessment has shown that the two largest contributors to greenhouse gas emissions from wild fishing is fuel consumption and for farmed fishing is the supply of feed. The aim of this research is to evaluate the inputs, the outputs and impacts associated with production of seafood right through the value chain using Life Cycle Assessment (LCA) approach. This study is important for a number of reasons, it will show how LCA can help with process efficiency, energy efficiency and decision support systems thereby contributing to a more sustainable seafood sector.

Keywords: Food-energy-water nexus, seafood sector, climate change, lifecycle assessment

Analysis of Data Submitted Under NECD Across Europe

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The updated National Emissions Ceiling (NEC) Directive (2016/2284/EU) requires European member states to monitor and report harmful air pollutant concentrations and deposition rates on sensitive habitats (e.g. NO_x, NH_3 and $PM_{2.5}$). In 2019, NECD Article 10 (4) submissions were provided by 28 member states, which required the provision of historic data for proposed long term sites within each countries National Ecosystem Monitoring Network. The data provided in these submissions are indicative of both the deposition and concentration of air pollutants for the proposed sensitive sites selected for inclusion by each country. This research focuses on nitrogen deposition and ammonia concentrations, due to their high risk for impacts on biodiversity. Statistical analysis was conducted on total submissions, number of sites, mean nitrogen deposition and ammonia concentration, in addition to variation in data reports using R-Studio. The data extracted from the 2019 NECD reports show high variations in the deposition/concentration of nitrogenous compounds between member states. Belgium and Ireland show a spread in data for each deposition parameter e.g. 0.068 to 76.662 mg/L N-tot (BE) and -1.000 to 55.900 mg/L SO_4-N (IE). Croatia has a maximum concentration value of 66.000 µg/m^3 NO_2, and a minimum value of 42.800 µg/m^3 NO_2, where Estonia has a maximum and minimum value both of 2.250 µg/m^3 NO_2. This data is currently being explored and with further analysis, will be used to indicate suitability of selected sites as indicators of the required "risk-based" approach across Europe. Future work within this dataset will allow for analysis of potential over and underestimation of nitrogen deposition and ammonia concentrations on sensitive habitats.

Keywords: Ammonia, Air Pollution, NECD, Concentration, Deposition, Nitrogen

Day Length Perception in Perennial Ryegrass

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Anticipated macro and micro-climate changes within the Irish Agricultural landscape, such as flooding and seasonal temperature disruption, could place stress upon plant breeders' abilities to maintain plant fitness and enhance agronomic traits essential for an increasing human population. Plants, including the agronomically valuable grasses grown within Ireland, measure seasonal temperate day length and adjust their growth and development accordingly. This is achieved by the coordinated action of the light signalling pathway and the circadian clock. Besides providing positional information, light signals also act as inputs to the clock, and the circadian machinery will then match day length with specific biological processes, allowing their perfect match within 24h day cycles. A properly running clock contributes to increased plant fitness and biomass, since many relevant metabolic processes are under circadian control through molecular feedback loops. Understanding how these responses are coordinated at the cellular level will be relevant for an important crop such as perennial ryegrass (*Lolium perenne*), a major forage crop in Ireland. Previous research has shown seasonal control of ryegrass growth and of specific developmental transitions such as flowering time. We established an early *in-vitro* screening method with distinct photoperiods matching Irish seasons, to assess root/shoot development. By analysing 17 independent varieties we aim to correlate their early performance when grown *in vitro* and their Pasture Profit Index obtained in field conditions. This screening could assist marker-assisted breeding and allow the selection of varieties better adapted to a changing climate. This strategy would combine food security issues with environmental challenges and thus contribute to enhance sustainability in the Irish agricultural system.

Keywords: Climate Change, Circadian clock, Sustainability, Sustainable Agriculture

Distributed Ledger Technologies to Globally Coordinate Grass-Roots Driven Actions on Climate, Biodiversity and the Environment

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The scientific community has presented compelling evidence on the devastating toll of our current policies and lifestyles accompanied by unsustainable carbon emissions, environmental contamination and destruction of natural habitats. They requested urgent actions to assure future quality of life and to curb various disaster scenarios. While these voices have garnered an unprecedented level of global support, national governments are still reluctant to enforce effective measures as they will unavoidably have short-term impact on economies and life styles of their electorate. Over the last decade, blockchain technologies have firmly established as a sophisticated tool for decentralised decision making and funding of "commons", i.e. widely shared goals. While the notorious Bitcoin mainly provides store of value, other distributed ledger technologies (DLTs) such as "Ethereum" have strongly emerged in the meantime; these also run Turing-complete "virtual machines" enabling smart contracts, also nicknamed "programmable money", which provide a cryptoeconomically secured, tamper-proof and immutable ledger for establishing trust within global communities as a solid foundation for crowdfunding, crowdsourcing and governance. By objective vetting of experts and community-based validation of technological concepts and data, e.g. obtained from simulation and Internet of Things (IoT) based sensor networks, these elements can form the crucial pillars of decentralised autonomous organisations ("DAOs") to optimise conception, selection, fundraising, monitoring and management of grass-roots projects, as opposed to just organising protests, which actively contribute to solving the complex challenges of sustainability on the global scale. Undoubtedly, underpinning cryptoeconomical Web3 concepts like formalised reputation and staking schemes, bounty networks, token bonding curves prediction and curation markets still require substantial optimisation towards real-world viability including user convenience. However, in view of the stark failure of legacy mechanisms to efficiently tackle imminent issues of climate, environment and biodiversity, it is certainly worth sophisticating these DLT-enabled schemes to the benefit of mankind.

Keywords: Blockchain, distributed ledger technology, DLT, smart contracts, Web3, governance, internet of things, climate change, biodiversity, sustainability

The dairy biorefinery: integrating biological, physical and electrochemical processes for cheese whey valorisation

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Fermentative hydrogen (H_2) generation from cheese whey, with simultaneous production and extraction of volatile fatty acids (VFAs), was studied in UASB reactors operated in batch and continuous mode. The extraction unit was a silicone membrane coil submerged in distilled water, installed to the UASB reactor through a recirculation loop, which allowed concentration-driven VFA extraction. H_2 yields up to 0.9 mol_{H2}/$mol_{glucose}$ were achieved, in batch, at 35°C and pH 5.0. Undissociated VFAs were extracted through the silicone membrane, with a strong preference for the most hydrophobic, longer chain (butyric) than the shorter chain (propionic, acetic) carboxylic acids. Sugars, nutrients and lactic acid were retained, resulting in an extracted solution of up to 2.5 g/L butyric acid with > 90% purity. The results of the continuous experiment confirmed those obtained in batch, with H_2 production rates up to 2.0 L_{H2}/L/d and selective butyric acid extraction both *in-line* (from the UASB recirculation) and *off-line* (from the UASB effluent). Besides H_2, the gas mixture produced by cheese whey fermentation contains up to 70% CO_2, which was further exploited for VFA production *via* microbial electrosynthesis (MES). An H-type MES reactor, consisting of a carbon cloth cathode and a Pt-Ti anode electrode, was continuously fed with gaseous CO_2, and achieved acetic acid production rates up to 216 g/m^3/d when operated at 20-25°C with an imposed cathode potential of -1.0 V vs. the Ag/AgCl reference electrode. A reductive current up to 8 A/$m^2_{electrode}$ was also generated, and coulombic efficiencies (CE) up to 40% were achieved. Cyclic voltammetry and scanning electron microscopy analysis confirmed that the electrochemically-assisted CO_2 reduction was catalysed by an electrotrophic biofilm growing on the cathode electrode. Microbiological analyses are on the way to investigate the key microorganisms involved in such bioprocess.

Keywords: Circular economy, Dairy industry, Dark fermentation, Membrane pertraction, Microbial electrochemical technologies

LimerickAir - a distributed network of low cost monitors mapping particulate air pollution

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LimerickAir is a network of low cost particulate air pollution monitors, distributed across Limerick. Each consists of a Plantower PMS7003 PM2.5 sensor and a BME280 temperature, pressure, and humidity sensor, controlled by custom Python modules running on a Raspberry Pi Zero Wireless. PM2.5 values are recorded every 0.7 seconds, recalculated to 5 minute mean values and plotted as daily graphs using pandas and matplotlib, and shared to Twitter using Twython. The low cost of optical sensors such as the PMS7003 facilitates a vast increase in the spatial resolution of air pollution monitoring, particularly in urban areas. While co-location studies have shown that low-cost optical sensors may exaggerate PM2.5 levels, certain sensors including the PMS7003 show a strong linear correction to reference monitor data. Thus while distributed low-cost sensor networks could not be used to monitor compliance with air quality standards, they can be used to map air pollution using GIS. Such mapping may allow source identification from analysis of pollution spatial and temporal distribution, and indicate potential mitigation strategies. Data from LimerickAir monitors shows both spatial and temporal differences between sensors, providing proof of concept for low-cost sensor networks mapping air pollution. The main trend observed over the past year was strong elevation of PM2.5 levels from late afternoon until early morning from September to April, but not during the summer months – strongly indicative of home heating sources. Levels appear to be linked to weather conditions, particularly thermal inversions. Other smaller events, picked up by different monitors at different times, appear to record the movement of air masses transporting particulates from as-yet unidentified sources across Limerick. The daily publication of graphs on Twitter has led to some public interest, and local media coverage, demonstrating the value of dissemination of information over social media.

Keywords: Air quality, PM2.5, Python, GIS

Customisable Benchtop Platform for the detection of Nitrite and Nitrate utilising Colorimetric Chemistries

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Reliable high frequency data relating to the water quality of lakes, rivers and oceans is essential for water management and for monitoring and improving the overall quality of water resources. Determining the concentration and composition of potential contaminants in natural waters is necessary to characterize and understand the aquatic environment. We present a modular benchtop platform for the detection of colorimetric chemistries; this platform can be further modified to be used in the field or integrated into autonomous sensing platforms with the addition of a fluidic handling system. The platform has been developed using low cost LED/photodiode based optical detection. The benchtop sensing platform consists of an Arduino microcontroller, in house fabricated read board and an optical detection cell consisting of an LED and Photodiode mounted externally to a cell or fluidic chip. This platform can also serve as a test bench for characterisation of various LEDs and Photodiodes and validation of optical microfluidic chip designs. Colorimetric chemistries are favourable for this LED Photodiode based detector setup, the coloured response can be directly measured, and concentration can be correlated. The Benchtop platform was paired with an LED and photodiode based on the λ max of the Griess assay for colorimetric Nitrite (NO_2^-) detection. The intensity of the LED can be further controlled using a PWM driver, the ability to change the light intensity allows for customisation of the cells pathlength and optimisation of the detection sensitivities. The use of an inline heat source allows for the regulation of fluidic temperature to control and minimize reaction times. The use of heat is also advantageous as it allows for the use of reducing agents such as Vanadium chloride (VCl_3) so that Nitrate (NO_3^-) can be indirectly detected as Nitrite with the Griess assay.

Keywords: Colorimetric Chemistries; Nutrient Detection; Optical Sensing; Microfluidics

Electrochemically assisted cheese whey fermentation for CO_2-free volatile fatty acids production

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Dark fermentation (DF), in which sugars are converted to volatile fatty acids (VFAs), is a robust technology for cheese whey valorisation. In DF, the substrate-to-product conversion efficiency is limited by CO_2 production. Such CO_2 can, however, be recycled into VFAs via microbial electrosynthesis (MES). In this study, we coupled DF and MES, in the same bioreactor, to maximise the VFA yield from a synthetic solution simulating the composition of diluted cheese whey upon homolactic fermentation. A 20 mM lactic acid solution was fed into the biocathode of dual chamber H-type MES cells inoculated with anaerobic sludge from a dairy industry. The cells were operated in fed-batch mode at 25°C for four feeding cycles (25 days in total) with an applied cathodic potential of -1.0 V vs. Ag/AgCl reference electrode. The integrated process resulted in the production of propionic and acetic acid, with negligible net-CO_2 generation, at molar ratios compatible to the following pathway: (i) fermentative conversion of lactic acid to propionic acid, acetic acid and CO_2, and (ii) electrosynthesis of acetic acid from CO_2. Scanning electron microscopy and cyclic voltammetry confirmed the presence of electroactive microorganisms on the carbon cloth cathode electrode, acting as biocatalysts for the electrochemical reduction of CO_2 to acetic acid. Propionic acid was the most abundant fermentation product, suggesting that the applied potential caused a shift from the most typical cheese whey fermentation pathway obtained in the pH range of this experiment (around 6), in which butyric acid is usually the main product. Similar results were obtained when increasing the lactic acid concentration to 200 mM, suggesting that the same valorisation process can be applied to raw cheese whey. Electrochemical and microbial community analysis are currently being undertaken to elucidate the microorganism-electrode interaction, as well as the synergies between the microorganisms underpinning such novel bioelectrochemical process.

Keywords: Biorefinery, Circular economy, Dairy industry, Propionic acid, Microbial electrosynthesis

Developing a plastic reduction programme for Irish households and schools

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Plastic has become a ubiquitous material globally, with recent research quantifying the damage caused by plastic waste to the environment with horrifying results. These revelations have raised public concern over plastic waste, prompting calls for action. The project aimed to build upon the current public concern regarding plastic and take it to the next level, active public engagement with the issue. The 12 month EPA funded project aimed to develop a technology mediated citizen science programme for auditing plastic use in Irish homes and schools to actively engage the public on this issue. Two versions of the programme were developed; one for households and one for schools. Thirty-nine households and sixteen schools trialled the programme. The household pilot programme ran over four months. Participants audited the disposable plastic in their home, received a feedback report advising on simple sustainable changes, set plastic reduction pledges and were provided with follow on support to make these changes. Participants in the pilot schools programme took part in a four-week teacher-led plastic reduction curriculum. This incorporated lessons, activities, audits of class and home plastic use and development of a school plastic reduction action plan. Both programmes succeeded in raising awareness of disposable plastic use and led to behavioural changes. Households took on plastic reduction pledges, and schools developed plastic reduction action plans. The household programme succeeded in raising awareness levels of their plastic use in 62% of participants. On programme completion participants expressed intentions to continue making reduced plastic choices in the future saying these behaviours were now normalised within their life. All teachers reported increased pupil awareness of plastic issues, with 58% of teachers reporting a large change in awareness levels. 50% of participating schools also selected to use the programme to assist them in developing a plastic reduction action plan.

Keywords: Plastic reduction, Environmental Education, Citizen Science, Awareness raising, Behaviour change

The use of MSW-compost on land, a study of metal and nutrient leaching

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It is estimated that 138 million tonnes of bio-waste are produced in Europe annually, with only 25% being high-quality compost and digestate. Currently, residual organic waste is generated as by-product of municipal solid waste treatment. Its reuse varies across EU countries, due to the lack of guidance at European level. Some countries restrict the use of compost derived from municipal solid waste (MSW – compost) to landfill cover whereas other countries have regulated its used as marketable compost. The restricted use of MSW - compost is linked to the organic and inorganic contamination. Despite this, under the European view of the Circular Economy, MSW-compost has great potential to be reused and recycled. Controlled use on land would off-set carbon emissions by diverting the material from being incinerated or landfilled, resulting in a carbon positive soil additive. Our study aims to risk-assess the use of MSW-compost as a soil amendment by monitoring resulting water for metal and nutrient content. Four treatments 1) control, 2) sewage sludge chemically stabilized (10 t/ha), 3) MSW-compost (10 t/ha) and 4) MSW-compost (25 t/ha) were established in duplicate. Preliminary results show that metals and nitrate concentrations in the leachate were below threshold criteria in surface water quality regulations. Ammonium levels above detection limits were detected at week one. Results gathered so far show that the use MSW-compost in land compares to sewage sludge application in relation to water pollution potential. MSW-compost could be used as a soil improver under a regulatory alignment similar to the sewage sludge regulations.

Keywords: MSW – Compost; water leaching; metals; nitrates; ammonium

The drivers and advancement of a phosphorus deficient growing medium, for the testing of recovered phosphorus fertilisers

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Phosphorus (P) is a naturally occurring life sustaining mineral, for which there is no substitute. Much of the world's modern agricultural and subsequent food production is sustained by the application of mineral P fertilisers, the majority of which are produced from finite phosphate rock. There is much debate over the long term global reserves of phosphate rock with estimates of peak P occurring in the next 30 to 300 years. In the face of dwindling P reserves, and to reduce the environmental effects of P contained within municipal wastewaters, numerous technologies have been developed to recover P from a variety of wastewater streams and return it to the soil as a P rich fertiliser. Each technology produces a different product with varying physical and chemical characteristics that fluctuate according to the recovery process and wastewater properties. The research outlines the development of a P deficient growing medium, of suitable nature to test P availability through grass dry matter production, of a variety of recovered P products. The growing medium must be repeatable and contain insignificant levels of plant available phosphorus to ensure with confidence that the recovered fertiliser from municipal wastewater, and not from the residual growing medium P, supplies the phosphorus absorbed by the grass. A number of design iterations were conducted by blending a variety of sands, silts and clays to form a uniform well-structured growing medium, capable of supplying plant roots with the required quantities of air, water and nutrients, with the absence of P or other organic materials. An expansion coefficient and mixing process was developed to allow for the expansion of the hydrated mineral elements. To date three growing mediums have been developed with low, medium and high pH, all containing a P content of less than 1mg/l of Morgan's extractable P.

Keywords: Phosphorus, phosphorus recovery, pot trials, growing medium

Physio-chemical characterisation and ecotoxicology risk assessment of starch and gelatine blend bioplastics

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The European Union Plastics Strategy, which targets a complete ban on single use plastics by 2030, is leading to a rapid development of ecologically benign alternatives. Although biodegradable plastics have already been introduced, to some extent, to the market, they remain peripheral in terms of adoption and usage. Anecdotally, this relates to cost, lack of promised market demand, and material versatility. Currently available biodegradable plastics do not fully address all these pre-determined requirements, as they degrade over relatively long time-spans and are predominantly based on fossil fuels. International and national plastics strategies now demand the evolution of natural polymers, which match the physio-chemical characteristics of traditional plastics. Engagement with the full spectrum of relevant stakeholders is critical to this success. In this study on packaging and its alternatives consumer feedback was generated through semi-structured focus groups. Costumer awareness was investigated on biodegradable and compostable alternatives and the importance of labelling packaging so consumers can make informed decisions. Bioplastics generated in this study were derived from potato starch and gelatine from different sources, fish, porcine and bovine. The study aims to determine ultimate tensile strength, ecotoxicology safety and biodegradation time of the bioplastics. Tensile strength results suggest great potential for bioplastic derived from starch and fish gelatine, which is significantly stronger than pork and bovine gelatines blends. Ecotoxicology assessments with algae showed no toxic effect on the organism. Further ecotoxicology assessment in soil environments were undertaking to examine fully the environmental sensitivities of the bioplastics. Biodegradation trials to determine the timeline for complete bioplastic degradation have delivered promising results but further test data is required.

Keywords: Bioplastic, starch and gelatine blend, biodegradable, compostable

Environ 2020

Dublin City University Water Institute

October 20th – 22nd 2020

Ireland's Water, Energy & Environment in a Climate and Biodiversity Emergency

30th Irish Environmental Research Colloquium

POSTER PRESENTATION ABSTRACTS

(Listed by Poster Session and Theme)

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Sustainable Land-Use, Agriculture & Food (SLAF)
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Human Health (HH)

Nutrient Sensor for Monitoring Phosphate in Natural Waters

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A deployable sensing platform for real-time monitoring of phosphate in water bodies has been developed comprising of a 3D printed microfluidic chip, inexpensive UV-led and Photodiode optical detection and a low power SIGFOX LPWAN communication system. The platform was field deployed the Tolka River, Dublin for 44 days during which it collected 1223 measurements and streamed to a live IoT channel in the public domain. The sensor was tested in the lab by reading through a known concentration spiked water tank. During the deployment in the Tolka river, the sensor registered a minimum of 4.1µM and a maximum of 47.1µM of phosphate level which coincided with rainfall events. Elevated levels of phosphate were recorded during tropical storm Lorenzo (30th September 2019), when 23.8mm of rainfall was recorded. The sensor together with all necessary peripheral components is designed and housed inside a PELI case. The sensor logs the data locally on the SD card as well as transmitting it via the LPWAN SIGFOX network to our live channel on Thingspeak. The raw transmitted string of data is processed and presented in several appropriate graphs in a single-window, which helps to simultaneously monitor kinematics of the chemistry involved. The processing of the raw data string takes place in almost real-time and time-stamped as per the selected time zones. Use of LPWAN SIGFOX and custom Lithium-Ion battery pack (14.4V 26.8Ah) has allowed the system to operate autonomously for 15 days on the single charged battery pack. Laboratory and field data demonstrate reasonable reliability and scalability in a remote chemical sensing application.

Keywords: Phosphates; real time monitoring; Tolka River

Spatial and temporal distribution of lead in drinking water of different water supply zones in Dublin

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The demand for clean drinking water is increasing with global development. Lead is a dangerous neurotoxin that can be dissolved in water. Many historic water supply networks contain lead fixtures, and insufficient water treatment can result in corrosive action, sometimes causing a lead crisis in certain supply catchments. This poster presentation explores the data available on lead contamination of drinking water within different supply zones in Dublin as per the Irish water website. At present, the accepted control methods in developed countries are maintaining aging infrastructure and monitoring legal lead levels in drinking water on regular intervals. Conventional laboratory and on-site protocols are costly, time-consuming and varying in degrees of accuracy. According to the EU Regulations, the acceptable lead level is 10µg/L. Excess intake of lead has drastic health effects on a community, pregnant women and young children, the most vulnerable to exposure. Stillbirth, miscarriage, physical and psychological development are all directly influenced by blood lead levels. The results will help in analysing and quantifying the levels of lead contamination in Dublin.

Keywords: Lead contamination, drinking water, health effects, Dublin

Phosphate sensing using a novel and near real-time microfluidic portable sensor

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The need for real-time, reliable and robust sensors is still at the forefront of monitoring needs for nutrient analysis in freshwater systems. Herein, describes a lab-on-a-disc (LOAD) microfluidic device for the detection of phosphate in freshwater. The LOAD device consists of a centrifugal platform with specifically designed network of microfluidic channels to enable precise metering and mixing of on disc reagents, incorporating reagent storage within the chambers of the microfluidic disc design. To enable rapid analysis, a customised analysis system has also been developed to facilitate disc rotation and automated reading from the LOAD device. The system facilitates automated experimental protocol execution and recording of data via a PC interface. This work also details optimisation of the path length disc design, where modifications will be included in the detection channel using optical enhancement techniques e.g., absorbing and reflective coatings and refractive index modifications. This is done to reduce stray light that the detection channel is exposed to, significantly improving the signal to noise ratio (S/N) and baseline noise, hence increasing the sensitivity that can be achieved by the system. Therefore, more tests can be incorporated on the disc. This work demonstrates the improvements in detection performance using these disc modifications.

Keywords: Phosphate, real-time monitoring, microfluidics, optical enhancement

Using data analytics to predict water level in catchments

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In recent years, more and more emphasis has been placed on the predicted rise in water level as becomes a more pressing issue as a result of global warming. Flooding is one of the most prevalent and most destructive natural disasters often resulting in loss of life. Flooding occurs when there is more water upstream than usual and as this flows downs stream to the low-lying areas, the excess water flow into the surrounding areas. Application of machine learning (ML) techniques has received significant attention in recent years. One of the more popular applications of ML is prediction systems. Predicting water level changes is notoriously tricky, it depends on a complex mixture of data including the history of water level, precipitation among other data sources. In this research, Artificial Neural Networks (ANN) are used as a basis to create our predictive system. ANN are a sub field of machine learning where the algorithms are inspired by the structure of the human brain. It can be considered to be a "black box" winch takes one or multiple inputs, such as sensor data, processing them into one or multiple outputs. Our system uses data provided by sensors, to create a computer tool to predict river water level Using ANNs in particular using Long Short-Term Memory models (LSTM). LSTM have recently become popular choices for problems related to sequential time series data. They are very effective in handling long-term temporal dependencies. Predictions based on machine learning could significantly contribute to water resource management (for both short- and long-term hydro logical event prediction such as flooding, rainfall or storms) providing better performance and cost-effective solutions.

Keywords: Long Short-Term Memory models (LSTMs), Neural Networks, Prediction systems, Water Levels, hydrological cycle

Irish Peatlands and their Connection to Water Quality

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Peatlands are wetland ecosystems that are characterised by the accumulation of organic matter called 'peat' which is derived from dead and slowly decaying plant material under high water saturation conditions. Peatlands are wetlands that feed into the river catchment for their area. Wetlands provide many important functions including water supply, flood water storage, pollution control, groundwater recharge, habitats for wildlife. Peatlands are part of the Irish landscape and form part of our oldest natural heritage; occurring as raised bogs, blanket bogs, and fens. It is estimated that peat soils comprise 17% of the total land surface of Ireland. They play an important role in the global hydrological cycle helping to maintain both water quantity and quality. Peatlands have been modified through drainage and associated conversion to other land uses such as grassland, forest plantation, energy, horticulture and peat extraction. The literature review will discuss studies previously undertaken to assess the effect of drained and extracted peatlands on water quality. Salient water quality parameters to be studied in peatlands will be reviewed and analytical techniques utilised will be outlined. This poster will outline the gap in knowledge surrounding data on the physical and chemical properties of peatland water. Knowledge portrayed from this poster will create more awareness to stakeholders and highlight the value of Irish peatlands and their associated water in terms of ecological services.

Keywords: Peatlands, catchment, water quality, analysis, physical and chemical properties, ecological services

Water Quality and Resources (WQ)

Socio-Economic Assessment of Water Governance and Management Legislations in the Republic of Ireland

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Present water resource management and governance in Ireland may not be enough to meet benchmarks set in various water legislations in Ireland. This is evident from the widening disparities in water demands and supply and the steady decline in the ecological status of coastal and transitional water bodies, rivers, lakes and groundwater status triggered by the increasing impact of climate change, population growth, agricultural pollution and industrial demands. A recent study from the Environmental Protection Agency on 2,703 surface water bodies and 514 groundwater bodies in Ireland revealed a 2.6% reduction in the quality of river bodies. The proportion of water bodies reaching satisfactory status was 52.8%. Beyond these challenges, citizen awareness on the social value of water, integrated management and governance procedures and implementation processes of solutions to water resource issues in the face of future climatic variation remains questionable. This research proposes to assess water resource management practices and governance in the Republic of Ireland under the purview of existing legislations in addition to social values associated with water vary across spatial scales. How those values change in response to, for example, effects of climate change in Ireland through a combination of analytical reviews, surveys, key informant interviews, and a social return on investment. In addition, a set of integrated mechanisms and strategies that can help spur benchmark performances in the future will be propose.

Keywords: Climate Change, Water Resources Management, Water Governance, Socio-economic values, Republic of Ireland

Citizen Science Investigations in River Environmental Stewardship: The Maigue River Catchment

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With continued declines in Ireland's river water quality, the second cycle of the River Basin Management Plan (RBMP) recognised the need to increase community involvement to engender improvement and protection of ecological status in Ireland's waterbodies. Globally, citizen science (CS) programmes activate volunteers in a wide range of nature conservation and ecosystem service initiatives. CS, as a standard component in integrated catchment management, has the potential to help achieve the water quality objectives set out in the RBMP and Water Framework Directive. This study partners catchment communities with an academic researcher, supported by a Rivers Trust (RT) and a Community Water Officer, to jointly implement and measure environmental stewardship. The study will investigate that potential of CS as a bottom-up approach to improving water quality by building awareness and increasing capacity and involvement of local communities in issues and decision-making related to the 'at risk' catchment of the Maigue River. Specific challenges and pressures to the water quality of the Maigue River Catchment (MRC) include: alien invasive species, biodiversity decline, and the ecological status of the water and riparian zones. This presentation will outline planned work including a questionnaire survey, semi-structured interviews and co-design and co-development of a CS programme with catchment communities. The programme will be promoted, trialled and empirically studied, thus providing peak potential to meet the objectives of improving water quality in the MRC. Ultimately, the project aims to foster the connection, engagement and cooperation of people and communities with their natural heritage, local catchment and waterbodies, and this will mutually benefit the welfare of society, the natural ecosystem and water quality in the MRC.

Keywords: Water quality, citizen science, community engagement, connection to nature, biodiversity, integrated catchment management, Maigue River

HoliFab: Precise Flow Control using Photo Actuated Hydrogel Valves and PI Controlled LED Actuation for Microfluidic MEMS

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To actively and accurately control flow within a microfluidic system has been a major challenge for many years. To achieve this, a selection of external valves and pumps are often used, thus increasing the scale of the microfluidic system. Advances in material science have allowed for polymer gel structures to be integrated within microfluidic channels as valves and actuated by various means such as varying electrowetting, or by using the local chemistries to actuate. Herein, we present a soft polymer valve which is photo responsive. This approach is attractive in that the control stimulus (light) requires no physical contact with the actuator, unlike electronic stimuli, which require contact structures to be integrated into fluidic system during fabrication. Initial reports were encouraging, demonstrating that valve behaviour could be implemented using these soft photo responsive gels. For example, a spiropyran-functionalised pNIPAAm gel has been shown to be photo-actuated in a channel to produce a valve function. The mechanism involved photoconversion between the non-polar spiropyran and the much more hydrophilic protonated merocyanine isomer. These polymer valve structures can be used as passive pumps rather than a conventional open/closed valve, by pulsing light from the LED, we can actuate the structures to intermediate states of expansion/contraction to tune flow rate through the microfluidic channel. By implementing a variant of the well-known PID control algorithm, we can control the power going to the LED which is illuminating the hydrogel actuator, which using real-time flow rate measurements as the control variable, we can accurately control flow rate in a microfluidic channel. These structures have the potential to be integrated into microfluidic environmental sensors. This would remove the need for bulky external pumps and valves and allow for a reduction in energy consumption, as you are only powering an LED instead of pumps and valves, which are normally seen as power hungry components.

Keywords: Microfluidics, Material science, Flow control, PID

Tide: A driver of faecal indicator bacteria levels in bathing waters

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Bathing water quality is monitored all year to ensure health and safety to the public in accordance with the EU Bathing Water Directive 2006/7/EC. The detection of the presence of faecal pollution in bathing waters is vital regarding public health risks. It is crucial to identify the origin of contamination to design tools to minimise their impact. Identification of faecal pollution sources can be difficult because diffuse contamination from livestock and seabirds prevails in these rural areas. This study focuses on the bathing waters: The Brook Beach, Portrane and Balcarrick Beach, Donabate. It aims to identify drivers that impact faecal indicator bacteria (FIB) levels in bathing waters and looks at the various sources on faecal pollution and the risks associated with public health. The team conducted a transect study for each beach over a 12 hour tidal cycle, commencing at high tide sampling every 30 minutes; following the tide. *E. coli*, intestinal enterococci were cultured from all samples and their levels analysed. To detect human, seagull, ruminant, dog and horse faecal contamination microbial source tracking (MST) was used. A third study to determine the levels of FIB entering and leaving the estuary depending on tide and whether this may impact the FIB levels in these waters was carried out in Rogerstown estuary. Current data found that FIB levels vary by one order of magnitude on both Portrane and Donabate beaches at the compliance points however further up on Portrane beach a pattern with tide and rising levels of FIB can be seen. Both beaches presented all MST markers indicating that bathing water is a complex environment which requires further study. The estuary study indicates a clear tidal impact from the estuary on FIB levels on Portrane bathing water which may be responsible for events of high bacterial levels on occasion.

Keywords: Water quality, public health, faecal indicator bacteria

Acclimatize: A Resilient Model for Bathing Water Quality

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Acclimatize is an interdisciplinary project carried out by researchers in University College Dublin and Aberystwyth University, funded by the EU Interreg Va Ireland-Wales programme. Acclimatize aims to identify and quantify the biological and geographical sources of faecal contamination of bathing waters in a large scale urban area and to assess the impact of climate change on water quality. This operation works in partnership with local authorities and national agencies to design and deliver new practical management and monitoring protocols. The immediate results will be used to develop real-time predictive models that will predict the effects of climate change on Irish coastal waters. Over a two-year period, bi-weekly samples were taken from eight river systems and three designated bathing zones in Dublin Bay. The levels of faecal indicator organisms, *E. coli* and intestinal enterococci, were enumerated and the source of faecal pollution was determined using microbial source tracking (MST). Multiple linear regression models were used to assess the impact of these river systems on these bathing water zones. The results showed a significant correlation between faecal indicator levels in urban streams and two of the at-risk bathing zones. In addition, there was a significant correlation between the feacal indicator levels in these streams and the human MST marker. Therefore, small polluted streams, severly impacted by human faecal pollution, had a significant impact on bathing water non-compliance. These extensive water quality surveillance results will be used to develop an overall drainage model of the Dublin catchment area.

Keywords: Bathing Water Quality

Water Quality and Resources (WQ)

A study of temporal variations in pyrethroid pesticide occurrence in Irish surface water environments

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Due to their non-polar nature and high degree of lipophilicity, pyrethroids (about 25% of the world's insecticide market) tend to sorb to solid particulates in waters. Following rainfall events, agricultural run-off can cause solid particulates to enter water bodies. Although the majority (≤90 %) of the pyrethroid concentration can be removed with secondary treatment, the approximate 10 % that remains in water is at a concentration that can be acutely toxic to certain sensitive species, making monitoring their concentrations in natural waters vital for preserving biodiversity. Gas Chromatography-Mass Spectrometry (GC-MS) with electron impact (EI) ionization has traditionally been the most popular technique for analysis of volatile non-polar compounds. However, hard ionization techniques such as EI can produce excessive fragmentation of certain analytes resulting in reduced sensitivity and selectivity. Pyrethroid pesticides are one such group of compounds that exhibit this excessive fragmentation, making reaching the Limits of Detection (LOD) required to comply with Environmental Quality Standards (EQS) difficult unless very large sample volumes are processed. Softer forms of ionization, such as Chemical Ionization (CI), yield improved sensitivity for this class of compounds. In this study, a GC-CI-MS method was investigated for the quantitative determination of pyrethroid pesticides. An urban and a rural catchment water body were sampled from October 2018 to September 2019, which were concentrated using solid phase extraction (SPE) prior to analysis. Parameters including LODs, Limit of Quantitation (LOQs), matrix effects, range, recovery, precision and accuracy are presented. The results of this year-long study establish a better awareness of pyrethroid contamination within an Irish context and encourage further investigation into water management practices.

Keywords: Pyrethroids, pesticides, GC-MS, gas chromatography, mass spectrometry, surface water, watchlist

An Investigation of Microplastics in Clean Water Systems

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The mechanical properties of plastic, alongside its inexpensiveness and relative ease to produce, has resulted in continual growth in its manufacture. Mechanisms such as mechanical fracture from water turbulence and photo-oxidation degrade larger plastic items (macroplastics), causing eventual fragmentation into microscopic pieces (secondary microplastics). Microplastics are also created intentionally for utilisation within products, such as personal care commodities (primary microplastics), with the generally accepted definition being any plastic item <5mm. To date, most research in this field has focused on the marine environment, with a recent report from the World Health Organization (2019) calling for "more information on the source of microplastic pollution in drinking-water as well as the mechanisms and efficacy of removing plastic particles in drinking water treatment." A significant current issue is the inability to compare results between studies, due to the lack of standardisation of methodology and reporting standards. Therefore, although studies may show reliable results independently, conclusions cannot be drawn between current water treatment plant, tap water and bottled water studies. This study aims to develop a reliable and repeatable protocol for sampling, quantification and qualification of microplastics, providing a novel comparability study which delivers an extensive overview of drinking water from varying sources. Samples will be taken from three potable water treatment plants in Northern Ireland with an upland, river and reservoir source, tap water from households and bottled water, with results subsequently compared. Various treatment stages throughout the treatment process will also be analysed, providing insight into treatment processes with the greatest removal efficiencies. Volume-reduced sampling will be employed, followed by purification, filtration and finally polymer quantification and identification using primarily FTIR analysis. It is expected that water sources associated with greater urban/agricultural land-use will demonstrate a greater abundance than non-intensively farmed rural areas and bottled water a greater abundance than tap water.

Keywords: Microplastics, water treatment, drinking water

Occurrence, sources and fate of pharmaceuticals present in Irish surface waters

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The ever-increasing use of pharmaceuticals in the last decade have led to the contamination of global surface water ecosystems from µg/L to ng/L concentrations. The concentrations, fate and toxicological implications of many pharmaceuticals and their residues remain generally unknown. The continual release, stability and biological activity of these "micropollutants" can lead to chronic environmental exposure, with ensuing behavioural and health-related effects to wildlife and potentially to humans. At each stage of the pharmaceutical lifecycle, there is a significant risk of environmental exposure. For this reason, it is imperative to implement both source directed and end of pipe control measures to mitigate hazards to the environment and humans. The objective of this project is to provide a "cradle to grave" life cycle assessment of how the pharmaceuticals are manufactured, prescribed, used and disposed of and relate it to how this may cause detrimental effects to fauna. Furthermore, 16 pharmaceuticals are investigated in this study including 7 antibiotics; 2 anticonvulsants; 3 contraceptives; 1 anti-inflammatory; 1 antilipidemics; 1 anti-depressant and 1 biguanide in an Irish catchment based study. These pharmaceuticals were selected from the water framework directives "Watch List", in addition to pharmaceuticals commonly found in EU surface waters that have a low removal efficiency in conventional activated sludge type wastewater treatment plants. Surface water sampling was followed up by solid phase extraction and liquid-chromatography tandem mass spectrometry. These selected pharmaceuticals have been assessed to generate a risk quotient indicating their potential risk to wildlife. Outcomes from this research will aim to provide information on the relevant concentrations of pharmaceuticals in Ireland while improve education surrounding appropriate use, disposal and waste management of pharmaceutical products.

Keywords: Pharmaceutical, surface water, micropollutant, Watch List

Contaminated land – effectiveness of surfactants on heavy metal removal

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Contaminated land poses a hazard to human health and the environment. The most common contaminants found at these sites are heavy metals. Heavy metals do not decompose in the soil, making them persistent pollutants which can lead to their concentrations steadily increasing in soils. Heavy metals can enter the human body through direct digestion, inhalation of particles and from food which has absorbed heavy metals. Heavy metal poisoning can have severe health consequences for humans and may even cause death. Soil washing is a possible way of remediating contaminated land of heavy metals. This study focuses on the use of surfactants to remove both heavy metals and organic contaminants such as petroleum hydrocarbons simultaneously from heavily polluted soils. The two surfactants which have been chosen for this study are Fairy Liquid which contains mostly anionic surfactants and GreenKLEEN, which contains mostly non-ionic surfactants. The heavy metals that were chosen to be monitored were copper, lead and zinc and their initial concentrations were 115mg/kg, 1450mg/kg and 225mg/kg respectively. The soil was then mixed with water or surfactant at different concentrations of the solution and washed over a 20μm sieve before sampling for analysis. The resulting concentrations of heavy metals at each stage were compared in order to determine the benefit of using surfactants for heavy metal removal. The heavy metal analysis was carried out by an external accredited lab using acid digestion and inductively coupled plasma – mass spectrometry (ICP-MS). Initial results suggest that these surfactants can be used for heavy metal concentration reduction in the soil with chemical soil washing. For copper, lead and zinc the following reductions have been achieved with Fairy liquid, 42%, 10% and 11%, for GreenKLEEN, 55%, 32% and 20% and for water, 21% and increase in lead and zinc by 28% and 27% respectively.

Keywords: Contaminated land, heavy metals, surfactant, remediation, soil washing

Disaggregated N_2O emission factors associated with deposition of sheep excreta in temperate grasslands

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Grazing ruminants deposit urine and faeces onto pasture soils, which can cause emissions of a potent greenhouse gas, nitrous oxide (N_2O). IPCC provides default emission factors (EF; proportion of deposited nitrogen emitted as N_2O) associated with ruminant excreta deposition. However, due to great spatial and temporal variation, development of country-specific (Tier 2) EFs is encouraged. Thus, the aim of this project is to generate Tier 2 EFs for N_2O emissions from sheep excreta deposition in grasslands, as well as disaggregate emissions by type of excreta and season of application (spring, summer, autumn). An experiment was set-up in April 2019 on a managed lowland grassland site in Teagasc Research Centre in Athenry, Co. Galway in Ireland. For each season, four treatments were applied to the soil in a fully randomized block design: control (C), sheep urine (U) and dung (D), artificial urine (AU) and an additional treatment in autumn: sheep urine with nitrification inhibitor (UNI). Static chambers were used to measure N_2O fluxes for one year after each application. For each season, initial results showed a peak of N_2O flux within the first days after U and AU application, and a significant effect ($p<0.05$) of treatments on cumulative N_2O emissions calculated 15 weeks after autumn application. The partial EF estimated 15 weeks after urine application was 0.04, 0.03 and 0.07 % for spring, summer and autumn respectively. After dung application, it was -0.05, 0.01 and 0.09 % for spring, summer and autumn, respectively. This is much lower than the IPCC default Tier 1 EF of 1% (for 365 days period) associated with sheep excreta deposition. These results highlight the importance to refine such EF. In 2020, the same experiment is reproduced in a different sheep grazing system, in Connemara, characterised by upland rough-grazed grassland on peat soil.

Keywords: Nitrous oxide, denitrification, sheep urine, sheep dung, emission factor, grassland

Sustainable Land Use, Agriculture and Food (SLAF)

Development of a mathematical model for permeability requirements of a bioplastic film for use in modified atmosphere packaging of red meat

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The use of bioplastics in modified atmosphere food packaging has been limited by their poor barrier properties. To investigate the required barrier properties, a mathematical model was developed to predict the effect of permeability on the shelf life of red meat in high oxygen modified atmosphere packaging. *Pseudomonas spp.* is a gram negative bacteria and is most susceptible to changes in carbon dioxide concentration, hence it is a good indicator of whether the permeability is indirectly decreasing the shelf life by allowing too much carbon dioxide to permeate out. The *Pseudomonas spp.*, carbon dioxide and oxygen dynamics were modelled based on predictive microbiology and gas transfer. These differential equations were solved using MATLAB and the results were successfully validated against two published data sets that varied temperature, headspace concentration and film permeability. From analysis of the resultant model, it was found that to maintain a shelf life of beef steaks within 4% at 5°C, a carbon dioxide permeability of $1.6x10^{-5}$ m^3 m^{-2} h^{-1} was required, much higher than typical permeabilities of packaging films of around 10^{-8}. The results showed that the barrier property requirements for plastic films are often over cautious and use a one-size-fits-all approach, this research, however, indicates a more tailored approach could be taken. Using surface response methodology, the model was simplified to a single equation calculating shelf life predictions as a function of various package design parameters, including permeability. From here, a new bioplastic film will be developed to meet the predicted permeability requirement by adjusting the thickness of the barrier layer. This bioplastic will then be pilot tested against the conventional plastic films to see how the results compare.

Keywords: Mathematical model, permeability, modified atmosphere packaging

STAT5A and *STAT3* gene variants in six breeds of Irish beef cattle: implications for milk production and fertility traits

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STAT genes encode a family of proteins that are involved in pre- and post-natal growth and development. In cattle, variants in these genes have been associated with economically important traits including milk production and embryonic survival. The objective of this study is to report the frequencies of single nucleotide polymorphisms (SNPs) in the *STAT5A* and *STAT3* genes in six Irish cattle beef breeds. Data for five *STAT5A* SNPs and two *STAT3* SNPs in 120,000 beef cattle were obtained from the Irish Cattle Breeding Federation (ICBF). Genotype frequencies for *STAT5A* ranged from 0.03 to 0.49 percent, and 0.33 to 0.43 percent for *STAT3* in populations of Aberdeen Angus, Belgian Blue, Charolais, Hereford, Limousin and Simmental breeds. The next objective is to estimate the effects of the *STAT5A* SNPs on milk production, composition, fertility and carcass traits in these beef breed populations. The association between each SNP and deregressed predicted transmitting ability (PTA) will be analysed with ASREML using a weighted mixed animal model approach. Results of this analysis may warrant further functional analysis before consideration for incorporation into genetic evaluation programmes for maximising the rate of genetic gain in Irish beef cattle. The role of genetic and genomic technologies and predictions in livestock breeding programmes is an important factor for a future requiring sustainable national agricultural practices.

Keywords: Sustainable agriculture, genetics, *STAT* gene, beef cattle, single-nucleotide polymorphism

Estimating the frequencies of meat quality gene variants in Irish beef cattle

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The *calpain* (*CAPN*) and *calpastatin* (*CAST*) genes play significant roles in meat quality. The beef component of the livestock sector is considered the least efficient animal protein producer indicating a requirement to mitigate the environmental impact of beef animals. Selecting for cattle with improved meat quality traits may improve the value and profitability of animals on farm and therefore support the sustainability of cattle enterprises in concert with efforts to reduce environmental impact. The objective of this study was to estimate the frequency of single-nucleotide polymorphism (SNP) variants located in *CAPN* and *CAST* for a population of 120,000 Irish beef cattle sampled across six breeds. Data for six SNPs (3 in *CAPN* and 3 in *CAST*) were obtained from the Irish Cattle Breeding Federation (ICBF). In relation to *CAPN*, MAF values ranged from 0.09 to 0.21, 0.14 to 0.40 and 0.19 to 0.45 in *CAPN1_316, CAPN1_530* and *CAPN1_4751* respectively. MAF values concerning *CAST* ranged from 0.40 to 0.47, 0.34 to 0.50 and 0.17 to 0.28 in *CAST_282, CAST_2870* and *CAST_2959* respectively. Future work will involve estimating the effects of these polymorphisms on meat quality across these six breeds. Elucidating the effects of genotypic variation at the *CAPN* and *CAST* genes can provide valuable information for breeding programmes to enhance genetic gain for key traits, thereby impacting the efficiency and sustainability of cattle enterprises.

Keywords: Calpain, calpastatin, beef cattle, single-nucleotide polymorphism

Sustainable Land Use, Agriculture and Food (SLAF)

Insect pests of cherry laurel grown for foliage production in Ireland

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Cherry Laurel, *Prunus laurocerasus*, is an important species, grown for cut foliage in Ireland. As an important filler in floral arrangements, good quality product and blemish-free leaves is a necessity. Grown usually amongst other foliage species cherry laurel has been damaged by a number of insects, however information on the main pest groups is lacking. This project aimed to monitor the growth pattern of Laurel and assess the timing and severity of insect damage. Plantations of various laurel cultivars, including Etna, Caucasica and Novita were monitored from 2017 to 2019. Both timed searches and pheromone and non-species specific sticky traps were used throughout the season. Insect pest incidence was comparatively low in all monitored years to damage arising from pathogens, such as *Pseudomonas*. Insect damage was very variable across locations, but damage ascribed to common green capsid, tortrix moths and thrips were the most prevalent of pests in all years. Key periods of activity, related to the availability of suitable plant resources, indicate when pest management approaches can best be implemented. Trap data did not necessarily correspond to pest incidence on individual plants, which makes predicting pest incidence and timing of interventions at a plantation level or regional level difficult. Our results suggest the best approach may be to target periods when plant resources are most susceptible, and to respond to interannual variability of plant flushing periods, particularly the second flush. Laboratory experiments indicate not all insect pests complete their life cycle on laurel which suggests that pest management needs to consider how other host plants are contributing to their densities within each plantation. Under the Sustainable Use Directive (SUD) all cut-foliage producers need to adopt IPM strategies to tackle pest and disease issues, and the results of our study informs how insect pests could be targeted better.

Keywords: *Prunus laurocerasus*, *Tortrix*, Light brown apple moth, cut foliage, *Lygocoris pabulinus*, pest management, IPM

Using Reconstructed Soil Microbiomes for Improving Soil Bioremediation

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Bioremediation is the use of plants, bacteria and fungi to remove toxic pollutants from soil, air and water. Compared to established techniques such as thermal treatment and chemical oxidation, bioremediation has the advantages of being relatively cheap and environmentally friendly. However, its use in treating environmental pollution is still being improved, as it is a slow process and the range of pollutants that it can be used to treat is somewhat limited. The goal of this project is to test a variety of different species of plants such as *Sinapis alba* and *Lolium perenne* to discover which plants provide the greatest phytoremediation potential. The selected plants are being used in a pilot scale trial that tests the plants ability to degrade total petroleum hydrocarbons (TPHs) in contaminated soil. Contaminated soil from three different sources are being used. The soil comes from oil contaminated sites in Ireland, Spain and China respectively. Simultaneously, a degradation rate experiment is being run to test the degradation rate of a number of different bacterial consortia constructed to degrade TPHs. The consortia are introduced into a flask with minimal media and 2% v/v oil, each week a solvent extraction will be performed on one of the samples and TPHs will be analysed using GC-FID. After a month the degradation rate will be determined. This project is part of a larger European collaborative project called GREENER. The aims of which are to remove pollutants from water and soil/sediments, while generating side products of interest, such as bioelectricity.

Keywords: Bioremediation, Phytoremediation, Total Petroleum Hydrocarbons, Soil

Sustainable Land Use, Agriculture and Food (SLAF)

Improving the efficiency of a petroleum degrading bacterial consortia to bioremediation soil contaminated with heavy fuel oil at the former Irish Sugar factory site in Carlow

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Chemical pollution, arising from industrial, agricultural and domestic activities seriously compromises the health of ecosystems and humans worldwide. A large number of hazardous compounds, such as polycyclic aromatic hydrocarbons (PAHs), petroleum hydrocarbons and emerging pollutants, appear in contaminated soils, sediments, ground and surface waters. In Europe, 24 countries have at least one onshore or offshore oil field. In china, the soil pollution area in the oil extraction area is about 480 * 104ha, accounting for 20% to 30% of the oil extraction area. In order to minimise the risks associated with the accumulations of these chemicals in the environment, low-cost and environmentally friendly methods for the treatment of contaminated areas must be developed to the point where they are both scalable and economically viable. Several physical and chemical methods have been explored to remove pollutants in the environment. However, these methods are complex, energy consuming and/or expensive. Therefore, using bio degradation to solve environmental problems has become the best solution. Biotechnological remediation of chemical contaminated sites requires efficient microbial degradation microorganisms which can be introduced into the contaminated soil (bioaugmentation). This project focuses on the development of improved bacterial consortia for use in soils that at polluted with petroleum hydrocarbon (petrol, diesel, heavy fuel and lubricating oils) and polycyclic aromatic hydrocarbons contaminated sites. Bacterial enrichments were cultivated on mineral media with petroleum hydrocarbons as the sole carbon source. Metagenomic sequencing of these enrichments were carried out in order to identity the major bacterial groups present in the enrichment consortia. Individual strains within the consortia were isolated and characterised for their ability to degrade petroleum hydrocarbons. Through the study, a variety of microbial agents will be obtained for bioremediation of different contaminated sites. This project is part of H2020 Greener project, aim to development of innovative, efficient and low-cost hybrid solutions.

Keywords: Bacterial communities, hydrocarbon degradation, genes response mechanism

The application of CRISPR-Cas to *Salmo salar* detection from environmental DNA

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Biodiversity loss is at an all-time high increasing the need for simple and rapid species monitoring systems. Management and conservation of fish species within aquatic environments requires knowledge of distribution, traditionally gained through visual detection and counting. These methods are expensive, time consuming and can lead to harm of the species of interest. Environmental DNA offers a solution to this through detection of DNA shed into the environment by the target species. Development of simple and rapid techniques to monitor fish species for conservation strategies and detection of invasive species is vital to further the capabilities of environmental DNA. We have developed a novel CRISPR-Cas based assay for rapid species assessment as a route to a simple, cost-effective biosensor device. The assay combines isothermal Recombinase Polymerase Amplification with a CRISPR-Cas system consisting of two main elements; a guide RNA specific to the target and an effector Cas12a nuclease. The Cas12a nuclease is unique in that it can only recognise DNA downstream from a specific protospacer adjacent motif (PAM). These features support a highly specific sequence recognition system that can distinguish closely related species that may be refractory to conventional qPCR assay design.

Keywords: CRISPR-Cas, eDNA, biosensor, *Salmo salar*

Investigation of Littoral zone carbon flux in a humic lake in the west of Ireland

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Peatlands in Ireland are the largest terrestrial store of carbon. These habitats are, however, particularly vulnerable to carbon mobilisation as a result of human activities which have greatly modified carbon exchange between the atmosphere, land and downstream freshwater bodies. This mobilisation of carbon has been reported as an increase in dissolved organic carbon in multiple aquatic peatland catchments in the Northern Hemisphere. The potential impact of this destabilisation in carbon stores is poorly understood for both terrestrial and aquatic ecosystems, with a greater focus up until now placed on investigating the impact on the pelagic zones of lakes and the inputs from larger streams and rivers. However, the role of the littoral zone, which surrounds the lake edge, in carbon dynamics represents a gap in global literature. This project aims to investigate carbon cycling in the littoral zone of Lough Feeagh, examining its contribution to carbon gas exchange and environmental controls within the lake. In addition, the littoral biological community will be examined with an emphasis on the decay and cycling of organic matter such as leaf litter and the contribution of the littoral zone to energy fluxes through the aquatic food-web.

Keywords: Littoral zone, carbon flux, humic lake, dissolved organic carbon, littoral biodiversity, peatlands

Lough Arrow - Conservation Status Assessment and Collaborative Actions for the Natura Network

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The Collaborative Actions for the Natura Network (CANN) is an ambitious INTERREG VA project (2017-2022), to improve the conservation condition of selected Special Areas of Conservation (SACs) within Border Regions of Ireland and in Western Scotland, under the European Union's Habitats Directive (92/43/EEC). This PhD research is part of the wider project activities focused at one of the CANN sites; Lough Arrow, a designated SAC, containing a representative example of the Annex I habitat "Hard oligo-mesotrophic waters with benthic vegetation of *Chara* spp." The current conservation status of this Annex I habitat is significantly impaired and deemed by the most recent Article 17 conservation assessment to have a "Bad" classification nationally. This classification is due to a number of pressures impacting the habitat at a national scale, most notably, the impacts from pollution and invasive species, which are compromising both habitat quality and availability. This project will determine the current conservation condition of the Annex I habitat occurring in the lough by benchmarking national and EU standards. Monitoring water quality of L. Arrow for temporal changes in concentrations of nitrogen, phosphorus, pesticides, and photosynthetic pigments undertaken during the five-year CANN project can indicate impacts on this lake's Annex I conservation status. During the CANN project, a number of novel *in situ* conservation measures are used to potentially improve the conservation condition of the habitat. This research will assess the efficacy of these control measures

Keywords: Biodiversity, water quality, Habitats Directive, Water Framework Directive, environmental monitoring, invasive alien species management

Co-occurrence of complex parasite assemblages in the cockle *Cerastoderma edule* in the Irish coast

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Simultaneous infections by multiple parasite species from different groups are common in many shellfish, including cockles, and may trigger a whole spectrum of outcomes conducting or suppressing diseases within the hosts. This study investigates the diversity and abundance of parasites well-known to cause bivalve mortalities - Haplosporidia, Ostreid herpesvirus type 1 (OsHV-1), *Vibrio* spp., and Microsporidia - as well as the interactions and coinfections of the different infectious agents at an individual and population level in *Cerastoderma edule* along the Irish and Celtic Seas. Haplosporidia was the most frequent pathogen group detected in the study, followed by *Vibrio*. However, no microsporidian species nor OsHV-1 were detected in the cockles screened. Coinfections with haplosporidian and *Vibrio* species in wild and fished *C. edule* populations were detected throughout the year. Nevertheless, single infection with haplosporidian or *Vibrio* species was more common than coinfected individuals, which may more easily succumb to parasite load. Likewise, it was suggested the opportunistic role of *Vibrio* species in coinfected individuals. Being the anthropogenic disturbances, the seawater temperature, as well as the host condition, pointed as the main drivers of the spatial and seasonal variability observed through the samples. These results highlight the complexity of the interactions between multiple pathogens within a host, which are the product of processes occurring not only within individual hosts but also across space and over time.

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Keywords: Cockle health, coinfection, Haplosporidia, *Vibrio*, ecological drivers

Impact of Biofouling on Membranes of Diffusive Gradient in Thin Film Passive Sampling Devices for Priority Metals

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Passive sampling devices, such as the Diffusive Gradient in Thin Film (DGT) devices, follow well-defined uptake rates under ideal conditions. In environmental waters, biofouling leads to unpredictable impacts on uptake by passive sampling devices and hence must be mitigated to ensure reliable results. When DGT devices are used for the monitoring of trace metals, traditional antifouling methods such as the incorporation of biocidal metals into design, or methods that may disrupt equilibrium at the device surface, are unfeasible. Assessment of biofouling of commonly used passive sampling device membranes, polyethersulphone (PES) and polycarbonate (PC) filter membranes, was performed by deployment at 31 sites across the Atlantic and Mediterranean regions in both coastal and transitional estuarine waterways for periods of 2 to 14 days. The surface coverage by fouling was determined for each sample and speciation of fouling diatoms was assessed to genus level. While deployments of 4 days or less typically exhibited low levels of coverage, a majority below 1% surface coverage, 14-day deployments of PES and PC exceeded 99% surface coverage at some sites. However, PES at certain sites exhibited heightened surface coverage after 4 days (54.06%), highlighting the unpredictability of biofouling as an environmental factor. The membranes tested were susceptible to a highly diverse range of biofouling diatoms, with over 25 genera identified across 31 sites, and many sites exhibited extensive bacterial fouling. The diversity and impact of fouling diatoms, particularly in longer deployments, supports previous suggestions that deployment of passive sampling devices must be short (approx. 5-8 days suggested by previous authors) to ensure device viability.

Keywords: Passive sampling, biofouling, Atlantic, diatoms, DGT

An Investigation and Visualisation of the Stratification of Abiotic Properties of Irish Coastal and Estuarine Waters

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The areas of Irish estuaries and coastal waters are rich in biodiversity and their ecosystems depend on a balance of physical properties. Abiotic properties such as temperature, dissolved oxygen, pH and salinity have a direct effect on the biotic factors of the seas. Stratifications, including haloclines, thermoclines and chemoclines, can affect the balance of these biotic and abiotic factors. Stratified layers can occur naturally but can also be negatively influenced by anthropogenic influences including pollution, agriculture, industry and climate change. Maintaining the ecosystem of these waters is vital to preserve and encourage biodiversity. The EPA continually monitor the coastal and estuarine waters of Ireland as part of the EU Water Framework Directive. Part of the monitoring activities of the EPA is to measure the abiotic properties of water column samples at different depths from over 850 locations around Ireland several times a year. Over a quarter of a million observations have been collected over 16 years, and it is a holistic analysis of this data that is focus of this data science research. Time-series analysis, visualisation and statistical methods are being developed to programmatically identify and explore the stratification of Irish coastal and estuarine waters between 2002 and 2018 with respect to abiotic features. In addition, an interactive visualisation dashboard is under development to facilitate exploration of the data. Data analysis will use the software R with packages including Dplyr, Ggplot2, Plotly, Tidyr, Highcharter, Tidyverse, Knitr, Shiny and Flexdashboard.

Keywords: R, data analysis, visualisation, stratification, coastal and estuarine

Investigations of the performance of a marine antifouling material inspired by *Scophthalmus rhombus*

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Surfaces from natural organisms capable of reducing or preventing epiphytic growth are of interest in engineering and materials sciences. The idea of using natural systems for inspiration, termed 'biomimetics', is regarded as the 'study of the structure and function of biological systems and processes as well as models for the sustainable design and engineering of materials and machines'. The world of biomimetics is a multidisciplinary one, needing careful understanding of 'biological structures', processes and principles of various organisms found in nature and based on this, designing nanodevices and nanomaterials that are of commercial interest to industry. Looking to nature for bioinspired surfaces offers researchers an abundance of topographies to explore. Biological organisms are known to have highly evolved and complex topographies that exhibit antifouling potential, i.e. shark skin. Many studies have examined antifouling potential of topographic patterns, textures and roughness scales found on natural organisms. In this study, the antifouling potential of a scale from the species, *Scophthalmus rhombus* is studied for the first time. *Scophthalmus rhombus* is a small flatfish of the family *Scophthalmidae*. These fish species inhabit regions from Norway to the Mediterranean and the Black Sea. They reside in shallow sandy and muddy coastal areas at depths of around 70 – 80 meters. It was proposed that an AF effect could be reproduced by replication of a synthetic surface inspired by *Scophthalmus rhombus* whereby both chemistry and topography would play a role in enhancing antifouling capability. This study details a number of strategies used for the production of biomimetic antifouling surfaces and describes some of the many challenges encountered in designing effective antifouling materials for use in ocean energy.

Keywords: Marine inspiration, antifouling technology, textured surfaces, biofouling, diatoms

Application of PDMS Passive Sampling for the Analysis and Quantification of Dissolved Water Concentration of Priority Contaminants in Water Bodies in Support of Compliance Monitoring

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Traditionally marine pollution monitoring programmes such as the Water Framework Directive (WFD) or the Oslo Paris Commission (OSPAR) have mandated the collection and analysis of spot water and/or resident biota for compliance assessment. However, the use of these conventional matrices for compliance purposes can often result in logistical and analytical challenges, such as the non-availability of biota at sampling locations and matrix specific limits of detection when trying to measure at environmentally relevant levels. While currently only acceptable as a supporting technique for legislative compliance purposes, Polydimethylsiloxane (PDMS) sampling devices have the potential to determine pollutant concentrations in the order of pg/L, potentially overcoming current analytical threshold limitations while also meeting logistical requirements for spatial and temporal sampling, and as such are sensitive and cost-effective alternative tools for environmental monitoring purposes. Passive samplers were deployed to determine time weighted average (TWA) dissolved water concentrations of priority contaminants at four sites along the Shannon Estuary from Limerick Dock to the outer reaches of the estuary. A decrease in concentration of 15 polycyclic aromatic hydrocarbons (PAHs) was observed from Limerick dock at 11736pg/L through to the Upper Shannon Estuary at 8390pg/L to both the Fergus Estuary 5229pg/L and to the Lower Shannon Estuary at 4116pg/L. Similar decreases in polychlorinated biphenyls were detected along the gradient from Limerick Dock to the outer estuary. This study ultimately demonstrates the applicability of PDMS devices for the purposes of both investigative and temporal trend monitoring.

Keywords: PDMS, Passive Sampling, WFD, Priority Pollutants

The Impact of electromagnetic fields and chemicals from the subsea power cables on marine species

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For decades, power transmission cables have been installed across bays and river mouths, and connecting near-shore islands to the mainland, with little consideration of possible effects to marine species from electromagnetic fields (EMFs), and the released chemical compounds. In Ireland, there is currently only one functional offshore windfarm. However, with the increase in demand of sustainable energy, energy companies plan to sink almost €6 billion into the Irish Sea over the next half decade or so on offshore wind projects. As the number of Irish offshore windfarm projects increase, there will also be an increase in the number of subsea power cables that would transport the energy generated from the wind farms to the onshore electrical substations. On this note, it becomes pertinent to understand the impacts that underwater transmission cables, and its released chemical compounds, have on the marine environment as it could assist Irish companies in making more informed decisions before applying for a foreshore license. In this project, the first task involved identifying primary species in marine or estuarine waters of the Irish Sea that may be sensitive to EMFs, after which the design characteristics of 10 typical AC and DC cable configurations were modelled to better describe the intensity and spatial extent of the magnetic fields from existing and proposed systems. On the other hand, 4 subsea cable samples of various ages (ranging from 32 years to 12 days) will be tested in the laboratory for a 3-month period to determine the release rate of chemical compounds and plastics from the cables. The results from the test will give an insight to the extent of pollution caused by subsea cables, if any at all.

Keywords: Marine, Subsea Cables, Chemicals, Electromagnetic field, Pollution

A Statistical Monitoring Approach for Non-residential Water Distribution Systems: A case-study

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Fault detection and diagnosis in non-residential WDS is becoming an increasingly important topic in practice, which is beginning to drive research activity in this space. Commercial and environmental pressures are necessitating reductions in unscheduled downtime, performance degradation and water-energy loss, which requires early stage detection and diagnostics of faults. While, the potential for reducing water consumption by effectively detecting faults in large buildings has been shown to be significant, the application of fault detection and isolation to building water networks remains largely unexplored. In this paper, a fault detection and isolation scheme is presented which consists of a combination of principal component analysis (PCA) and the use of Hotelling's T2 – statistics and Q – statistics as detection indices (also knowns as squared prediction error). In the absence of a process model, PCA has been successfully used as a data driven fault detection technique in this study. Hoteling T2 – statistics and Q – statistics were employed to detect abnormality within incoming water time series from the food processing company in Ireland. The results of the study indicate that the implementation of PCA based fault detection in WDS has the potential to improve detection and diagnostics when compared to existing methods used in the literature.

Keywords: Water Distribution System (WDS), Principal Component Analysis (PCA), Fault Detection and Isolation (FDI)

Evaluating novel PMMA SODIS reactors for leachables in South Africa

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Harvested rainwater (HRW) is a valuable water source especially where the supply of fresh water is limited. However, studies have shown the presence of microorganisms including pathogenic microorganisms in HRW. Solar disinfection of water (SODIS) is a cost-effective point of use technology for water disinfection in resource-poor communities worldwide. The simplest approach to SODIS involves filling transparent containers, usually 2L PET bottles, with water and exposing them to strong sunlight for at least 6 hours. In order to increase the volume of water treated, various enhancement technologies, including two large -volume batch solar reactor prototypes, were investigated by the European Union (EU) Horizon 2020 WATERSPOUTT project. The prototypes consisting of PMMA tubes positioned in the centre of a V -trough solar mirror were tested in Stellenbosch, South Africa. Prototype I (140 L treatment volume) was installed in Enkanini informal settlement and consisted of three PMMA reactor tubes (200 mm diameter). Prototype II (88 L treatment volume), was installed next to a local church building in the Skoolplaas farming community and had eight PMMA tubes (100 mm diameter). Both prototypes were supplied with water from harvested rainwater tanks. A concern using SODIS is the possibility of toxic leachables getting into the water from the plastic material of the reactor. To test for toxicity, the treated water from each reactor was sampled monthly between August 2018-April 2019. Untreated water from the corresponding HRW tank was also sampled. Samples (1L) were processed using solid phase extraction with Oasis HLB glass cartridges. The eluted samples were tested for mutagenicity using the Ames Test and for oestrogenicity using the E-screen assay. No mutagenicity or oestrogenicity was detected in any sample. The results affirm the suitability of the novel PMMA reactors for use in solar disinfection of HRW under natural environmental conditions in South Africa.

Keywords: Harvested rainwater, solar disinfection, PMMA, leachables, Ames, E-screen

Design and Development of an experimental rig for the validation of CFD models for granular reactors

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Computational fluid dynamics (CFD) modelling is becoming more popular as a tool for the optimization of bioreactors and bioprocesses. The physics of anaerobic granular reactors is complex and it involves multiphase flow and, in some cases, heat transfer processes. Analytical validation of the results in general is not possible due to this complexity. As the use of CFD for this application is still an emerging technology, experimental data for the validation of the results is not readily available from the literature. Equipment that allows for the validation of velocity profiles in multiphase flow is expensive, and not commonly available. In this context, this work aims to develop and validate a low-cost in-house rig which uses particle image velocimetry (PIV) to capture the profile of the liquid in a multiphase (solid, liquid, gas) flow. Thermocouples are used to capture the temperature at different locations. The rig was built in acrylic, which allows for flow visualisation. A 100mW 532nm Green Laser Diode Module was used as the light source; it was fitted with concave lenses in order to create a laser sheet to illuminate a thin section of the rig. A Sony RX10IV camera was used to collect the images. Hollow glass microspheres of 10 µm were seeded into the flow. Images from the PIV setup were collected, processed using PIVLab and compared with CFD simulations. Temperatures at different points of the reactor were also analysed. Validation of the model will allow it to be used in the future validation of CFD simulations of anaerobic granular bioreactors.

Keywords: UASB reactor, Biogas, Computational Fluid Dynamics, PIV

Development of an in-house rig for measuring bubble velocity for validating computational simulation results of UASB reactors

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Bubbly flow regimes appear in USAB (upflow sludge anaerobic blanket) reactors during the wastewater treatment process with generation of biogas. As the velocity of the biogas affects the performance of the reactors, a computational model is being developed to predict the behaviour of the multiphase flow. The validation of the computational model requires the use of experimental data. Considering that only the physics of the flow is being validated, an in house, transparent, lab-scale rig is being built for this work. The data for local parameters (e.g. bubble size and velocity) will be collected using non-intrusive methods. The understanding of these parameters can lead to the optimisation of multiphase flow processes. The measurement of the velocity and size of gas bubbles requires a full understanding of all physical aspects involved. The aim of this work is to develop an efficient, low-cost, non-intrusive method to determine the velocity of a rising bubble of air in a stagnant water column. To accomplish this, a rig was built with a vertical rectangular channel with 180X180 mm cross section. The rig was built in acrylic, with a gas inlet at the bottom of the reactor. The gas flow rate used in the experiments is 25 L/h. From the current methods available in the literature, photographic technique seemed to be the most suitable alternative considering reliability and implementation. Images taken of the section of interest will be processed and analysed in conjunction with results and correlations found in the literature. The expected outcomes of this project include the velocity and size of the gas bubble produced and a new understanding of the motion of the bubble in a column of liquid. The method proposed by this study will contribute to the development of a validated computational model of a USAB reactor in a further work.

Keywords: Imaging Techniques, Bubble Velocity, Multiphase Flow, UASB Reactor, Biogas

Microbial acclimation to salinity in the anaerobic digestion process

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It is well known that high salinity, i.e. sodium concentrations above 5g/L, negatively affect the anaerobic digestion process, and in particular, methanogenesis. However, certain microbial communities are able to acclimate after long term operation, with increased tolerance to high sodium, which is strictly linked to their resilience and structure. In this study, the long term response and acclimation trend of different microbial inocula to moderate saline conditions (5 g/L Na^+) were assessed in terms of process performance and microbial community diversity. Experiments were conducted in two laboratory-scale hybrid expanded granular sludge– anaerobic filter (EGSB-AF) reactors operated at 37°C for 180 days, with non-acclimatised anaerobic granular sludge as inoculum. Both reactors were fed with a mixture of glucose, acetate and tryptone as a carbon source at an organic loading rate of 3 g COD/L day. The results showed that the salinity negatively affected the strength and settling properties of the sludge, causing its partial disintegration, though marginally affecting the overall reactor performance. After 100 days of operation, the systems had a different sludge bed composition, one comprised mainly of flocculent biomass, whereas the other had a mixture of flocs and granules. Despite the morphological differences, a steady average biogas production of 2.45 L/day, with a methane content of nearly 70%, was indeed achieved in both reactors, and a remarkable average COD removal efficiency above 95% was achieved. Microbial community analysis is currently ongoing to assess the differences in the dynamics of both reactors. From a macroscopic view, these results suggest that the effects of moderate salinity upon the structure of the biomass were counteracted by the reactor's configuration and operational conditions. The EGSB-AF promotes biomass retention upon sludge disintegration, keeping an active microbial community in the system, and thus, allows a high, stable methane generation and COD removal from saline wastewater.

Keywords: Salinity, inhibition, anaerobic digestion, acclimation

Photoelectrochemical oxidation of nitrogen compounds in wastewater and hydrogen production

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Nutrient pollution has a detrimental effect for the ecosystems, caused by the excessive spread of nutrients to the air, soil and water. Nitrogen-based compounds are one of the pollution contributors. When found in excess, nitrogen-based compounds provoke adverse effects in water bodies, known as eutrophication. These effects include the algal bloom, depletion of dissolved oxygen and ecosystem unbalance, which could cause the death of animals living in it. Nitrogen excess is usually removed in wastewater treatment plants by several biological treatment steps. However, space and economic constrains prevent the full implementation of these processes for the required discharge limits in some plants. Due to the need of managing nitrogen pollution in a more sustainable and efficient way, this project aimed to reduce nitrogen excess and recover energy in the form of hydrogen using an alternative non-biological process. A photoelectrochemical process was studied for the oxidation of nitrogen compounds. These compounds are oxidized by the photoexcited holes generated by the incoming irradiation at the photo-anode. Consequently, the photoexcited electrons are driven to the cathode by the external circuit that connects the two electrodes to produce hydrogen. This study is focused on the oxidation of two of the nitrogen species commonly found in wastewater: ammonia and urea. A photoelectrochemical cell was used with an immobilized TiO_2 semiconductor as photo-anode and a Pt metal cathode. Due to the pH-controlled equilibrium that exits between ammonia and its ionic form ammonium in water, the ammonia oxidation study was carried out over a range of different pH.

Keywords: Photoelectrochemical oxidation, Urea, Ammonia, Hydrogen

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The Integration of Scientific Evidence into the Formulation of Environmental Law and Policy

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The Treaty on the Functioning of the European Union states at Article 191(3) that in preparing its policy on the environment, the European Union ("EU") shall take account of available scientific and technical data. Taking air pollution legislation as a case study, this research tracks the evolution of EU air pollution standards and the scientific evidence that informs the setting of such standards. The regulation of air quality in the EU was, and to a certain extent still is, fragmented. Air pollution was first regulated at EU level in 1970 through legislation which aimed at reducing air pollution from passenger cars. This was followed some time later by directives on air quality limit values for sulphur dioxide and suspended particles, lead, and nitrogen dioxide. Air quality was consolidated to a certain extent by Directive 96/62/EC on ambient air quality assessment and management, termed the "Air Quality Framework Directive." Under this directive, four "daughter directives" were established, regulating limit values for the main pollutants identified at that time. These Directives have since been repealed and Directive 2008/50/EC on ambient air quality and cleaner air for Europe and Directive 2004/107/EC relating to arsenic, cadmium, mercury, nickel and polycyclic aromatic hydrocarbons in ambient air now regulate the area. When setting air quality standards, current EU legislation states that it takes into account relevant World Health Organisation ("WHO") air quality guidelines. The WHO standards were replicated in EU air pollution legislation but have now diverged from those of the EU over recent iterations of WHO guidelines. The EU has acknowledged these discrepancies, most recently in its 2019 Fitness Check of the Ambient Air Quality Directives. This study examines when these variations first occurred; considers the reasoning behind the disparities and the scientific evidence currently informing EU air quality guidelines.

Keywords: Scientific evidence, air pollution, policy, legislation, European Union

Development of an Algorithm to Predict Pollution Levels in Cities Caused by Vehicles

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The National Ambient Air Quality Monitoring Programme 2017-2022 has recently been launched in Ireland to quantify the effect on health of poor air quality. This reflects a broad international trend in the area with cities such as London and Paris already rolling out plans for the elimination of polluting cars. The European Environment Agency (EEA) estimates that in 2015, for the 41 countries of Europe, 422 000 premature deaths were caused by $PM_{2.5}$, 79 000 and 17 700 deaths caused by NO_2 and O_3 respectively. Therefore, the air pollution level on the road-side should be put into a priority position for policy guidance on reducing the air pollution in the city. The central aim of this research is to gain an understanding of air pollution level at different heights in an urban street canyon and develop an algorithm to predict pollution levels in cities at different breathing heights, specifically, that caused by vehicles. The solution to the problem firstly lies in the quantification of the level of exposure to pollutants by pedestrians, caused primarily by adjacent traffic. The assumption that there is a differentiated influence to children's health from low-height air quality on roadside footpaths will be tested. This will involve setting up a duel level monitoring station near a congested city street in Dublin and a set of in-lab tests. The design of the instrumentation will demand careful consideration to achieve a realistic appraisal of the context on breathing, especially for children. This will be correlated to traffic flows via a derived algorithm that predicts pollution levels based on traffic flows. A report is to be developed to influence policy decisions in the area of transport to achieve safe levels of vehicle flow types to stay within medically determined safe levels of pollutants.

Keywords: Air pollution, vehicles, urban street canyon and breathing heights

Emissions from and Fuel Consumption Associated with Off-Road Vehicles and Other Machinery

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Currently there is a need for the development of an inventory type approach for the study of non-road mobile machinery (NRMM) and the associated emissions generated from such machines. Currently there are a large amount of studies which investigate air quality and the associated emissions from e.g. traffic and combustion, however NRMMs have remained largely under investigated in this context. The main purpose of this research is to examine country specific profile of vehicle and machinery numbers, age and amount and type of fuel used and to investigate the emission profiles of such machinery. Investigations into current legislation and directives will be explored and the development of an inventory will be investigated. The inventory will be established using tier 1, 2, and 3 methodology, however the choice of method will be dependent on the availability of appropriate data.

Keywords: Non-road mobile machinery, emission profiles, fuel consumption

Air Quality (AQ)

Comparative Study of Uncertified Particulate Matter (PM_{10} and $PM_{2.5}$) sensors

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Cork Institute of Technology maintains a particulate monitoring station on behalf of the EPA as part of the National Ambient Air Monitoring Program. This yields access to high quality PM concentration data which enables a comparison with a newly developed Purple Air sensor. Cork City Council has installed an extensive network of these sensors, whose freely available real-time data has generated a lot of public interest. Three Purple Air (PAII) sensors were located immediately adjacent to one 'reference' instrument, a Leckel750 (gravimetric method /24hr averages) along with two 'equivalent' instruments, a Fidas2000 (optical method /hourly averages) and a BAM1020 (□-ray attenuation method /hourly averages). The operating conditions and statistical analysis were as specified in CEN16450 . Calculated values of the between instrument uncertainty Ubs (hourly averages) for all three PAII instruments yielded values between 2.8 and 5.8 ug/m3, which compared very well with 5.5ug/m3 for the two equivalent instruments. The temporal trend of all three instruments was in excellent agreement with the certified instruments. Whereas the BAM and FIDAS display high correlation (slope = 1.089 Correlation = 0.96) the equivalent slopes for the three PAII sensors are 1.22,1.32 and 1.37 respectively. Most notably at PM10 levels > 30 ug/m3, all three PAII instruments read high by as much as a factor of two. In a parallel study the standard gravimetric accumulation time interval of 24 hours was reduced to 6 hours. Mass increases of 47mm filters conditioned and weighed as per CEN12341 was determined using a 7-digit balance (SartoriusMSA2.7S, 0.1ug resolution). The results displayed good agreement with the two equivalent methods (respective PM10 means were 13.95, 14.05 and 16.35ug/m3). This would suggest that the 24-hour temporal resolution used in the standard gravimetric method can be significantly reduced and will be investigated further.

Keywords: Particulate Matter, PM, Air Quality Monitoring

Innovative Energy Tracking; Changing the way we use energy

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There is a unanimous consensus among the scientific community that human greenhouse gas emissions are causing the average global temperature to rise and that this would have unacceptable effects on our planet and its eco systems. In response to this, the European Union has set targets in line with the Paris Agreement that each of its nations reduce their greenhouse gas emissions by 40% by 2030 and then by 95% by 2050 compared to 1990 levels. This is a reduction of at least 1.7 Megatons per year to reach the 2050 goal. Looking at Ireland's greenhouse gas emissions by sector, Electricity, Heating, Transport and Residential are responsible for 85% of Irish greenhouse gas emissions. It is therefore evident that the majority of these emissions are created by the average person going about their daily life and that if we are to achieve this 2050 goal this lifestyle must adapt. MyCarbon is an energy tracking application currently in development that aims to contribute to the reduction in greenhouse gas emissions. MyCarbon aims to do this by using internet of things technologies to seamlessly track domestic energy use in the home and provide the information in a simple, graphical display. MyCarbon seeks to enable and guide the user to change their lifestyle in order to use energy more efficiently and achieve a reduction in their emissions. Using comparisons to similar technologies and their effect on one's daily lifestyle, the viability of MyCarbon as an effective aid to reduce emissions is validated. The infrastructure and equipment required to track domestic energy is explored to understand its availability. Finally, the costs and resources required to produce and publish MyCarbon as an effective tool are estimated along with an estimation of its possible effect on greenhouse gas emissions in Ireland.

Keywords: Greenhouse gases, energy use, lifestyle changes

Co-digestion of cattle slurry and *Lolium perenne* silage for butyric acid production

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The co-digestion of grass and cattle slurry in anaerobic digestion has the advantage of mitigating the negative impacts slurry has on the environment while at the same time providing enough nutrients and buffer to convert grass into valuable bio-chemicals and fuel. This work investigates the feasibility of co-digesting cattle slurry and *Lolium perenne* silage to produce butyric acid. The experiment was performed using 500 mL bottles to which 2 g VS L^{-1} day^{-1} of cut (2 cm) or uncut silage was added alongside liquor from a stable anaerobic co-digestion reactor of ryegrass silage and cattle slurry (Thurles Rig). Cattle slurry and inoculum (digestate from Thurles rig) were added to each bottle in a 2:1:1.5 (silage:slurry:digestate) ratio based on VS. All the bottles were incubated at 37 °C under constant agitation. The highest volatile solid (VS) removal obtained was 45.2 ± 4.3 % in bottles fed with cut silage after 6 days of incubation. This high VS removal translated into high butyric acid (3.16 ± 0.02 g COD L^{-1}) and acetic acid (3.65 ± 0.05 g COD L^{-1}) concentration. This corresponded to a 29% and 14 % increase in butyric and acetic acid when compared to the digestion of uncut silage. A prolonged incubation (14 days) was applied only to the uncut grass but did not contribute to enhancing butyric acid production since mainly propionic acid (3.20 ± 0.51 g COD L-1) was detected. On the other hand, the buffering capacity of slurry was mainly observed from days 6 to 14 during which pH increased from 5.5 to 7.6 and acetic acid and butyric acid were consumed for methane production. This work demonstrated the feasibility of producing butyric acid from the co-digestion of grass and cattle slurry. A two-phase system could allow for both butyric and methane production.

Keywords: Volatile fatty acids, cattle slurry, grass fermentation, butyric acid

Developing an understanding for the role of Hydrogen in Ireland's decarbonisation strategy

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The climate emergency we currently experience is undoubtedly the most threatening environmental and social problem of modern age. In a world where our electricity, transport and heating are still heavily carbon intensive, even developed countries like Ireland seem to be inching away from fossil fuels and investing in cleaner energy at a pace that urgently needs acceleration. Furthermore, ambitious climate and energy targets set by the Paris Agreement, the European Union and by the state itself must be met in the near and medium-term future, adding even more pressure towards a scenario of fast change. In this context, this study proposes to explore the potential of Hydrogen in helping decarbonise the Irish energy system, integrating it with current energy generation technologies. This emission-free, versatile energy carrier can be a key component of a future low- or zero-carbon economy, generating electricity at high efficiencies, enabling clean transport and facilitating a bridging between fossil fuels and renewable resources. This research will perform quantitative and qualitative analyses to assess the suitability of Hydrogen for a variety of potential applications, from long distance transport to local emergency/backup generators, taking into consideration the current Irish environmental, social, economic and political scenarios. In the context of Ireland's much needed decarbonisation strategy, how, where and when can Hydrogen fit in will be discussed.

Keywords: Hydrogen; Decarbonisation; Ireland; Energy; Environment

Energy (E)

Analysis of Solar Technologies for Households in Ireland

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The average electricity demand per dwelling in Ireland is 4200kWh per annum while the average gas demand per dwelling is 11000kWh per annum. This gas consumption is a leading reason that Irish households produce 60% more than the European average. Incorporating solar technology into a household can reduce these harmful greenhouse gases while also contributing to the energy demands of the dwelling. Solar technology can be a big contributor towards the 2030 climate target set by the EU to cut greenhouse gases by 40% compared to levels in 1990. A comparative study which focuses on different available solar technologies is presented. Different technologies are compared; flat plate collectors, evacuated tube collectors and photovoltaic to thermal (heat pump & electric element) systems. Each household will have different needs depending on the energy demand within their household so it is important to look at all aspects of each of the technologies. Methods of increasing efficiency & improve performance are presented as well as cost analysis of the systems. Each of the technologies excel in different climates, so it is important to know different radiation and temperature levels around the country. This work makes it easier to compare the different solar technologies available and under which parameters they perform best.

Keywords: Solar energy; solar technologies; households

Exploring dragonflies and damselflies as indicators of climate change

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Dragonfly and damselfly records were received from volunteer recorders as part of Dragonfly Ireland 2019 – 2024, an all-Ireland citizen science survey. Data were validated based on photographs, descriptions, flight period and geographical location. 2,857 records of 26 dragonfly and damselfly species were received in 2019. These data were compared with data from the original Dragonfly Ireland survey 2000 – 2003 for changes in frequency of occurrence, flight period and range. Four of five species that showed a limited southern distribution in 2000 - 2003, had increased their ranking of frequency of occurrence among 26 species, while all five had increased their frequency of occurrence as a percentage of all records received. Four damselfly species showed an apparent shift in flight period with peak records occurring earlier than recorded in 2000 – 2003 or a greater proportion of records received earlier in the season with an earlier onset of the end of the flight period. Two of the species with a limited southern distribution in 2000 - 2003 showed a marked northward expansion in their range. The results showed that volunteer citizen scientists generated data which could be validated and was robust. These data suggest the presence of climate related changes in the frequency of occurrence, flight period and range of a number of Irish dragonfly and damselfly species. Further data will be collected in 2020 and 2021 to enable a more robust analysis of these changes.

Keywords: Citizen science, climate change, dragonfly, damselfly

ENERGE - Energizing Education to Reduce Greenhouse Gas Emissions

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As the current school building stock in Europe ages there is a need for low-cost solutions to reduce greenhouse gas emissions (GHG) from schools. This is particularly the case given (i) new schools or deep retrofit can take several years and (ii) new EU building energy directives and climate actions. Solutions must enable long-term resource efficiency and thus require multi-stakeholder buy-in. ENERGE is a multinational project funded by the Interreg North-West Europe designed to address these challenges through a combination of physical interventions, behavioural studies, and new educational approaches. The goal of these interventions is to engage the school community in energy and GHG mitigation. ENERGE combines sociological, pedagogic, and communications expertise with low-cost technologies, ICT interventions and systems engineering to achieve 15% reduction in total energy consumption at 12 demonstration site schools across France, Germany, Luxembourg, Ireland, the Netherlands and the UK. To date site assessments at demonstration schools and developed indoor climate monitoring and electrical metering plans have been developed. ENERGE Committees, comprising students and teachers that will champion the project were established at each demonstration school to provide focus for transnational/community engagement, and secure long-term impacts. A comparative review of curriculum and teaching related to energy in the schools highlighted significant variations in both addressing this issue in the curricula. The governance, administrative and financial models of each school was analysed to determine how energy efficiency programmes at a regional and national level for schools can be sustained/developed. ENERGE will also link to successful examples of energy management in the public and private sector. Key progress to date will be discussed as will some of the early findings.

Keywords: Greenhouse gas emission, energy management, energy consumption, education

Climate Change (CC)

Forecasting the Emergence of an impactful Forest Pest (Hylobius Abietis) into future climates through environmental modelling

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The Large Pine Weevil (*Hylobius abietis)* is the most damaging pest of temperate forestry in Ireland and throughout Northern Europe. Climate Change has the potential to alter the distribution, abundance, emergence and impact of forest pests. An essential component of Integrated Pest Management (IPM) is the accurate prediction of the severity and timing of Pest outbreaks. This is most pertinent to management decisions regarding pesticide application and optimising the timing of any application or treatment. The Large Pine Weevil develops in the stumps of felled conifer trees and emerging adults feed on new transplants on site. With no successful means of controlling weevil populations in stumps currently available, it is necessary to protect plants through insecticidal intervention. Methods like Stump Hacking are used for predicting the scale of emergence. As a key component of a larger project on IPM, this project will hope to simulate modelling through existing data on weevil populations in Ireland in a novel approach that will utilise data from stump assessment of weevil developmental stage. Additionally, subsequent site-specific patterns and weather conditions as well as likely impacts of climate change on weevil life cycles will be integrated. Following an existing UK model (Wainhouse et al., 2014) developed to represent geographic variation in voltinism of pine weevil under climate change, it has been shown the UK model could be used to predict site specific patterns of weevil emergence based on data from local weather stations. Through incorporating site specific factors (temperature, elevation, soil, etc.) from pre-existing data in Ireland and adapting the UK simulation model through R programming, the research aims to refine the forecasting method of weevil attack for foresters in Ireland whilst simultaneously projecting the impacts of climate change on this significant forest insect.

Keywords: Climate Change, Environmental modelling, Forest Pests

Modelling Climate Policy Success: Applying a Car Stock Model to an Ex-Post Analysis of Climate Taxation Regime

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This paper quantifies the energy and CO_2 emissions savings associated with this policy measure over a 10-year period by updating and extending a bottom-up car Stock model of the private car vehicle fleet which determines i) a detailed bottom-up picture of historical emissions from private cars, and ii) a "what-if" counterfactual scenario of emissions of the car fleet in the absence of the policy measure. In July 2008, the government of Ireland introduced a change to the Vehicle Registration Tax (VRT) from a tax based on the vehicle sales price to one based on the emissions class of the vehicle. Annual Motor Tax (AMT) was changed from a rating based on engine size to one based on carbon dioxide (CO_2) emissions. The change in taxation precipitated a dramatic shift in new car sales towards diesel and more efficient cars. Results indicate a cumulative reduction of 2.1 MT of CO_2 emissions between 2007 – 2018 based on the relative difference between emissions had there been no change in 2007 purchasing trends and the realised emissions savings based on the distance travelled by the private vehicle fleet over the period. The key innovation in this study is the use of bottom-up technology Stock models, typically employed to forecast future trends, to calculate historical emissions over an extended period and calculate a counterfactual 'no-policy' scenario. Outputs from such ex-post bottom-up technology rich models provide a solid basis for the ex-post analysis of past policy.

Keywords: Climate policy, technology stock models

Developing sustainable scenarios for passenger light-duty vehicles in Ireland

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Transport is the largest energy-consuming sector in Ireland and contributes to 42% of total final energy consumption in 2018. This sector relies almost entirely on fossil fuels and is responsible for 40% of energy-related CO_2 emissions in the same year. Private cars dominate both fuel consumption and CO_2 emissions within this sector and accounted for just under 40% of transport energy use. On the other hand, there is a consensus that transition to a low-carbon transport sector will require a substantial shift from fossil-based conventional Internal Combustion Engines (ICEs) to alternative fuels and more efficient hybrid, electric or fuel cell powertrains. In order to achieve a cleaner and more sustainable future, the Irish government set ambitious targets for market penetration of Battery Electric Vehicles (BEVs) and Plug-in Hybrid Electric Vehicles (PHEVs) in 2030, when the climate action plan targets aim to have about one million electric vehicles on the road. However, despite the technical and environmental advantages of advanced vehicles, they will likely struggle with some serious barriers associated with their costs, fuel availability and driving range which, in turn, could hinder the consumers to adopt such technologies. The objective of this research study is to test the circumstances under which this target will be met and to measure the implications for fuel consumption, CO_2 emissions, energy mix and energy dependence. In this study, the Irish TIMES model which is a bottom-up technology rich energy systems model for Ireland is used. The model provides several energy system configurations to meet useful energy service demands optimised to least cost and subject to a techno-economic and policy constraints for a long-term period.

Keywords: Sustainable transport, Energy systems model; TIMES; Passenger light-duty vehicle; CO2 emissions; Electric vehicles

Waste Management (WM)

An overview of recovery of phosphorus from municipal wastewater and the Phos4You project

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Phosphorus recovery from municipal wastewater (MWW) has received increased attention due to diminishing reserves of rock phosphates and an increased focus on a sustainable society. An overview of the emerging phosphorus recovery technologies developed and tested in the EU NEW Interreg funded Phos4You project at pilot and laboratory scale is reported in this presentation. These processes are at an early stage of investigation and show promising results. The objectives are to assess technologies to recover phosphorus (P) from the liquid and solid phases such as wastewater, sewage sludge and sewage sludge ash to produce a valuable P product. The technological feasibility of recovering P from MWW has been demonstrated. Tetraphos® process recovers P contained in sewage sludge ashes by chemical leaching and purification to produce high quality phosphoric acid. The thermochemical technology EuPhoRe® recovers P from the sewage sludge and generates ashes by removing heavy metals and increasing bioavailability of P in the ashes. The PULSE process produce calcium and/or magnesium phosphate after acid leaching of P from sewage sludge followed by reactive extraction and fractionated precipitation steps to remove contaminants. The bio-acidification of sludge followed by precipitation of struvite is another way of recovering phosphorus. The phosphorus from the liquid phase is recovered by microalgae treatment and the Struvia process by precipitation of calcium phosphate using lime. About 80% of the phosphorus can be recovered from the sludge and its ashes compared to 60% recovery of phosphorus from the liquid phase. The recovered P can be reused as fertilizer directly or after processing by the fertilizer industries. Barriers and difficulties to implementation of these processes can vary depending on the resources available, scale of application and stakeholder perspectives.

Keywords: Phosphorus, phosphorus recovery, municipal wastewater

Investigating the possibility of 'closed loop' circular economy waste management options on a construction case study project

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Construction and demolition waste (C&DW) and its management is one of many developing environmental concerns, partially due to the increased awareness of sustainability and perhaps equally, to the rising costs of landfill levies, taxes and raw materials. The construction sector by its nature is not an environment-friendly activity. The current linear approach of take, make, dispose within the industry is unsustainable. The industry's failure to acknowledge the environmental effect of construction processes has contributed to a global crisis caused by depletion of resources and an increase in C&DW generation around the planet. Ireland produced 4.75 million tonnes of C&DW in 2017. The construction sector in the EU is the highest producer of waste in comparison to any other industry, accounting for 35% of the total waste produced. C&DW has a low value recovery rate and traditionally, in Ireland, C&DW was sent to landfill. However, the number of landfills in Ireland is decreasing rapidly from over 200 in the 1980's to just 3 in operation today. This is inevitably causing the construction industry to consider alternative methods of waste management practices. There needs to be a shift towards creating circular economy markets that avoid exporting waste outside of Ireland. Circular economy approaches offer the best opportunity of reducing waste sent to landfill and this study aimed to identify current waste management practices and investigate the possibility of changing these practices into a cyclical model where waste becomes a valuable resource. This was achieved by conducting case study action research through site waste audits to a large building project including two skip audits of a mixed waste skip. The study concludes that there are markets available for construction waste in Ireland that can help to keep the industries waste in a circular economy.

Keywords: Construction and demolition waste, circular economy, resource efficiency, sustainable construction, case study

Waste Management (WM)

Enhancing the economic viability of anaerobic digestion through exploiting the whole biomass of mango waste and its residuals after digestion

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Improvements over the last number of years in the anaerobic digestion process could lead to a dependence on fossil fuels. The operational costs, the large amounts of digestate generated, the expenses spent on it and the volatility of fossil fuel price indexes are representing major environmental and economic challenges to the anaerobic digestion process. Increasing the bio-products of the anaerobic digestion process could possibly help in increasing its profitability and limiting these challenges. The study investigates the influence of the mango starch and seed coats on the biogas produced from mango waste. In order to overcome the environmental challenges, the digestate was tested and had proven its bio-fertilizer potential. The present study concluded that, the effect of the starch on the anaerobic digestion biogas of mango waste is low while, the effect of the seed coats is quite high. This finding supports the conduction of further investigations to evaluate the effect of the production of mango starch and seed coats-based products on the profitability of the anaerobic digestion process. The highest energy balance achieved through conduction of lab-scale experiments was 65 % at 32 °C, 3.93 g-VS organic concentration and 37 % sludge concentration, which yielded a maximum CH_4 of 62.5 %. This finding encourage application of the gate fees for accepting bio-waste, in which may help in overcoming economic challenges.

Keywords: Anaerobic digestion; Mango waste; Waste management; Integration approach; Design of experiment; Response surface methodology; Bio-energy

Enhancing anaerobic digestion of oleate by conductive materials

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The degradation of long chain fatty acids (LCFA) is the rate-limiting step of lipids anaerobic digestion (AD) due to LCFA absorption onto the biomass and the inhibition of acetogenesis and methanogenesis by LCFA. Conductive materials such as magnetite, carbon nanotubes, granular activated carbon, were previously tested to mitigate such inhibition of methane production in anaerobic reactors. In the present study, effects of magnetite and multi-wall carbon nanotubes (MWCNT) on AD of oleate under mesophilic condition were investigated. 1.0 g/L sodium oleate was supplied as substrate and 0, 0.1, 0.5 and 1.0 g/L of magnetite or MWCNT were added to batch vials incubated for 35 days. The cumulative methane production, the concentrations of volatile fatty acids (VFA) and LCFA were monitored by gas chromatography. Biological samples were preserved at -20 ℃ for 16S rRNA gene sequencing analysis and fluorescence in situ hybridization (FISH) analysis. Results from the methane production indicated that the lag phase of the methane production was six days shorter than the other groups and the methane production rate was accelerated by two times than the control group by adding 1.0 g/L MWCNT. Furthermore, MWCNT was able to reduce the acetate accumulation when compared to the control group, by 32% and 21% with 1.0 g/L and 0.5 g/L of MWCNT, respectively. No significant stimulation was observed from magnetite supplement. Although this is a promising strategy to improve the AD of lipids, further insight on the microbial community dynamics is needed to unravel the mechanisms behind it.

Keywords: Anaerobic digestion, LCFA, Conductive materials

Towards circularity in the supply chain: An exploration into the opportunities and challenges of implementing new sustainable business models in fashion

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An emerging environmental challenge in the global fashion industry is overconsumption, which, combined with decreasing use-time of clothing by consumers, results in growing volumes of textiles being sent to landfills or for incineration. It is estimated that over 100 billion items of clothing are produced each year, with extremely short lives of less than 12 months in some cases. In Ireland alone, an estimated 80,000 tonnes of textiles are discarded by Irish households annually. Sustainable business models such as repair, rental, take back and re-commerce, offer an opportunity to reduce the environmental impacts but maintain the important consumer and commercial benefits of fashion. This study, undertaken (between April and October 2019), investigates each of these models through the identification and review of case examples of both global and local industry best practice. This, combined with insights gained from interviews of key industry insiders, informs conclusions on the barriers and opportunities facing these new business models. Of particular emphasis is how these models could change the current fashion market within Ireland and alleviate the barriers preventing their widespread use. This piece of academic research concludes that a combination of high costs, a lack of legislative framework around design, and low levels of knowledge and consumer acceptance, present key obstacles for SBMs within the fashion industry in Ireland. Conversely, commitment within sectoral organisations and bodies, combined with a growing acceptance of the convenience of these models for consumers, present important enabling factors. A number of national and international good practices are recommended which include reduced VAT on repair services, increased use of influencers to educate consumers and regulation to increase supply chain transparency.

Keywords: Sustainable Business Models (SBMs), Circularity, Overconsumption, Fashion, Textiles, Second-Hand, Waste, Re-commerce, Re-use

Waste Management (WM)

An economic evaluation of the treatment of piggery waste through small-scale anaerobic digestion

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Ireland's agriculture sector accounted for 33% of all greenhouse gas (GHG) emissions in 2017. A significant contributor to this was the country's large livestock population, consisting of 7.36 million cattle and 1.62 million pigs. Of the renewable energy technologies available, anaerobic digestion (AD) is particularly promising to the sector, as it can capture harmful methane and nitrous oxide emissions released from manure, while simultaneously producing renewable bioenergy. Despite the apparent benefits of AD, Ireland has been slow to adopt the technology, ranking 20th within the EU-28. Considering that over 2.3 million tonnes of pig manure is produced annually, the potential for adoption is clear. Although this feedstock stream is theoretically available, the lack of decentralised AD infrastructure has limited its implementation to date. Small-scale anaerobic digestion (SSAD) could potentially overcome this barrier, as, in addition to many of the benefits afforded by centralised AD systems, it can provide a portable and flexible option in agricultural environments with lesser organic feedstock sources. However, the technology still faces uncertainty regarding its financial viability, particularly in an Irish context. This study seeks to shed light on the area by accessing the economic viability of constructing and operating SSAD plants on commercial pig farms of various sizes. The insights generated from the study includes the plant's energy input/output, CO_2 savings, and financial indicators. This research 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, farm-scale, cost-benefit analysis

Technology and the Environment (TE)

An analysis of water purity using image analysis

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Clean drinking water is one of the top concerns in the modern world. On January 1st 2016 the United Nations published its sustainable development goals including goal number six for clean water and sanitation. This shows that clean water is still a key issue faced by many people internationally. The aim of this project is to make it simpler to identify if water is safe for human consumption. This project will use image analysis and classification to test the purity of water samples by comparing them against a control sample of clean water that meets the European Union's and World Health Organisations water quality standards. Multiple sets of images will be collected using different camera types such as infra-red and thermal. By using machine learning, deep learning and image classification a program will be created to determine if these images contain drinkable water. Similarly, to the 2019 AquaSight project a convolutional neural network will be utilised in order to classify these images. The secondary goal of this project is to identify what image type produces the highest accuracy in regards to determining the purity of water. Finally, the combined datasets of each of the image types will be tested to see if the different images types will be complimentary to improving the classifiers accuracy. Depending on time constraints different image classification techniques will be used to create an image analysis algorithm that is capable of specifying the exact pollutant that is contaminating the water; if one does exist.

Keywords: Potable water; image analysis; neural networks

Development of Multi-Parameter sensing system for Environmental Monitoring

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Water quality testing is an important part of environmental monitoring which affects not only aquatic life but the surrounding ecosystem as well. Pollutants such heavy metals have been increased in the last few years, especially in developed countries, which have the highest consuming pollutants. According to WHO, the United States, Germany, and Russia—with only 8% of the world's population, consume about 75% of the world's most wide used metals. The United States, with 4.5% of the world's population, uses about 20% of the world's metal population and 25% of the fossil fuels produced each year. Heavy metal such as lead and cadmium are among the most important pollutants because of their non-biodegradability and toxicity. The use of pesticides is widely reported, and the trend in the use is expected to increase substantially in the next few decades. Among pesticides, carbamate are widely used in grains. Carbamates exposure have a negative effect on cellular metabolic mechanism and mitochondrial function. Electrochemical sensing technology has the potential to change the way we see quality control analysis in the environment. Electrochemical sensor can provide a cheap, portable and easy to use method of application in quality control analysis. In this project, a portable electrochemical system for the on-site detection of heavy metal and pesticides in water has been developed, two electrochemical sensors -one for the detection of cadmium and lead, and the other for the determination of CBR and CBF in water. By integration these sensors into a multi parameter system, it is possible to get real time quality control update during water processing.

Keywords: Heavy metals sensor, pesticides sensor, portable system

Determination of NSAID drugs using Micellar Electrokinetic Chromatography with UV detection

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The presence of analgesic drugs residues in the environment is a growing problem due to their nonmedical use and abuse of prescription drugs. Recently, capillary electrophoresis (CE) has been developed for the determination of a variety of chemical substances. This project describes a micellar electrokinetic chromatography method for detection and determination of selected acidic drugs from the group on non-steroidal anti-inflammatory drugs i.e Paracetamol, Ibuprofen, Ketoprofen, Diclofenac and Aspirin in environmental water. Separation conditions including buffer (type, pH, and concentration), sodium dodecyl sulfate concentration, organic modifier concentration, injection size and separation voltage were studied during development and optimisation of the method. A capillary with 40 cm total length was used, and the analytes were separated within 7.5 min using 15 mM sodium tetraborate (pH 9.2) containing 90 mM of SDS and 10% (v/v) methanol, and the applied voltage was 15 kV. The linearity of the method was studied in the concentration ranges 12.5 –200 µM for the analytes. Repeatability of this method on an intra-day scale for Peak migration time with relative standard deviations RSDs of 0.5 %, 0.25 %, 0.2 %,0.2 % and 0.3 % (n=6) and a peak area 1.5 %, 0.8 %, 1.3 %,1.3% and 0.5 % (n=6) were obtained for Paracetamol, Ketoprofen, Aspirin, Ibuprofen, and Diclofenac respectively.

Keywords: Analgesic drugs, Capillary electrophoresis and wastewater

Technology and the Environment (TE)

An Accuracy assessment of an RTK-corrected UAV terrain surface using geostatistical modelling

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Many environmental and geological applications require georeferenced spatial data of the surface of the earth. Studies often require ongoing monitoring of phenomena over time with changes in the physical landscape being measured, for example cliff face evolution due to erosion or changes in vegetation growth over large areas. In many cases UAV's, or drones, have proven to be a particularly suitable spatial data collection technology. Conventionally, UAV surveys have used GCP's (Ground Control Points) as a basis for georeferencing. The establishment of GCP's can, however, be time-consuming, difficult and sometimes dangerous. The development of RTK-equipped UAV's offers the possibility of georeferenced spatial data collection without the need for GCP's. The accuracy of RTK-corrected UAV data has, to date, been assessed with respect to marked, coordinated check points on the ground. Typically, these check points are set-out similar to GCP's both in terms of location and number with ten such check points being a typical number. Such reliance on a relatively small number of discrete points does not provide a full determination of the errors within the phogrammetric model. This research models the error surface over the entire photogrammetric model using geostatistical interpolation of a dense grid of check points. Knowledge of this error surface, caused by distortions in the photogrammetric model, can provide a robust accuracy assessment of the quality of georeferenced spatial data produced by RTK-enabled UAV's. By identifying patterns in the error surface the accuracy of the data can be evaluated with a view to confirming its suitability to the application and its limitations.

Keywords: Accuracy assessment, UAV, geostatistical modelling

Thermal analysis of an indoor office room using smart window for improved physiological and responses on inhabitants and workers

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Standard glazing surface areas such as in building facades are susceptible to allowing living spaces to overheat due to solar gain during hot weather leading to irrepressible space heating. These glazing window allow shortwave spectra heating and solar radiation to pass easily to the building interior creating discomfort for occupants which makes it problematic for occupants to live or work under such thermal condition. Smart switchable windows offer a modern smart controlled technological solution with low electrical consumption and sophisticated architectural features which lowers the levels of transparency and opacity through the activation of an electrically conductive interlayer between two glass panes to create a comfortable thermal condition for occupants. This paper describes a two dimensional thermal analysis of an office room installed with a controllable glazing window. A full scale CFD model of an office room was developed to analyse the effect of the smart glazing to control the penetration of the solar gain into the room interior. Based on this study, the analysis extended from the essential setting of natural convection in a differentially heated cavity applied to three case scenarios in a building HVAC system which include, Case A: No ventilation in the room, Case B: Passive ventilation and Case C: Air conditioning system. A transient CFD analysis combined the study of natural convection in the office room space as the window is exposed to variable heat condition for the three different HVAC systems. Analysed results of thermal condition for the smart glazing indicates a potential to control transmission of solar heat gain in the visible range by changing its transparency/ opacity state. Obtained results also indicate controllable glazing systems have a very significant advantage controlling the amount of energy that is consumed for better energy efficiency.

Keywords: Glazing, Simulation, Office room, CFD, HVAC

Microbes and the Environment: establishing the broader impact

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Microorganism are seeing a renewed popularity in the current approaches to address or ameliorate a variety of environmental pollution issues, while a broader unanswered question resides in the understanding of how these specific large applications, often a single species, are affecting the wider biological diversity. As such, the aim of the current research is to investigate the broader implications of bacterial applications on in-vitro(microcosms) and in-situ(field) systems. The proposed project will initially focus on the development of bacterial applications for the bio-accumulation/bioremediation of sites contaminated with heavy metals and plastic. At present, 15 bacterial isolates with strong resistance to heavy metals have been identified from landfill leachate(LFL), several of which have displayed the ability to bioremediate heavy metals, including Ni, Cu, Cd, As, Co, Fe and Zn in pure culture. In tandem to this research, a review of plastic degrading microorganisms, and the genes involved in this metabolism, has been conducted. Plastics of particular interest include both highly biodegradable plastics (eg. polylactic acid), and more resistant synthetic polymers such as polyethylene(PE), polycaprolactone (PCL) and polystyrene(PS). Following on from this, it is envisaged that the second phase of this research will involve the creation of a recombinant microorganism (containing genes for heavy metal and plastic bioremediation) using traditional molecular cloning tools, which can be used to inoculate simple in-vitro microcosms. These systems will be used to characterize the environmental resilience to these particular bacterial applications and aim to capture, before and after, physiochemical properties and biological diversity, including pH and nutrients analysis. Finally, a framework of effects and implications will be drawn up for use by specific regulatory bodies.

Keywords: Microcosms, heavy metals, plastic, recombinant microorganism

Evaluation of a Photoelectrocatalytic Reactor for Water Remediation

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Photoelectrocatalytic water remediation is a novel approach to treating water, which improves upon photocatalysis by removing post treatment separation of the photocatalyst, reducing recombination of charge carriers and potentially improve the mass transport by electromigration of charged species. This method uses at least one semiconducting electrode and an applied bias to produce reactive oxygen species. The reactive oxygen species produced can oxidise potentially environmentally dangerous chemical compounds and microorganisms into harmless products. In this work 3 different photoelectrocatalytic reactors have been design and tested. Each reactor used an aligned Titania nanotube mesh photoelectrode, with a gas diffusion electrode as the counter electrode. The photoanodes where produced via in situ anodisation of the titanium mesh in ethylene glycol (97 vol%), distilled water (3 vol%) and NH_4F (0.3 wt%). The mesh's where tested for the photocurrent repose and established that having 2 mesh's together only resulted in a small decrease in current compared to a flat sheet. The first assessment was to evaluate the effectiveness of different aeration methods for the inactivation of *E. coli*. After establishing the most affect method of aeration, the effective of different biases was investigated followed by the role of conductivity using variously molarity of Na_2SO_4 electrolyte.

Keywords: Photoelectrocatalytic reactor, Titania nanotubes, *E. coli*, Gas diffusion electrode

Technology and the Environment (TE)

Potential applications and enrichment of marine anaerobic methanotrophs controlling the emission of greenhouse gas methane to the atmosphere

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Methane is a widely used energy source, but it is also the second largest contributor to human induced global warming, after carbon dioxide. Large quantities of methane are generated and stored beneath the ocean, but the emission to the atmosphere of this important greenhouse gas is partly controlled by anaerobic oxidation of methane coupled to sulfate reduction (AOM-SR). AOM-SR is mediated by anaerobic methanotrophs (ANME) and sulfate reducing bacteria (SRB). AOM-SR is not only regulating the methane cycle, but it can also be applied in environmental biotechnologies, such as the decontamination of industrial wastewaters rich in sulfur and metals at the expense of methane as carbon source and electron donor. This research investigated new approaches to control AOM-SR and enrich ANME and SRB with the final purpose of designing a suitable bioreactor for AOM-SR at ambient pressure and temperature. This was achieved by studying the effect of (i) pressure and of (ii) the use of different sulfur compounds as electron acceptors on AOM, (iii) characterizing the microbial community and(iv) identifying the factors controlling the growth of ANME and SRB. A biotrickling filter (BTF) packed with polyurethane sponge and pall rings at ambient pressure and temperature was successfully used to enrich deep sea sediment ANME (22%) and SRB (50%). This study showed that the BTF is a suitable reactor configuration for the enrichment of these slow growing microorganisms, with an AOM rate of 0.4 mmol l^{-1} day^{-1}, the highest rate reported so far in a BTF system inoculated with deep sea sediment. However, the obtained desulfurization rates are 100 times lower than the rates achieved with other commonly used electron donors (e.g. hydrogen and ethanol). The BTF design should be further improved for future biotechnological applications of AOM-SR.

Keywords: Methane, Anaerobic methanotrophs, sulfate reducing bacteria, indulstrial wastewater, biotrickling filter reactor

Qualifying and Quantifying the Reuse sector in Ireland

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This research project looks into methodologies to assess and measure the Irish reuse sector. Reuse involves taking a product that someone is finished with and reusing it for the same purpose it was used for before. Available literature on eight chosen regions was analysed and combined with information from personal contacts to determine an overview of good practices in other countries, drawing lessons for Ireland, and identifying gaps in the information that needs to be gathered. Together with reuse practitioners in Ireland, the research team are developing methodologies for the qualitative as well as quantitative assessment of the sector which will be piloted in the coming months. Through the small-scale piloting, the measurement methodologies can be refined and any barriers to data gathering can be identified. Therefore, the project will test the capability of the Irish reuse sector to supply necessary data and inform policy makers on the required supports to the sector. This in turn will inform future potential investors to support job creation and social enterprise, as well as supporting the provision of low cost, high value products. The quantitative data collected through the methodologies developed will allow Ireland to benchmark the reuse sector against those of other E.U. Member States and regions. It will also provide a picture of the scale of reuse which can be compared to overall material flows, consumption rates, waste arisings and rates of recovery and recycling. By developing methodologies for the qualitative and quantitative assessment of the sector, this research will provide policy makers, stakeholders and practitioners with a crucial overview of the non-waste reuse sector in Ireland – vital information as reuse takes its place as an essential climate action and as Ireland and Europe move towards Circular Economy models.

Keywords: Reuse, circular economy, secondhand goods, waste prevention, material flows, climate action

Modelling the effect of moulting on metallic pollutant accumulation in freshwater macroinvertebrates

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In this work, we propose an illustrative biodynamic model that accounts for the periodic process of moulting in a freshwater macroinvertebrate species, using the isopod *Asellus aquaticus* as an example. In particular, we examine a scenario where the process of moulting proves to be a dominant source of variability in the overall measured bioaccumulated contaminant concentration. Further to this, we present a case for moult-synchronous sampling as a means of overcoming this variability, and we demonstrate how it could result in decreased measurement error in uptake and bioaccumulation studies. In Ireland, and throughout the world, the qualitative and quantitative detection of pollutants in freshwater environments is vital in informing our understanding of the health of our water bodies. The quantification of trace metal concentrations in the environment proves particularly difficult in a real-world scenario, but under controlled laboratory conditions a range of analytical techniques permit the measurement of accumulated metal concentrations in specimens of identified indicator species. Many indicator species are macroinvertebrates that undergo regular moulting of the exoskeleton. However, uptake and accumulation studies may omit the potential effects of moulting on the measured whole-organism concentrations. In addition, a number of environmental models have been proposed for the uptake, accumulation and excretion of various pollutants in freshwater and marine invertebrates, however, these models have not, to the best of our knowledge, considered the process of moulting in detail. The moulted exoskeleton is a significant component of the overall body mass (in the region of 10% for *A. aquaticus*), so it may contain a large fraction of the accumulated trace metals. Not accounting for the removal of these contaminant concentrations could result in an inaccurate picture of accumulation.

Keywords: Environmental modelling, trace metals, moulting, macroinvertebrate

Ecotoxicology (ETox)

The impact of algal food on phenotypic endpoints of daphniids

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Trophic interactions are crucial for growth and performance of aquatic species in freshwater ecosystems. Among them, algae and daphniids have gained significant attention in relevance to ecology and ecotoxicology. Algae provide as energy producers provide daphniids with their primary food source and have an impact on their physiology, ageing and growth. In this study, the impact of algal food quality and amount was assessed over the lifespan, growth, reproduction, and responses to metal toxicity of daphniids. Daphniids were fed with an algal suspension of *Chlamydomonas rheinhartii*, which was either prepared fresh (immediately from algal cultures) or derived from a frozen batch (of the same algal species). A detailed metabolomics analysis was performed over the impacts of food type to the metabolic level using hyphenated mass spectrometry approaches. Additional molecular markers of enzyme activities shed light to the impact of food associated with changes in the physiology of daphniids.

Keywords: *Daphnia magna*, food impact, physiology, metabolomics

Ecotoxicology (ETox)

Lethal and sub-lethal effects of thiamethoxam ingestion on adult hoverfly *Episyrphus balteatus*

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Systemic pesticides, such as neonicotinoids, are absorbed by plants and transported throughout their tissues, thus controlling pests that feed on all parts of the plant. Residues of systemic pesticides can occur in floral nectar, thereby posing a risk to nectar-feeding beneficial insects. In the extreme, acute poisoning can result in death of the insect, but even sub-lethal exposure can impede their behaviour and ability to provide ecosystem services. We investigated the lethal and sub-lethal impacts of oral exposure of the systemic pesticide thiamethoxam on a common European hover fly, *Episyrphus balteatus*, which functions both as a pollinator and predator of aphid pests. Five days after eclosion from the pupal stage, adult flies were fed 5 µL of sugar-water spiked with thiamethoxam at one of ten concentrations ranging from 0 to 24 ng/µL (ppm). Mortality was insufficient to estimate LD50 values 72 hours after exposure, but by 12 days after exposure longevity of dosed flies was significantly reduced. Sub-lethal effects were measured by observing the time spent on various behaviours and the ability to grip smooth surfaces during the two weeks after ingestion. Two days after exposure, resting showed a weak positive correlation with dose, and flying and grooming had weak negative correlations with dose; these effects were not observed at later time points. The relationship between the ability to grip smooth surfaces and dose changed over two weeks in a non-linear fashion, with the strongest negative correlation occurring three days after thiamethoxam ingestion. These results indicate that *Episyrphus balteatus* appears relatively resilient to oral ingestion of this commonly used pesticide and suggest that the role of hover flies as ecosystem service providers may be of increasing importance in agricultural systems still reliant on neonicotinoids for pest control.

Keywords: Thiamethoxam, *Episyrphus balteatus*, dietary exposure, lethal impacts, sub-lethal impacts

The Impact of Climate Change on Healthcare

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Climate change penetrates all levels of society. Recently, the dialogue of climate change has been growing in presence and shifting in ideas. In this review we analyse the thoughts of medical students on climate change as they explore the impact of climate change on medical conditions, anxiety, refugees, and medical waste. A literature review was conducted which focused on policies in place by international organisations such as the United nations and World Health Organisation, as well as exploring medical databases. The main findings showed growing numbers of natural disasters, such as the lack of safe drinking water, clean air and adequate food supplies. have direct and indirect impact on human morbidity and mortality; recent exposure to fine matter airborne particles is correlated with symptoms of anxiety; education on waste reduction and segregation is vital; adverse weather events have forced humans to migrate. This is due to the destruction of homes, infection rates, violent and political conflict, and lack of employment. A list of actions has been proposed calling upon AMSI, medical students, student originations, third level institutions, and the media.

Keywords: Climate change, healthcare, medical conditions, anxiety, medical waste, climate refugees

Detection of Verotoxigenic *Escherichia coli* (VTEC) in Irish private groundwater wells

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Approximately 750,000 people in Ireland source their drinking water from a private well. Waterborne transmission of Verotoxigenic *Escherichia coli* (VTEC) through these unregulated private wells, has emerged as an important transmission route. Cattle manure and septic tanks are possible contamination sources, with persistent heavy rainfall and poor well head construction and maintenance contributing to microbial ingress. Ireland has the highest incidence of human VTEC infection, at nine times the EU average in 2017. The aim of the study was to investigate the prevalence of VTEC contamination in Irish private wells. Groundwater wells (n=21) were sampled during October 2019. Water samples (30 L) were analysed *using the "CapE" method (Morris, 2016). DNA was extracted from overnight filter enrichment broths and tested by multiplex real-time PCR for eae, vtx1 and vtx2 genes.* Verotoxin genes were detected in 9/21 wells (43%), seven of which were also positive for *eae*. *Positive samples were tested for genes associated with* the top 6 VTEC serogroups implicated in human infections in Ireland (O157, O26, O153, O145, O111 and O104). One or more of these gene targets were identified in all positive samples by multiplex real-time PCR. Multiple serogroups were detected in 4/9 samples, with O145 (n=6), O157 (n=5) and O103 (n=4) the most prevalent. Data relating to well vulnerability were geospatially linked to individual well locations and assessed for bivariate association with VTEC presence. No significant associations were noted ($P>0.05$). Private wells are at risk of contamination with pathogenic *E. coli* capable of causing human disease. Data generated from more widespread sampling may lead to a greater understanding of contamination mechanisms and improved surveillance.

Keywords: Verotoxigenic *E. coli*, VTEC, drinking water, groundwater, private wells, waterborne zoonosis

Human Health (HH)

Environmental Occurrence and Potential Health Impact of Phthalates in Ireland

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Phthalate esters are synthetic organic chemicals used in many consumer products including cosmetics, toys, flooring and medical devices, and are ubiquitous within the environment (Gao and Wen, 2016)the concentrations of dimethyl phthalate (DMP. Humans are constantly exposed to phthalates, with increasing evidence of detrimental health effects (Ejaredar et al., 2015PubMed, EMBASE, PsycINFO, CINAHL, Global Health, CAB abstracts, and ERIC; Jurewicz and Hanke, 2011; Polańska et al., 2016PubMed, EMBASE, PsycINFO, CINAHL, Global Health, CAB abstracts, and ERIC). The European Commission is preparing to amend the Authorisation List (Annex XIV to REACH) with the additional identification of four phthalates as substances of very high concern (SVHCs) with endocrine disrupting effects on human health or the environment (European Commission, 2015)Having regard to the Treaty on the Functioning of the European Union, Having regard to Directive 2011/65/EU of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment, (1. The phthalates in question are bis(2-ethylhexyl) phthalate (DEHP), dibutyl phthalate (DBP), benzyl butyl phthalate (BBP) and diisobutyl phthalate (DiBP). Other phthalates have yet to be studied extensively, and it is predicted that these replacement phthalates may prove to be as dangerous as those under legislative control. This study examined eleven phthalates in a range of Irish environmental matrices. A novel triple-quad LC-MS method was developed with optimisation of sample preparation (SPE and US). The examination of phthalate burden in Ireland has shown that levels in Ireland are consistent with those reported elsewhere in Europe. Concentrations ranged from N.D. to 95 µg/L in aqueous samples and 0.01 to 315.21 µg/g in solid samples, with DiBP and DBP as the most prolific phthalates. Soil was identified as the largest sink of phthalates in our environment. A wastewater epidemiology approach was employed to assess human exposure to phthalates via measurement of phthalate metabolites. Exposure modelling determined that exposure in Ireland was below regulatory limits, and consistent with previously reported levels. A meta-analysis related the level of exposure to an associated risk, providing the first step in phthalate risk assessment within the Irish environment. This will close the knowledge gap from lack of biomonitoring data and inform future policy.

Keywords: Phthalates, Environmental Occurrence, Wastewater Epidemiology, Human Health

Antibiotic resistacne genes in bacteria and bacteriophages: A land use study of rivers

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The World Health Organisation recognises antimicrobial resistance as one of the most exigent threats to global human health. The environment can act as reservoir and highlights its importance as an area of research. Bacteriophages can contribute to the spreading of antimicrobial resistance, as they can obtain and transfer antimicrobial resistance genes via transduction. Rivers that flow through agriculture, industrial and urban areas are subjected to different environmental pressures that can shape the microbial community of the river. Faecal pollution of surface water can result in surface waters being contaminated with clinically important antibiotic resistance genes. We aimed to assess water quality from three rivers impacted by different land uses, from a longitudinal and spatial standpoint. We wanted to assess the levels and origins of feacal pollution and the potential levels/concentration of clinically important antibiotic resistance genes. Water samples were taken every two weeks from fourteen locations on three rivers. Faecal indicator organisms including somatic coliphages were enumerated, as were faecal microbial source tracking markers (human & ruminant). Levels of genes conferring resistance to □-lactams, fluoroquinolone, tetracycline & sulphonamides were determined from bacteria and bacteriophage DNA fractions. Faecal indicator levels ranged over three orders of magnitude. The highest levels of the human marker were observed in urban impacted rivers, where they correlated with ARG levels in the bacteria but not in bacteriophage. Similarly, in agriculture impacted rivers, we observed significant correlations between the ruminant marker and ARG levels, not in the bacteriophage. Respectively, 100% and 84% of the bacterial and bacteriophage fractions were positive for the tested ARGs. Bacteriophage DNA fractions had lower ARG levels than in bacterial fractions. Overall, we see that ARG levels in bacteriophages are a major contributor of total ARG levels in rivers, and that land use is significant driver shaping the microbial diversity seen.

Keywords: Land use, Antibiotic resistance, water quality, Bacteriophages

Development of lab-on-a-chip detection system for environmental monitoring of Polychlorinated Biphenyls (PCBs) in soil

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Polychlorinated biphenyls (PCB) are a group of 209 possible chlorine-substituted linked benzene rings (congeners) that occur as a pollutant in the environment. They are derivatives of incomplete combustion of carbon-based energy sources. Their pollutant nature is expressed in their carcinogenic and mutagenic properties. This knowledge has necessitated a scenario in which strict environmental monitoring is conducted to determine environmental PCB levels. This scenario, though ideal, is not the case in real life. It is further complicated by the limited by the multistep and time shortcomings of present conventional analytical tests and PCB physicochemical properties. High-resolution gas chromatography with ion capture and mass spectrometric detection systems have been shown as reliable detection systems, though expensive and time consuming. As a result, the screening of large numbers of samples has been limited and supplemental methods are required necessitating tests to determine ELISA as a feasible alternative. This laboratory research project critically reviews ELISA as a laboratory tool for the detection of PCB in soil samples. This research has focused on the integration of electrochemical techniques with an immunoassay method to develop a real time portable and accurate solution for detection of PCB in soil. Our integrative approach facilitates a real-time detection of this family of organic compounds, by reducing the time of analysis to less than one hour. Additionally, the use of a lab-on-a-chip platform delivers a portable solution that could be used for in situ monitoring. By optimizing an indirect displacement immunoassay that investigates presence and concentrations of PCB, we have obtained, thanks to the miniaturization of the platform compared to standard ELISA plates, a highly accurate system that provides fast results. The outcome of this project will provide a portable device for PCBs detection in soil, also the final result will integrate immunoassay techniques in a lab-on-a-chip application for high specificity and sensitivity.

Keywords: PCBs, immunoassay, real time, portable

Balancing conservation of the natural environment with outdoor recreation: An investigation of stakeholder perceptions

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Over the last number of years, in part due to the success of schemes such as the Wild Atlantic Way and a significant increase in outdoor recreation, the number of visitors to outdoor environments has increased in Ireland. While increased visitation to outdoor sites provides many benefits, socially and economically, it also has adverse impacts on the natural environment. Although some areas are designated for conservation, little has been done in Ireland to date to a) quantify the environmental impacts of outdoor recreation activities; and b) develop sustainable management strategies that combine outdoor recreational demands with the conservation needs of protected sites. This study investigates the degree to which the views of a range of stakeholders differ in relation to recreational management strategies in Ireland. Using case studies, the research will also describe the contexts in which enablers and inhibitors among stakeholders develop and how both types can influence the development of best management practices. The project will include mixed methods to investigate stakeholder perspectives on how to protect conservation while developing outdoor recreation in Ireland. Firstly, interviews will be carried out to gauge insights from key stakeholders. Following an analysis, qualitative surveys will be undertaken to quantify the value of outdoor recreation spaces in terms of biodiversity, health and wellbeing and the importance of conservation in outdoor recreation. Finally, the quantitative Q-methodology technique will be used to gain further insights into stakeholder management from the perspective of key participants in outdoor recreation in Ireland. The results of this study will be the development of an outdoor recreation management toolkit to support stakeholders in in conserving the outdoor environment in Ireland.

Keywords: Outdoor recreation Conservation Stakeholder engagement

Investigating the presence of microplastics in rivers flowing into Dundalk Bay

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Less is known about the presence and characterisation of microplastics in Irish freshwater systems, than in the marine environment. To address this deficit, this study is focusing on seven rivers flowing into Dundalk Bay. These rivers were sampled from September to December 2019 at both headwater and outflow sites, with repeated sampling of two locations also carried out in early 2020. At each location, 200 litres of water was passed through a series of graded sieves down to a size of 50µm. A combination of sequential sieving, centrifugation and digestion by hydrogen peroxide, followed by Rose Bengal dye treatment, ensured that any microplastics present within a size range of 50µm to 5mm were captured and characterised. Microplastics were recorded based on size, shape and colour. Results to date indicate varying levels of microplastic pollution across the seven rivers, but also within specific rivers. This variation would suggest that settling or sedimentation of some microplastics may occur and that rivers may act as sinks for microplastics. Microplastics were found in all samples at all sites on the rivers and had a minimum concentration of 0.48 microplastic items/L and a maximum concentration of 6.14 microplastic items/L. The use of a sieve with a smaller mesh size (50µm) than the nets used in trawls for microplastics at sea (generally 330µm) resulted in a capture of microplastics in a size range that may have been overlooked in other studies to date.

Keywords: Microplastics, rivers, Dundalk Bay

Is water quality a determinant of beach choice? A survey of bathing water users in the West of Ireland

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Ireland's coastal bathing waters are generally of a high standard. In 2018, 94% of identified bathing waters (137 of 145) met the minimum criteria for bathing water quality and 103 were classified as "Excellent" (71%). However, antimicrobial resistant (AMR) bacteria have been detected in waters deemed safe for bathing, which represents a public health concern. The EPA-funded PIER (Public health Impact of Exposure to antibiotic Resistance in recreational waters) project will investigate whether water users are at risk of infection or colonisation with AMR bacteria. This study, a scoping exercise for PIER, aimed to explore attitudes and public knowledge on bathing water quality and terminology regarding AMR. Following ethical approval for the study, and stakeholder analyses, an anonymous cross-sectional self-completed survey was distributed to recreational water users (≥18 years) at three locations over a 5-week period (July to August 2019). Questions were on demographics, use of the beach and knowledge of bathing water quality and AMR terminology. The majority of the 81 respondents were female (57%), and were regular (≥3 times per month) swimmers (64%). Top reasons for choosing the beach were location (62%) and onsite facilities (54%). Barriers to using the beach included jellyfish and poor water quality, which the respondents associated most with sewage (44%) and high bacterial levels (38%). Respondents only sought information on water quality 'sometimes' (38%) or 'rarely' (30%) before entering the water. While 80% of respondents were unfamiliar with the term 'antimicrobial resistance/AMR', 93% had heard of 'superbugs'. Access and infrastructure are key elements in facilitating the use of bathing water, whereas poor water quality is a major barrier. The public are generally aware of bathing water quality monitoring, but not where to find results. Participants' knowledge of AMR terminology will guide development of accessible literature for PIER.

Keywords: Recreational water, bathing water, water users, antibiotic resistance, water quality, antimicrobial resistance

Environmental factors modulating Lyme disease risk in Ireland

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Lyme disease, caused by *Borrelia burgorferi sl.* bacteria, is the most prevalent tick-borne illness in Europe, and its incidence is increasing in many countries. The main Lyme disease vector in Europe is *Ixodes ricinus*, which feeds on a variety of mammalian, bird, and reptile hosts. There is evidence that local vertebrate species richness affects tick abundance and nymphal tick infection prevalence (NIP). NIP is thought to be directly linked to the Lyme disease risk in an area, so ascertaining the environmental factors affecting NIP in a locality is important for disease surveillance. We present a study assessing vertebrate species richness at different woodland sites in Ireland and ascertaining its relationship with NIP and local Lyme disease incidence. Woodland sites (coniferous, mixed/native) will be visited repeatedly over a 4-year period. On each visit, tick collection will be undertaken via towel dragging. Vertebrate diversity at each site will be assessed by means of faecal transect analysis, birdsong analysis, small mammal hair trapping, local (woodland management) knowledge, existing biodiversity datasets, and tick blood meal analysis. Collected ticks will be counted and will undergo Polymerase Chain Reaction to identify their last blood meal, to ascertain the prevalence of *Borrelia burgdorferi sl.* infection in the tick community, and to identify pathogen strains. The results of this study will supply novel information on how factors such as habitat type and vertebrate diversity (and the loss thereof) impact Lyme disease risk in an Irish context. The data from this work will also be used to generate local risk maps which can be used by diagnosticians to help in the diagnosis of Lyme disease, demonstrating how interdisciplinary approaches combining ecology and epidemiology can help with diagnostic accuracy. The study outline will be presented, along with a metanalysis of the literature.

Keywords: Lyme disease; ticks; habitat; vertebrate diversity; biodiversity; health and environment

The impact of environment on micro and macronutrients in meat

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This project focuses on the investigation of the production and analysis of general characteristics of meat. The nutritional profile of different meat types such as chicken, beef, pork, turkey etc. have been investigated by over 100 researchers over the last years (concentration of proteins, fats, vitamins, minerals and carotenoids). Meat comes from animals, so its nutritional value depends on many factors such as environmental characteristics (i.e. composition of soil, atmospheric pollution), animal feed and genetic factors. This project's goal is to determine if all the above factors play a role in meat's final content in nutrients and how the market distributes and sells that nutritional value. Price variations have been observed for different meat brands in the markets i.e. organic VS free range VS normal meat. Higher prices are based on meat properties such as absence of antibiotics and hormones, high concentration of good fats, proteins, vitamins and good minerals (i.e. Fe, Mg, Se etc. and lack of heavy metals such as Pb, Cd, As). However, a question that remains is whether those prices observed in the markets are reflecting those beneficial properties and if the differences between meat attributes are that big. Since consumers spend a significantly larger amount of money to get better quality meat, it is of great importance to investigate what is happening to the meat industry, from the beginning to the end, and to verify the nutritional value of different meat types and of different price ranges. This can be possible by setting a biomarker that will help us distinguish the differences between meat qualities.

Keywords: Environment, meat, biomarker, industry, nutrients

The human health risk of exposure to the microplastics in daily life

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News reports about plastic pollution tend to focus on the vast swaths of plastic in the oceans all over the world, but scientists have found tiny pieces of plastic omnipresently, in remote, pristine environments and even human lives. Globally, microplastics (MPs) have become a significant environmental health issue due to their potential risk to human health. Previous research has identified that there are different types of MPs in human stool. In our recent study, we found that large quantity of polypropylene (PP) MPs can be released at high temperature from the plastic products in everyday life. PP is the most widely used plastic in food supply and packaging since it is considered as safe plastic. However, it is determined that even "food-grade level" plastic may degrade toxic substances when heated above 40°C. This project is focusing on assessing the public's exposure to MPs in daily life and the potential health risks the MPs pose to the public. Raman spectroscopy and atomic force microscopy (AFM) has been used to test and analyze the quantity and size of MPs particles in water samples. In the current research phase, we collected water samples and filtered using a gold-coated filter (pore size of 0.8μm). The MPs on the filter were located and confirmed by Raman imaging and mapping using the 2830-2970cm^{-1} vibrational modes associated with PP. Subsequently, the confirmed MPs particle size were determined by ImageJ while their topographies were analyzed by AFM. Additionally, the toxicity testing of MPs will also be concerned in this study.

Keywords: Microplastics, Human health, Plastic products, Risk assessment

Environmental Sciences Association of Ireland

ESAI ANNUAL REVIEW 2019

Annual Review 2019

2019 was a busy year for the Environmental Sciences Association of Ireland (ESAI). Some of the key events and highlights are detailed in the following sections.

Environ 2019: The highlight of the year was our Environmental Researchers Colloquium (Environ). The 2019 Environ was hosted by the Institute of Technology Carlow, (15th – 17th April). The event gathered over 200 delegates from all over Ireland, NW Europe and Italy. This involved a mix of academic researchers, industry representatives, policy makers, as well as local community and media. The conference theme was "Engagement for Climate Action". Overall, 72 oral and 44 poster presentations were heard, and the quality of research presented was exceptional. The fact that the vast majority were delivered by young scientists and engineers bodes well for the future of environmental sciences in Ireland. On behalf of all the team at ESAI we would like to acknowledge and thank Dr. Thomais Kakouli-Duarte, Director of Research enviroCORE, and all the team at IT Carlow who worked extremely hard to make the event a success. Congratulations to all the winners in the ESAI Environ Student Presentation competition which featured nine awards this year with a special mention to Felipe Guapo, NUI Maynooth, Winner of the Best Oral Presentation at Environ 2019.

Researcher Awards

At the heart of great science lies a creative and moral instinct to explore and to question in order to create a better world. ESAI continue to recognise the excellence of young researchers in this regard at both undergraduate and postgraduate level.

Postgraduate Researcher of the Year Award: Congratulations to Molly-Ann Williams from the School of Biotechnology at Dublin City University (DCU) who is the 2019 winner of the prestigious ESAI Postgraduate Researcher of the Year Award. Molly-Ann has developed a novel method of the detection of environmental DNA (Edna) by combining isothermal amplification of DNA with CRISPR-Cas detection. Not only does employing CRISPR-Cas, more commonly known for its role in genome editing, dramatically simplify the next challenge of building a biosensor device, it enhances the differential detection of sympatric taxa and can be easily adapted to detect any species from eDNA samples from a variety of sources. Molly-Ann will be describing her research in more detail at the next Environ in Autumn 2020. Thanks to Dr. Tasman Crowe at UCD for judging this program.

Annual Review 2019

ESAI HEI Undergraduate of the Year Award: ESAI and our sponsors continue to recognise the excellence of young researchers through our Undergraduate of the Year Awards. Congratulations to all our deserved 2019 winners: Robert Conlon, Institute of Technology Carlow; Darren O'Sullivan, Cork Institute of Technology; Grainne McIvor, Dublin City University; Damien Smyth, Technological University Dublin; Clodagh King, Dundalk Institute of Technology; Niall McHugh, Galway-Mayo Institute of Technology; John Sheppard, Institute of Technology Sligo; Isabel Jorgensen, Trinity College Dublin; Peter Lynch, University College Dublin; Elaine Salomon, Ulster University; Katie O'Toole, Waterford Institute of Technology; Cliodna Colbert, University of Limerick; Grace English, Limerick Institute of Technology; Chloe Quinn, Waterford Institute of Technology; Denis Kiely, Cork Institute of Technology; Samantha O'Neill, Institute of Technology Carlow. Thanks to Niamh Power from CIT for managing this program.

During 2019 we also continued our **EPA funded Grassroots Award Scheme**. Special thanks to the EPA for their continued support. We would also like to acknowledge our ESAI Liaison officers 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.

ESAI members are the core of the organisation and over the summer of 2019 we have launched a new website to improve how we engage with our members. Special thanks to the comms team lead by John Gallagher, TCD for his outstanding work in this regard. We welcome your input and participation through our social media channels whether through our Listserver, LinkedIn, Facebook, Twitter or by subscribing to our Newsletters.

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 share their expertise and time. Participation within the ESAI council is voluntary and is a great experience for both early stage [PhD and Post Doc] and more mature researchers and also research supervisors. If anyone is interested to join the Council, please contact administrator@esaiweb.org.

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. I would also like to thank my predecessor Dr. Frances Lucy, former chair of the ESAI council for her wisdom and advice. The events of recent months will continue to challenge ESAI members, both professionally and personally throughout 2020 and beyond. ESAI will continue to adapt and seek ways in which we can serve the environmental community in Ireland though this coming year.

Liam McCarton, ESAI Chairperson
Liam is a member of the Development Technology with the Community (DTC) Research Group at TU Dublin and Director of Engineers Without Borders Ireland.

Making the most of your 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 Researcher 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
- Members of ESAI will receive free-of-charge E-Newsletters, Environews.
- Sponsorship opportunities

Handy Links For Staying Informed

- Find out more about ESAI Goals and Objectives
- Keeping in touch with the ESAI
- Further information on ESAI Code of Ethics and Constitution

2019 Events

Date	Event
January 1st	**ESAI Grassroots Workshop Support Scheme** Sponsored by EPA – Rolling Call
February 28th	**ESAI Grassroots Workshop Support Scheme** Sponsored by EPA – Rolling Call
March	**ESAI Environews Spring Edition available online www.esaiweb.org**
April 15th-17th	**Annual Conference** Environ 2019 co-hosted by Institute of Technology Carlow 29th Annual Irish Environmental Researchers Colloquium, Institute of Technology Carlow, Co. Carlow
April 15th	**Workshop @ Environ 2019** 09:30-13:00 EcoTrails: A Walk on the Wild Side! Banks of the River Barrow, Carlow
April 15th	**Festival @ Environ 2019** 14:00-17:00 Day-To-Day Sustainability – What Can I Do? Sustainability Fringe Festival: Delta Sensory Gardens, Carlow
April 15th	**Workshop @ Environ 2017** 14:00-17:00 Bioinformatics: Gene Discovery in Microbiomes Institute of Technology Carlow
April 16th	**Launch** ESAI Postgraduate Researcher of the Year Award Launch
April 16th	**ESAI AGM** 7:30-18:00, Institute of Technology Carlow All members welcome
April 17th	**ESAI Student Competition Prize Giving Ceremony**
June 30th	**ESAI Undergraduate of the Year Award Nominations Closes**
June 30th	**ESAI Grassroots Workshop Support Scheme for Postgraduate and Postdoctoral Researchers** Sponsored by EPA – Rolling Call
August 31st	**Undergraduate Membership Offer** Free Membership for all Undergraduate Members Scheme Rolled Out
September 30th	**ESAI Grassroots Workshop Support Scheme for Postgraduate and Postdoctoral Researchers** Sponsored by EPA – Rolling Call
October / November	**ESAI HEI Nominated Undergraduate of the Year Award Winners Graduate** Presentations taking place at HEI's nationwide
December	**ESAI Postgraduate Researcher of Year Award Winner Announced**
December 5th	**Environ 2020 co-hosted by Water Institute Dublin City University** **30th Annual Irish Environmental Researchers Colloquium** Call for Papers Opens – Register on www.environ2020.org
December 30th	**Free Membership for Undergraduate Members Offer Closes**
December 31st	**ESAI Grassroots Workshop Support Scheme for Postgraduate and Postdoctoral Researchers** Sponsored by EPA – Rolling Call

ESAI INCOME AND EXPENDITURE ACCOUNT 2018

For the year ended 31 December 2019		
	€	€
Opening balance as 01/01/19		**14,304.00**
Income		
Membership	3,080.96	
Membership	2,581.00	
Environ 2020 - Delegate Fee	585.00	
Environ 2019 - Delegate Fee	13,845.00	
Sponsorship	21,150.00	
Environ 2019 Prizes	1,000.00	
Total Income	**39,161.00**	
Expenditure		
Environ 2019 (inc prizes)	26,518.00	
Environ 2020	1,398.00	
Workshop	350.00	
Environ 2019 Refunds	700.00	
Website	3,182.00	
Administration	8,776.00	
Travel	442.00	
Accountancy	92.00	
Bank Charges	384.00	
Bank Charges (inc. Merchant banking)	1,230.00	
Insurance	1,155.00	
Postage & Stationary	77.00	
Postgrad Prize	0	
Governance	310.00	
Website Revamp	2,153.00	
Total Expenditure	**46,768**	
Excess Income over Expenditure		(7,607.00)
Closing Balance per Bank @ 31/12/19		**6,697.00**

ESAI Council Members 2019

Chairperson	Regular Members
Mr Liam McCarton	
Email: chairperson@esaiweb.org	Prof Frances Lucy – IT Sligo
Honorary Secretary	Dr Kevin Ryan – Cork County Council
Mr Philip Shine	
Email: secretary@esaiweb.org	Dr Joe Harrington – Cork IT
Honorary Treasurer	Prof Tasman Crowe - UCD
Dr Niamh Power	
Email: treasurer@esaiweb.org	Dr Tom Curran - UCD
Communications Officer	Dr Dorothy Stewart - EPA
Dr John Gallagher	
Email: communications@esaiweb.org	Mr Declan Feeney – IT Sligo
Editor	**Membership Officer**
Ms Caroline Wynne	c/o Ms Sinead Macken / Administrator
Email: lang.yvonne@itsligo.ie	Email: administrator@esaiweb.org
Conference Coordinator 2020	**Webmaster**
Dr Jenny Lawler & Dr Anne Morrissey	c/o Dr Adrian Corcoran / Attik Designs
Email: conference@esaiweb.org	Email: webmaster@esaiweb.org
Conference Coordinator 2019	
Dr Thomae Kakouli-Duarte	
Email: thomae.kakouli@itcarlow.ie	
Conference Coordinators 2021	
Dr Jean O'Dwyer	
Email: jean.odwyer@ucc.ie	

Environ

Environ celebrates its 30th Anniversary

30 YEARS OF THE ESAI'S ANNUAL COLLOQUIUM

To mark this great achievement
the ESAI Announce their first honours list:

Dr Mary Brennan
Dr Debbie Chapman
Dr Micheál O'Cinnéide
Prof Mark Costello
Michael Ewing
Dr Billy Fitzgerald
Dr Shirley Gallagher
Emeritus Prof. Brid Quilty

esai
Environmental Sciences Association of Ireland

Celebrating contribution to the ESAI, Environ and Environmental Sciences