


nviron 2021

31ST IRISH ENVIRONMENTAL RESEARCHERS COLLOQUIUM



**Healthy Planet,
Healthy Communities.**

16th - 18th June 2021

 Online

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UCC Convenor's Welcome to ENVIRON 2021



The ENVIRON 2021 Organising Committee welcomes you to the 31st Irish Environmental Researchers' Colloquium (ENVIRON 2021), hosted online by the Environmental Research Institute at University College Cork. The ENVIRON colloquium is the largest gathering of environmental researchers in Ireland with over 250 delegates attending remotely 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.

This year's colloquium had an overarching theme of **"Healthy Planet, Healthy Communities"**, reflecting the intrinsic link between the natural environment and human health. Throughout the event, delegates had opportunities to engage with researchers across the country, discuss the conference theme and develop solutions and strategies to key environmental issues in Ireland.

The colloquium was formally opened on Wednesday 16th June by Professor John O'Halloran (President, University College Cork), Professor Sarah Culloty (Director of the ERI), Dr Liam McCarton (ESAI Chairperson) and Dr Jean O'Dwyer, followed by a Keynote Address by Dr Jonathan Derham (EPA). Over the course of the three days, 300+ attendees wove in and out of 21 oral presentation sessions and three poster sessions. This year, we welcomed new topics such as Environmental Geoscience and Environmental Engineering to build on the diverse range of topics previously hosted at ENVIRON.

ENVIRON 2021 was greatly benefitted by the addition of world-class experts, who added insight, discussion, and food for thought through keynote and plenary sessions. On June 16th, Kate Raworth, author and pioneer of Doughnut Economics, coupled with Roisin Markham of the Irish Doughnut Economics Network provided a fascinating and enlightening 'Co-Note' session answering the question "Can Ireland thrive within the Doughnut?" This highlight event was open to the public as well as ENVIRON delegates and sparked stimulating discussion among attendees.

On June 17th, both ENVIRON delegates and the public had a further opportunity to liaise with both national and international experts as we discussed the conference theme through a plenary session and live Q&A. Prof. Paul Ekins of University College London, Ms. Denise Cahill of Cork Healthy Cities and Dr Ina Kelly of the Health Service Executive provided a lively discussion of how the environment impacts human health, at the local and not-so-local level. Attendees were left with a message of hope for the future through collective initiatives like the Sustainable Development Goals and the inspiring work undertaken in Cork and other local settings.

We hope that all participants enjoyed ENVIRON 2021 and were encouraged by the fascinating research presented throughout the event. We look forward to seeing you all again at ENVIRON 2022.

Until next time.

Dr Jean O'Dwyer

ENVIRON 2021 Convenor

On behalf of the ENVIRON 2021 Organising Committee

ESAI Welcome to ENVIRON 2021 Delegates



The ESAI Council wish to extend to you a warm welcome to the 31st Irish Environmental Researchers Colloquium (ENVIRON) hosted in collaboration between the Environmental Sciences Association of Ireland (ESAI) and the Environmental Research Institute (ERI) at University College Cork (UCC). The theme of this year's conference is 'Healthy Planet, Healthy Communities.'

ENVIRON provides an annual platform for researchers to present to a wide audience and an opportunity to engage with the general public. This is our second "virtual" Environ and we would like to thank all sponsors and members who have registered for their patience and continued support. Building on last year's successful online event, this year, ESAI and UCC have joined forces with ExOrdo to deliver an exciting and engaging online conference experience. Registered delegates will have access to a suite of conference tools and can take part in virtual workshops, engage with keynote and plenary speakers and liaise with researchers and industry practitioners across the country during icebreaker sessions. The goal is to deliver the full Environ experience from the comfort of your own home.

Environ 2021 will officially open on Wednesday 16th June with an opening address by UCC Interim College President Prof. John O'Halloran, ERI Director Prof. Sarah Culloty, Dr. Jonathan Derham, EPA and ESAI Chairperson Liam McCarton. Later in the day from 5pm-6.30pm we ask the public to join us for keynote talks from Kate Raworth (author of Doughnut Economics), environment economist focused on exploring the economic mindset needed to address the 21st century's social and ecological challenges & Roisin Markham, founder and network steward of the Irish Doughnut Economics Network. Several events will take place over the three days, including a variety of oral and poster presentations, plenary speakers and social evenings. Environ will culminate on Friday 18th with our prizegiving ceremony.

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. Further information can be found at www.esaiweb.org

The ESAI wishes to sincerely thank Environ 2021 conference co-convenors Dr Jean O'Dwyer, Dr Timothy Sullivan, Dr Paul Bolger, Dr Aoife Corcoran and all the ERI team 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 UCC.

Liam McCarton
ESAI Chairperson

Environ 2021 Organising Committee

Conference Convenors

Dr Jean O'Dwyer

Dr Paul Bolger

Dr Tim Sullivan

Dr Aoife Bolger

University College Cork Planning & Scientific Committee

Dr Carlos Chique

Ms Luisa Andrade

Ms Irene O'Callaghan

Ms Hannah Binner

Environmental Sciences Association of Ireland (ESAI)

Ms. Sinead Macken

ESAI Administrator

Dr. Liam McCarton

ESAI Chairperson

ESAI Council

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nviron 2021



Environmental Research Institute

16th – 18th June 2021

Healthy Planet, Healthy Communities
31st Irish Environmental Research Colloquium

BIOGRAPHIES

Environmental Research Institute Environ Co-Convenors



Dr Jean O'Dwyer is Deputy Head of Environmental Science in the School of Biological, Earth and Environmental Science at University College Cork and Head of Environmental Geoscience at the Irish Centre for Research in Applied Geoscience (iCRAG). Jean has a Bachelor of Science in Environmental Science (2011) and a PhD in Environmental Health Science (2015) from the University of Limerick. Her research interests focus on the interaction between the natural environment and human health, with a particular emphasis on waterborne infectious disease and the impact of climate change on human health and wellbeing. Jean is a Principal Investigator in the Environmental Research Institute where she leads the Environment and Health Research Lab and is a Funded Investigator in the SFI Centre iCRAG under the Earth System Change spoke.



Dr Paul Bolger is manager of the Environmental Research Institute at University College Cork, Ireland. He has worked across academia, industry and government for over 20 years developing long term research solutions for global sustainability challenges. He is currently principal investigator on a number of research projects on climate change and the circular economy. Dr Bolger is an EPA 2019 Fulbright Scholar, as part of which he examined how interdisciplinary research is being facilitated at sustainability research institutes in Arizona State University, Cornell University, Colombia University and Duke University to achieve more robust research outcomes. Dr Bolger research interests are in how to utilise interdisciplinary and transdisciplinary (co-production) approaches to address complex environmental challenges, and in how broad academic knowledge across natural and social sciences, humanities, business and law can help society achieve sustainable development goals.

Environmental Research Institute Environ Co-Convenors



Dr Aoife Corcoran is the Communications Officer with the Environmental Research Institute, University College Cork. A trained scientist, Aoife has PhD in Cancer Biology and a BSc in Genetics, both from UCC. Prior to joining the Environmental Research Institute (ERI), Aoife held a postdoctoral position in paediatric medical oncology at the Dana Farber Cancer Research Institute in Boston, MA. She has also worked in the SME sector, both as a biochemistry applications specialist and scientific content writer with material science company Glantreo, and as an EU proposal writer with PrimeUCC. Aoife now brings her experience in both research and scientific communication to the ERI where she is providing support for the communication & dissemination activities of individual research projects as well as the Institute as a whole. Her remit also includes the management of press and public relations, writing press releases and management of outreach and stakeholder event, as well as developing content for the Institutes social media and website. Aoife is also a member of the Wildlife Rehabilitation Ireland fundraising committee, writing funding applications and developing fundraising strategies to support the NGO's newly launched wildlife hospital.



Dr Timothy Sullivan earned his BSc in Environmental Science at UCC, before completing his PhD within the Marine and Environmental Sensing Technology Hub, the School of Chemical Sciences and the National Centre for Sensor Research at Dublin City University. He subsequently completed postdoctoral training at the Department of Chemistry and Chemical Engineering at Eindhoven University of Technology (TU/e), NL. He is now a lecturer in, and since Sept. 2019, deputy head of the Environmental Science undergraduate programme at the School of Biological, Earth and Environmental Sciences (BEES), UCC. He contributes significantly to undergraduate teaching, both taught and research postgraduate programmes, and co-ordinates the MRes programme in Environmental Sciences at UCC. Tim leads the Materials and Environmental Science Applications (MESA) Research group based with the School of BEES and the Environmental Research Institute (ERI) and has contributed to over 40 published research papers, books, and conference proceedings in the areas of materials and environmental sciences.

Workshop at Environ: Monday 24th May



Workshop 1: Hugh Kearns, Thinkwell Australia

Hugh Kearns is recognised internationally as a public speaker, educator and researcher. He regularly lectures at universities across the world and has recently returned from lecture tours of the UK and the US which included lectures at Oxford, Cambridge, Harvard, Berkeley and Stanford. His areas of expertise include self-management, positive psychology, work-life balance, learning and creativity. He draws on over twenty five years of experience as a leading training and development professional within the corporate, financial, education and health sectors in Ireland, Scotland, North America, New Zealand and Australia. He has coached individuals, teams and executives in a wide range of organisations in the public and private sectors. Hugh lectures and researches at Flinders University, Adelaide, Australia. He is widely recognised for his ability to take the latest research in psychology and education and apply it to high-performing people and groups. As a co-author with Maria Gardiner, he has published ten books which are in high demand both in Australia and internationally.

Opening Event: Wednesday 16th June 2021



Chairperson: Environmental Research Institute Conference Co-Convenor Dr Jean O'Dwyer

Dr Jean O'Dwyer is Deputy Head of Environmental Science in the School of Biological, Earth and Environmental Science at University College Cork and Head of Environmental Geoscience at the Irish Centre for Research in Applied Geoscience (iCRAG). Jean has a Bachelor of Science in Environmental Science (2011) and a PhD in Environmental Health Science (2015) from the University of Limerick. Her research interests focus on the interaction between the natural environment and human health, with a particular emphasis on waterborne infectious disease and the impact of climate change on human health and wellbeing. Jean is a Principal Investigator in the Environmental Research Institute where she leads the Environment and Health Research Lab and is a Funded Investigator in the SFI Centre iCRAG under the Earth System Change spoke.

Opening Event: Wednesday 16th June 2021



Speaker 1: UCC College President Prof John O'Halloran

Professor John O'Halloran is Interim President at University College Cork since September 2020. Prior to this he was the Deputy President & Registrar and led UCC's first Academic Strategy to reimagine the curriculum, transform assessment and nurture graduate attributes to position UCC students for their future world of work. Having formerly served as Vice-President for Teaching & Learning, and as Vice-Head of the College of Science, Engineering & Food Science, he is an academic leader with an ambitious vision for the future of Higher Education. Professor O'Halloran has delivered transformation through collaboration on a range of Higher Education priorities including the advancement of research; enhancement of learning; digital education; lifelong learning; and professional development. He is committed to developing an inclusive culture at UCC - one where equality is upheld, and diversity is respected. He is also dedicated to putting sustainability at centre stage in UCC, in the community and beyond. Under his leadership UCC's Green Campus Programme became the first third level institution worldwide to receive the Green Campus award in 2010. Now ranked as one of the most 'sustainable universities' in the world, UCC has achieved significant impacts including the development of a Sustainability Strategy, influencing national policy and winning many international accolades. An ornithologist, he holds the Chair in Zoology at UCC and previously held academic posts at Colby College in the USA and at the University of Wales. He has published 250 research papers and several book chapters aimed at developing a deeper understanding of the ecological impacts of land-use change, climate change on a range of systems and processes.

Opening Event: Wednesday 16th June 2021



Speaker 2: Environmental Research Institute Director Prof Sarah Culloty

Prof Sarah Culloty is Head of the College of Science, Engineering and Food Science and has been Director of the Environmental Research Institute at UCC since 2014. The ERI is an institute that spans the university, has a multidisciplinary based focus and encompasses six research centres. With a focus on bringing disciplines together, the ERI focusses on three key challenges of Climate Action, Circular Economy and Healthy Environments. Sarah is a marine biologist and zoologist working on the impact of anthropogenic factors on aquaculture and fisheries industry and more recently has been looking at the potential future impact of climate change on these sectors. Sarah's research focusses on health and disease in the marine environment and most recently with a focus on the impact of climate change on aquaculture and fisheries. Her research has a large international dimension with active global collaborations. She serves on a number of boards including Fota Wildlife Park, the Irish Aquaculture Technology and Innovation Platform and the Centre for Environment, Fisheries and Aquaculture Science (CEFAS) UK.



Speaker 1: Environmental Sciences Association of Ireland 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. Liam has co-authored a number of books including "The Worth of Water", "A Technology Portfolio of Nature Based Solutions for Innovations in Water Management" and "Where There Is No Engineer - Designing for Community Resilience". Liam is a Director of Engineers Without Borders Ireland and leads their Innovation Academy and Development Education programs.

Opening Event: Wednesday 16th June 2021



Speaker 4: Environmental Protection Agency Dr Jonathan Derham

Dr Jonathan Derham is currently the head of the EPA Evidence Programme which includes, inter alia, the Environmental Research programme, Environmental Analytics, Strategic Environmental Assessment, and the State of our Environment Reporting unit. Through his professional career Jonathan has gained direct experience in a wide range of environmental policy areas in both the National and European arenas and has previously led EPA activity in Circular Economy, Resource Efficiency, Climate Change, Industrial Regulation, Environmental Liabilities, Mining, and Waste Management. Over his career Jonathan has represented the State in Europe across many policy areas and at UN COP meetings.

Co-Keynote Session Wednesday 16th June



Chairperson: Dr Ger Mullally, University College Cork

Dr Gerard (Ger) Mullally is a lecturer and Deputy Head in the Department of Sociology and Criminology in the School of Society, Politics and Ethics, University College Cork, specializing in the areas of environment, community, sustainable development and climate change. He began his research career in the Centre for European Research, UCC (1992-1997), after graduating from the inaugural cohort of the M.A. in the Sociology of Development, where he was a researcher on a number of EU projects on environment and sustainable development. In 1997, he was awarded a scholarship to the Advanced Study Course Systemic Complexity and Eco-Sustainable Development, Erice, Sicily. Ger joined the Cleaner Production Promotion Unit, CPPU (Department of Civil and Environmental Engineering) in June 1998 as a Senior Researcher and Programme Manager for Regional Sustainable Development (1998-2003). He rejoined the Sociology Department in 2003 as a college lecturer and is currently a research associate in the Environmental Research Institute, the Cleaner Production Promotion Unit, Institute for Social Science in the 21st Century (ISS21), and MaREI Centre for Marine and Renewable Energy, all at UCC



Speaker 1: Kate Raworth

Kate Raworth is an economist focused on making economics fit for the 21st century. Her book *Doughnut Economics: seven ways to think like a 21st century economist* is an international bestseller that has been translated into 20 languages, and was long-listed for the 2017 Financial Times & McKinsey Business Book of the Year award. She is co-founder of Doughnut Economics Action Lab, working with cities, business, communities, governments and educators to turn Doughnut Economics from a radical idea into transformative action. She teaches at Oxford University's Environmental Change Institute and is Professor of Practice at Amsterdam University of Applied Sciences.

Co-Keynote Session Wednesday 16th June



Speaker 2: Róisín Markham

Róisín Markham is the founder and network steward of the Irish Doughnut Economics Network (IDEN). A cultural thinker living with the question - How do we create a future worth living into? The Director of Innovation Services at BDT Consultancy. Róisín works in design strategy, service design and emergent systems change. A Scale Ireland advisor on sustainability as a core member of their working group. Joining Circuleire's Thematic Working Group later this month on Circular Design & Redesign. A visiting lecture on design thinking and rapid prototyping for the Cairnes School of Business and Economics, NUI Galway. And a recent visiting lecture in NCAD Product Design on digital facilitation praxis. Róisín blazed a trail through the localisation technology sector in the '90s. Ending her decade of accelerated learning as a HPSU COO and writing a global patent. She went on to develop an art studio and creative social research practice. Awarded an Irish Artist Tax Exemption in 2006. Her work has traversed business and enterprise, public sector and communities. Róisín lives with her family and two dogs near Cahore, Wexford. She is a steward to 9 oaks and creating a forest garden.

Thursday 17th June 2021

Public Keynote and Panel Discussion



**Chair: Environmental Research Institute
Conference Co-Convenor, Dr Jean O'Dwyer**

Dr Jean O'Dwyer is Deputy Head of Environmental Science in the School of Biological, Earth and Environmental Science at University College Cork and Head of Environmental Geoscience at the Irish Centre for Research in Applied Geoscience (iCrag). Jean has a Bachelor of Science in Environmental Science (2011) and a PhD in Environmental Health Science (2015) from the University of Limerick. Her research interests focus on the interaction between the natural environment and human health, with a particular emphasis on waterborne infectious disease and the impact of climate change on human health and wellbeing. Jean is a Principal Investigator in the Environmental Research Institute where she leads the Environment and Health Research Lab and is a Funded Investigator in the SFI Centre iCrag under the Earth System Change spoke.



Keynote Speaker: Prof. Paul Ekins

Paul Ekins has a Ph.D. in economics from the University of London and is Professor of Resources and Environmental Policy at the UCL Institute for Sustainable Resources at University College London. He also has extensive experience consulting for business, government and international organisations. Paul Ekins' academic work, published in numerous books, articles and scientific papers, focuses on the conditions and policies for achieving an environmentally sustainable economy. His book *Economic Growth and Environmental Sustainability: the Prospects for Green Growth* appeared in 2000. He was also a Member of the European Resource Efficiency Platform and Vice-Chair of the previous European Environment Commissioner's Expert Economists' Group on resource efficiency. He is a member of UNEP's International Resource Panel (IRP), and was the lead author of the IRP's report on resource efficiency commissioned by the G7 governments and presented in Japan in 2016. He was a Co-Chair of UNEP's sixth Global Environment Outlook (GEO-6), which was presented to the fourth United Nations Environment Assembly in Nairobi in March 2019. In 1994 Paul Ekins received a Global 500 Award from the United Nations Environment Programme. In the UK New Year's Honours List for 2015 he received an OBE for services to environmental policy.

Thursday 17th June 2021



Panellist: Denise Cahill

Denise Cahill is the Healthy Cities Coordinator for Cork City and Adjunct Lecturer in the School of Public Health in University College Cork. Denise has extensive knowledge, experience and understanding of health promotion, wellbeing and a commitment to the social determinants of health and the reduction of health inequalities. Denise graduated with a Degree in Sports & Exercise Science in 1998 and a Masters in Health Promotion in 1999. Denise has over 20 years of experience working in Public Health and Health Promotion in the Health Service in Ireland in a variety of roles including Public Health Research and Information Officer, Health Promoting Schools, Community Health, Physical Activity, Tobacco Control management, Health Promotion Training and now in the area of Healthy Cities. Denise has a strong and productive commitment to garnering productive Inter-Agency collaborations to promote public health and at present has a key role in a variety of health related Cork city based Inter-Agency projects and partnerships. Denise has a strong personal and professional interest and commitment to climate justice and environmental sustainability.



Panellist: Dr Ina Kelly

Dr Ina Kelly qualified in medicine in NUIG and trained in General Practice in Australia. On return to Ireland she became interested in public health medicine, did MPH and later Higher Specialist Training in Public Health Medicine, in Ireland and WHO Geneva. She works in the Midlands as a Consultant in Public Health Medicine. As Chair of the HSE Public Health Medicine Environment and Health Group (PHMEHG), she works towards protecting the Irish people's health from environmental hazards, and towards a wider involvement in health improvement through advocating and advising on a healthier environment. She has been interested in climate change and sustainability for several decades but her main work is in climate change adaptation. She has worked in this area with the Department of Health, DECC and other government departments, HSE, Royal College of Physicians of Ireland and is the health member on the Climate Change Advisory Council adaptation committee. Part of the public health medical role in climate action is to: develop a climate epidemiology function; advocate for Health in All Policies (HiAP); advise on the health impacts of climate change; and try to ensure we avoid maladaptation associated with unintended adverse health consequences from climate actions.

Thursday 17th June 2021

ESAI AGM



Guest Speaker: ESAI Postgraduate Researcher of the Year 2020: Sean O'Connor, IT Sligo

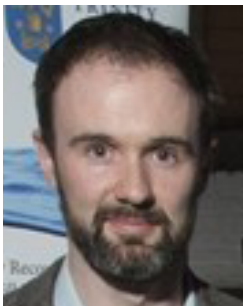
Seán O'Connor is a PhD Researcher funded by the EU INTERREG VI Renewable Engine Research Project at the Institute of Technology Sligo. His research involves collaborating with several public and private organisations to evaluate the current status of small-scale anaerobic digestion and to implement relevant improvement strategies and technologies. Seán's educational background includes a BEng (Hons) in Sustainable Energy Engineering from Cork Institute of Technology and an MBS in International Entrepreneurship Management from University of Limerick. His research interests include Environmental Science, Bioenergy, and Energy Engineering.

Environmental Quiz Night



Quiz Hosts: Dr Niamh Power & Dr John Gallagher

Dr. Niamh Power is a Lecturer in Civil, Structural & Environmental Engineering, in Munster Technological University. 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 MTU. She is involved with EU funded projects including Phos4You and ReNu2Farm. 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 the School of Engineering at Trinity College Dublin and Communications Officer for the ESAI. In addition to his role with the ESAI, his research explores the development of innovative solutions to current environmental, energy and engineering challenges, and adopting a circular economy approach in the life cycle of measurement, modelling and mitigation. Through his work he is currently an investigator on several National and European projects in areas of resources in the water, energy and building sectors.

Workshops @ Environ: Friday 18th June



Workshop

Workshop 2: Enriching Research and Curricula Through The U.N. Sustainable Development Goals (SDGs)

Workshop 2 Host: Dr John Barimo, UCC

Dr John Barimo is a Research Support Officer in the Centre for the Integration of Research, Teaching and Learning at University College Cork where he works directly with the Green Campus Programme. His current project is creating and curating digital resources and conducting faculty development workshops to support teaching staff with the integration of the U.N. Sustainable Development Goals into curricula across the UCC curricula. He holds a M.Sc. from Virginia Commonwealth University in Biology and Ph.D. from the University of Miami (USA) in Marine Biology & Fisheries. His previous academic post prior was Chair of Maths & Sciences at Miami Dade College (USA) where he had an active role in strategic planning and programme development. John's scientific research was centred around physiological ecology which interests in biotic interactions and environmental toxicology. His professional career spans academics, governmental agencies, nongovernmental organizations and private industry which includes civil service within the US National Marine Sanctuary Programme. John has also gained considerable experience working to provide educational opportunities within underserved communities and is an advocate of multicultural dialogue.

Workshops @ Environ: Friday 18th June



Workshop 2: Host: Dr Darren Reidy, UCC

Dr Darren Reidy is the Acting Sustainability Officer at University College Cork, Ireland, where he coordinates the delivery of the university's sustainability strategy across UCC operations, research, teaching and learning. Darren holds a PhD in Applied Ecology, a M.Sc in Ecological Assessment and a B.Sc. in Environmental & Earth System Sciences from University College Cork. Prior to taking on his current role at UCC, Darren worked for an NGO in the rural development sector and was the project scientist on an EU LIFE project, and a European Innovation Partnership both focussed on finding solutions to human-environment conflicts and promoting sustainable rural development in Ireland, through nature based solutions. Darren has particular interest in the role higher education can play in delivering the UN Sustainable Development Goals.



Workshop

Workshop 3: Collaborating For A More Sustainable Society – Enabling team science and inter/transdisciplinary research for sustainability

Workshop Host 3: Dr Paul Bolger, ERI

Dr Paul Bolger is manager of the Environmental Research Institute at University College Cork, Ireland. He has worked across academia, industry and government for over 20 years developing long term research solutions for global sustainability challenges. He is currently principal investigator on a number of research projects on climate change and the circular economy. Dr Bolger is an EPA 2019 Fulbright Scholar, as part of which he examined how interdisciplinary research is being facilitated at sustainability research institutes in Arizona State University, Cornell University, Colombia University and Duke University to achieve more robust research outcomes. Dr Bolger research interests are in how to utilise interdisciplinary and transdisciplinary (co-production) approaches to address complex environmental challenges, and in how broad academic knowledge across natural and social sciences, humanities, business and law can help society achieve sustainable development goals.

Workshop: Friday 18th June 2021

Workshop 3: Host: Connor McGookin, ERI



Connor McGookin has a primary research interest in the use of participatory methods in energy system modelling and planning. For the past four years, he has worked in a transdisciplinary team with researchers from energy engineering, sociology and community development in partnership with Ireland's electricity distribution system operator (ESB Networks) and local non-profit organisations supporting enterprise and community development on the Dingle Peninsula. The group operates under the working title 'Dingle Peninsula 2030' to explore, support and enable the broader societal changes required for the low carbon transition. A central component of this project has been his work to explore co-production strategies for meeting emissions reduction targets for 2030. This involves coordinating the research design and implementation with the transdisciplinary committee established, and widespread community consultations (including dedicated youth events and fifteen community meetings) to understand the concerns and priorities of residents. He is also an active member of the Imagining2050 and CRENCE projects.

Workshop 3: Host: Evan Boyle, ERI



Evan Boyle is currently undertaking his PhD in the Energy Policy and Modelling Group, supervised by Prof. Brian Ó Gallachoir and Dr. Gerard Mullally. The purpose of this research project is to analyse the multi-stakeholder approach to the socio-technical transition to a low-carbon society on the Dingle Peninsula. In the past, approaches to transitioning have been implemented as either top-down (government-led) or bottom-up (grassroots/community initiatives). Dingle Peninsula 2030 has the potential to be a unique blend of both approaches, through collaboration and co-creation between different individuals/ organisations, with each having different goals, expectations, and expertise. Using a participatory mapping approach, this research project maps the different individuals/ organisations involved in the Dingle 2030 project, to investigate how the multi-stakeholder network develops over time. On from this a reflective journal approach has been taken to investigate the collaborative approach to governance taken by the four partner organisations in the project. At a national level, this research is working alongside a range of public bodies to investigate current good practice for community engagement. Through engaged research, this piece of work seeks to understand how community engagement is currently implemented in the delivery of large infrastructure aligned with the climate action plan, and how this could be improved upon moving forward.

Friday 18th June 2021

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. Liam has co-authored a number of books including "The Worth of Water", "A Technology Portfolio of Nature Based Solutions for Innovations in Water Management" and "Where There Is No Engineer - Designing for Community Resilience". Liam is a Director of Engineers Without Borders Ireland and leads their Innovation Academy and Development Education programs.



Environ 2021 Environmental Research Institute Co-Convenor:
Dr Jean O'Dwyer

Dr Jean O'Dwyer is Deputy Head of Environmental Science in the School of Biological, Earth and Environmental Science at University College Cork and Head of Environmental Geoscience at the Irish Centre for Research in Applied Geoscience (iCRAG). Jean has a Bachelor of Science in Environmental Science (2011) and a PhD in Environmental Health Science (2015) from the University of Limerick. Her research interests focus on the interaction between the natural environment and human health, with a particular emphasis on waterborne infectious disease and the impact of climate change on human health and wellbeing. Jean is a Principal Investigator in the Environmental Research Institute where she leads the Environment and Health Research Lab and is a Funded Investigator in the SFI Centre iCRAG under the Earth System Change spoke.

Keynote Speakers



Energy 1

Prof Jerry Murphy, MaREI

Prof Jerry D Murphy is the Director of the MaREI centre for energy, climate and marine; MaREI has c. 250 researchers, 50 industry partners and has accumulated research funding of over €60M since inception in 2013. In 2017 Prof Murphy was awarded the Chair in Civil Engineering in UCC, only the 12th person to hold this post in 170 years. Prof Murphy represents Ireland at the International Energy Agency (IEA) Bioenergy since 2007. He was elected by his international peers to lead Task 37, (which includes for 19 countries at the cutting edge of biogas systems). In this role, he authored/edited 11 IEA Bioenergy reports, 14 case stories and chaired 6 International Symposia. Prof Murphy's expertise in circular economy advanced fuel systems is world leading. He has published over 160 peer review journal papers in high-impact journals. His h-Index (57) places him amongst the highest cited academics worldwide in the fields of biogas and anaerobic digestion. He is also ranked amongst the top 2% cited academics worldwide. He initiated UCC's collaboration with Zhejiang University (ranked in the top three Universities in China), was awarded the Engineers Ireland Excellence Award (2015) for best paper/presentation, The Marine Industry Award for Excellence in Marine Research (2017), an adjunct professorship in University of Southern Queensland (2018) a fellowship of the Irish Academy of Engineers in 2019 and in 2020 he was appointed as an international Expert to the advisory committee of DBFZ (German Bioenergy Research Centre).

Keynote Speakers



Biodiversity and Ecosystems 1 **Brian Gilmore, Cement Manufacturers Ireland**

Brian Gilmore has been in the cement industry for 14 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, which is essential for our modern way of life, the industry has much to offer in terms of resource recovery and the circular economy. The high temperature manufacturing process offers huge potential to provide long-term sustainable solutions for many of societies waste challenges. Prior to that Brian spent 11 years working in a hazardous waste management company innovating and problem solving for a diverse range of customers. The goal of our business was always to find the resource value in waste and establish viable recovery and recycling options for our clients. After his primary degree in Natural Sciences in Trinity he completed a two-year research project leading to an MSc and a published paper.



Circular Economy & Sustainable Waste Management **Prof Michael Morris, AMBER Centre**

Prof Michael Morris graduated with a PhD from Liverpool University in 1982. His PhD focused on the movement of atoms on surfaces to form ordered arrangements. After a post-doctoral fellowship at Imperial College in London he moved to Strathclyde University focusing on insitu surface reaction studies. Prof. Morris took an ICI endowed lectureship at Cardiff University before moving to ICI as where he was instrumental in the development of catalysts used to promote low temperature oxidation and reduce greenhouse emissions in turbines and combustion chambers. He was appointed to a post in Materials Chemistry at University College Cork in 1993 to develop materials science in the University. Prof. Morris moved to Trinity and the School of Chemistry in 2015 to lead the SFI funded research centre AMBER. His work has remained focused on self-assembly and phase separation in polymers and the use of polymer materials in modern society. As well as his long term interest in self-assembling systems, Prof. Morris has developed a keen interest in the circularity of modern plastic technologies and how the adverse effects of polymers can be avoided through proper use.. Prof. Morris has authored over 500 peer reviewed papers and more than 20 patents. Prof. Morris is a member of the ISO 323 Committee drafting standards for the transition to a circular economy.

Keynote Speakers



Marine & Coastal **Thomas Furey, Marine Institute**

Tommy Furey is the Marine Institute's Joint Programme Manager for INFOMAR, the Irish national seabed mapping programme, funded by the Department of Communications, Climate Action, and Environment, and delivered in partnership with Geological Survey Ireland. An earth scientist/geophysicist by background, having originally worked in 3D seismic, he now manages the Advanced Mapping Services team. He has a key role in supporting technology, innovation and product development associated with INFOMAR and its vast data resources, as well as in increasing the downstream use and application of the data. He is currently the EU Co-Chair of the Atlantic Seabed Mapping International Working Group setup in 2014 to contribute to implementation of the Galway Statement on Atlantic Ocean Cooperation. He coordinated the EMFF & NPWS funded SeaRover programme, a multi-year offshore reef habitat mapping assessment, and is currently coordinating an MI EMFF & Enterprise Ireland co-funded Small Business Innovation Research programme, focussed on satellite & airborne technology application for intertidal seaweed resource assessment. He also leads a seabed & habitat mapping work package in the 32 partner H2020 Mission Atlantic project, centred on Integrated Ecosystem Assessment.

Keynote Speakers



Energy 2 **Kerrie Sheehan**

Kerrie Sheehan has over 15 years' experience in research funding management, of which 8 years have been in the energy field. Kerrie is Head of Research and Technology Department in Sustainable Energy Authority of Ireland (SEAI). The Research & Technology Department coordinates SEAI's Research, Development and Demonstration funding programme, EU funded research and in-house technology experts, in areas such as offshore, wind, buildings and heat. Previous to starting with SEAI in 2017, Kerrie worked in UCD in for 12 years in various research management roles. Kerrie holds a BA in Mathematics and Geography, a Master's in Environmental Public Policy and is an FCCA accountant.



Environmental Geoscience **Dr Jean O'Dwyer, iCRAG**

Dr Jean O'Dwyer is Deputy Head of Environmental Science in the School of Biological, Earth and Environmental Science at University College Cork and Head of Environmental Geoscience at the Irish Centre for Research in Applied Geoscience (iCRAG). Jean has a Bachelor of Science in Environmental Science (2011) and a PhD in Environmental Health Science (2015) from the University of Limerick. Her research interests focus on the interaction between the natural environment and human health, with a particular emphasis on waterborne infectious disease and the impact of climate change on human health and wellbeing. Jean is a Principal Investigator in the Environmental Research Institute where she leads the Environment and Health Research Lab and is a Funded Investigator in the SFI Centre iCRAG under the Earth System Change spoke.

Keynote Speakers



Netpunus Interreg Project Sustainable Seafood Prof Neil Rowan, AIT

Prof Neil Rowan is Director of the Bioscience Research Institute at AIT since 2012. He was a Senior Lectureship at Strathclyde University, Glasgow, Scotland (RAE 5*), where he co-founded Strathclyde's Roberston Institute for Electronic Sterilisation Technologies. He has spent 3 decades in academia developing sustaining and disruptive technologies with a particular focus on advancing biotechnology for food, health and environmental applications. He has supervised 24 PhDs, 18 MSc by Research and mentored 17 Postdoctoral Researchers. Neil has published extensively (Scopus h factor 38, ca. 5,000 citations) that highlights converging collaborative research that crosscuts priority themes to generate solutions to complex societal challenges. He holds Professional Fellowships to Institute of Food Science and Technology (UK, Ireland) and Editorial Board member of Science of the Total Environment. He is Guest Editor of Current Opinion in Environmental Science and Health on 'Disruptive Green Deal Innovations'. He was appointed Adjunct Professor School of Medicine (NUI Galway); holds Honorary Professorship to University Kwa-Zulu Natal (South Africa), and Professorial Chair Evaluator for University Malaya (Malaysia). He is Funded Investigator at SFI-funded CURAM Medical Device Centre. He evaluates for Horizon Europe under Future Emerging Technologies; 'Neil J Rowan' is recognised as Google Knowledge Panel. Neil is extensively-funded under Interreg, Horizon 2020, Cost actions and MSCA with SMEs.

nviron 2021

AN APPROVED EVENT FOR CONTINUOUS PROFESSIONAL DEVELOPMENT



ESAI Student Competition 2021

The ESAI will be judging all student oral and poster presentations for consideration in this year's student competition. This year the ESAI will be including post-doctoral researchers for the first time for consideration for the new **Best Post-Doctoral Presentation at Environ**. All winners will be invited to submit an article on their research project to the ESAI Website and the ESAI E-Zine 'Environews'. Results will be announced at the prize-giving ceremony at the close of conference at 16:30, Friday 18th June. Best of luck to everyone!

The prizes and categories this year are:

- **ESAI Best Oral Presentation (€500)** sponsored by Environmental Sciences Association of Ireland
- **ESAI Best Poster Presentation (€250)** sponsored by Environmental Sciences Association of Ireland
- **Best Postdoctoral Presentation (€250)** sponsored by Environmental Research Institute
- **Best Environmental Geoscience Presentation (€250)** sponsored by Geological Survey of Ireland
- **Best Social Engagement Presentation (€250)** sponsored by Environmental Services Ireland
- **Best Ecology Presentation (€250)** sponsored by the Chartered Institute for Ecology and Environmental Management (CIEEM)
- **Best Water Related Presentation (€250)** sponsored by the Chartered Institution for Water and Environmental Management (CIWEM)
- **Best Waste and Resources Management Presentation (€250 and 12 months student membership to CIWM)** sponsored by the Chartered Institution of Wastes Management (CIWM)
- **Best Natural History Presentation (€250 & a 12 month subscription to the Irish Naturalist's Journal)** sponsored by the Irish Naturalist's Journal (INJ)
- **Best Analytical Chemistry Poster Presentation (€250)** sponsored by Eurachem Ireland
- **Richard Fitzgerald Poster Prize for Best Aquatic Environment Presentation (€250)** sponsored by AquaTT

Dr. Richard D. Fitzgerald



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

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

nviron 2021



University College Cork

June 16th – 18th 2021

Healthy Planet, Healthy Communities
31st Irish Environmental Research Colloquium

ORAL PRESENTATION ABSTRACTS

**Challenges towards integration of bubble column and photobioreactor
for a continuous photosynthetic biogas upgrading**Archishman Bose¹, Richard O'Shea¹, Richen Lin¹, Jerry Murphy¹¹MaREI Centre, Environmental Research Institute, University College Cork, Cork

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Photosynthetic biogas upgrading is postulated as a means of increasing both the environmental and economic sustainability of biomethane by co-producing it with high value microalgal bioproducts. In this two-step process, a bubble column reactor is utilised for absorbing CO₂ from biogas, upgrading it to biomethane. Correspondingly, carbonate is converted into bicarbonate leading to a decrease in the pH of the circulating algal medium. The absorbed carbon in the form of bicarbonates can then be used in the connected photobioreactor to produce microalgae for direct use or for extraction of high value products. In this process carbonate is regenerated back from bicarbonate which in turn increases the pH of the solution enabling a cyclical operation. To ensure a continuous cycle without the need to add external carbonate or bicarbonate, the carbon added in the bubble column from the biogas should not only satisfy the carbon uptake by the microalgae, but also make up for the carbon lost during microalgae cultivation and harvesting by stripping and through effluents respectively.

To evaluate this process, primary lab scale experiments undertaken revealed that a significant carbon loss occurs through stripping at pH levels below 9. In such conditions, a higher alkalinity induces a higher carbon loss. To ensure operations of photosynthetic biogas upgrading with a minimum carbon loss a higher pH and a lower alkalinity would be beneficial. This can be achieved by carefully selecting the operational pH and alkalinity of the medium as well as a higher liquid flow rate relative to the gas flow rate (L/G ratio) in the bubble column. However, such conditions also result in enhanced oxygen stripping from the microalgal solution into the upgraded biomethane making it unsuitable for gas grid injection purposes.

Further research work in optimising the combined system is necessary to establish practical operation of photosynthetic biogas upgrading, to ensure sustainability of scaled up commercial processes.

Integrating sensitivity and uncertainty analysis in the development of Marginal Abatement Cost Curves (MACC) for anaerobic digestion systems in Ireland

Jorge Diaz Huerta¹, Richard O'Shea¹, David Wall¹, Jerry Murphy¹

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Techno-economic assessments (TEAs) are used to review the potential technical and financial performance and the overall feasibility of projects in the energy generation area. Such TEA analysis can be coupled with a Life-Cycle Assessment (LCA) to compare and analyze the impact of different technologies or methodologies on the environment in terms of carbon abatement. Combining the net present value and abatement potential a Marginal Abatement Cost Curve (MACC) can be generated to compare the economic mitigation potential of different technologies based on the cost-effectiveness (CE) or cost-benefit they provide. However, depending on the system boundary used in the development of a MACC, it may not capture either the entire costs of the process or wider benefits of carbon abatement that a process or technology is providing. In Ireland, iterations of the Greenhouse Gas (GHG) MACC have been created for the Irish agricultural sector with the purpose of developing policies to reduce GHG emissions. The analysis included for the use of Anaerobic Digestion (AD) technologies for on-farm renewable energy production in the form of biogas and biomethane. This study aims to provide a better understanding of how a more holistic methodology to calculate a MACC could be accounted for by including the analysis of different boundary scenarios of on-farm anaerobic digestion and the benefits it provides. This can be achieved with the creation of a TEA tool that can assess the techno-economic performance of on-farm AD systems in Ireland at a range of different scales and using different feedstock that can account for alteration in the process. The TEA tool will be coupled with a LCA allowing for a more detailed assessment of the main cost drivers and the abatement the process provides. The results of the TEA, coupled with a sensitivity analysis, can potentially highlight the key variables affecting the techno-economic performance of farm scale AD plants, and once these are identified a uncertainty analysis such as a Monte Carlo Simulation can be carried out to assess potential outcomes on the impact of the TEA and LCA to construct a more representative MACC based on the most probable scenarios.

A low energy demand pathway for IrelandAnkita Gaur¹, Hannah Daly¹¹MaREI Centre, Environmental Research Institute, University College Cork, Cork

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Limiting global warming would require major reductions in GHG emissions in all energy-intensive sectors via various technological and social transformations. Energy efficiency improvements and technological innovations can drive the future reductions in emissions. These are supply side options which can have a possible rebound effect due to strong coupling between economic growth and energy use. Hence, exploring a pathway that ensures economic development and well-being are maintained while energy consumption is reduced is becoming increasingly important. This encompasses demand side options such as reducing consumption of energy intensive products through changes in settlement pattern and lifestyle, shortening and decarbonising the supply chain and more. In this study, we present a low-energy demand pathway for Ireland and its possible implications using the TIMES-Ireland model, which is an energy system optimisation model widely used for exploring mitigation pathways and policy implications. The low-energy demand scenario is designed around assumptions regarding settlement patterns, shift to public transport and active modes such as walking and cycling, dematerialisation of the economy, lower energy demand in residential sector among others. Preliminary analysis shows that reducing energy consumption not only helps in achieving the decarbonisation goals but also reduces the total system costs.

Energy 1

A perspective on advanced fuels production by integrating biological, thermo-chemical and power to gas technologies in a circular cascading bio-based systemBenteng Wu¹, Richen Lin¹, Richard O'Shea¹, Chen Deng¹, Jerry Murphy¹¹MaREI Centre, Environmental Research Institute, University College Cork, Cork

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In the transition to a sustainable energy future, producing green gas (such as biomethane) and bio-based valorised products (such as pyrochar) may offer a solution to a decarbonised energy system. Although current bioenergy technologies including biological, thermochemical, and power to gas (P2G) systems present promising potentials for implementing green gas, each technology still faces significant challenges with respect to their sustainability and conversion efficiency. The sustainable pathway leading to a decarbonised bioenergy system is yet to be defined. To address this issue, this paper provides a state-of-the-art review of existing bioenergy technologies, and further propose a circular cascading bio-based system with anaerobic digestion (AD) as the key platform, incorporating the production of electrofuels via P2G and value-added pyrochar via pyrolysis of solid digestate. The produced high-quality pyrochar can be applied in both AD and biological P2G systems to facilitate microbial interactions, allowing for improved biogas production and upgrading to advanced biomethane as a final product. The sustainability of the circular cascading system associated with systematic mass and energy balance is assessed in three scenarios depending on the origin of hydrogen from P2G. The carbon footprint of the electricity from which the hydrogen is sourced is shown to be a critical parameter in determining the greenhouse gas emission balance of the bespoke system. The output of this paper offers a solution to a potential bioenergy system towards a decarbonised energy future.

**Coupling decentralised biomass with large energy users
and optimising the operational logistics of on-farm AD in Ireland**Dónal Ó Céileachair¹¹MaREI Centre, Environmental Research Institute, University College Cork, Cork

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Developing economic solutions to on-farm anaerobic digestion will be essential to the success of Ireland's renewable gas industry. Alternatives to gas grid injection must be found for renewable gas generated from decentralised biomass located away from existing natural gas grid infrastructure. This concept is of utmost importance to regions looking to exploit their full potential for renewable gas production but where gas grid coverage may be limited or unavailable. Methodologies were developed to determine the location and biomethane potential of on-farm biomass feedstocks and also the amount of this biomass which is situated away from existing gas grid infrastructure. Rural farming regions are often considered decentralised but have suitable biomass that can be used for biomethane production. Ireland has a nascent biomethane industry, and many areas have no local access to the national gas grid, leaving a logistical challenge in utilising suitable biomass resources for biomethane situated away from the grid. The development of decentralised systems which can be integrated with large industry in such locations offers a potential alternative deployment opportunity. The location and biomethane potential of on-farm feedstocks in Ireland was determined using the most recent spatially explicit data. The total biomethane resource from all on-farm feedstocks was estimated at 67 PJ or 61.5% of energy use in industry in 2018. In terms of natural gas usage, the resource equated to more than 200% of industrial gas use, or 82.1% of total natural gas final energy consumption. GIS maps were then developed to show the quantity of each on-farm feedstock in different regions of Ireland and their distance from the existing gas network. The total decentralised biomass resource, and its proximity to large energy users, was then assessed. It was found that 17% of the on-farm biomethane resource, though beyond 15km from the grid, was within a 15km radius of a large energy user. Coupling decentralised biomass with large industry energy users can potentially maximise the dissemination of renewable gas use. Further methodologies were developed to assess multiple scenarios concerning the logistical operations of on-farm AD plants in Ireland. Within this analysis, the seasonality of grass silage and slurry production, the seasonality of energy demands in different industry sectors, and the end use of biomethane will be addressed to accurately model the logistics of on-farm AD systems in Ireland.

Environment and Health 1

Asthma prevalence and COVID-19 severity based on geographic location in the Republic of IrelandMartin Boudou¹, Jean O'Dwyer², Coilin OhAiseadha³, Paul Hynds¹¹Technological University Dublin²University College Cork,³Health Service Executive

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Recent figures suggest that approximately one eighth of the total population of the Republic of Ireland have been diagnosed with asthma, equating to the fourth highest global prevalence rate. Poor air quality due to high particulate matter (PM_{2.5}, PM₁₀) and pollen concentrations have been identified as the drivers for the high number of asthma sufferers, in concurrence with myriad environmental (e.g., temperate climate) and socio-demographic (e.g., smoking) factors. Several recent studies indicate that moderate/severe asthma is associated with more severe COVID-19 outcomes. The current analysis investigates the link between chronic asthma and the three primary COVID-19 outcomes, namely hospitalisation, ICU and mortality, within the context of patient location (rural, urban and commuter zones) in the Republic of Ireland.

Irreversibly anonymised, laboratory-confirmed cases of symptomatic COVID-19 occurring between 29th February and 30th November 2020 were obtained from the Health Protection Surveillance Centre (n=47,265). A majority (71.9%) of cases resided in urban areas (n= 33,950), while commuter and rural areas accounted for 15.6% (n=5976) and 12.7% of symptomatic cases (n=7399), respectively. A series of prognostic models were developed to identify the main factors of COVID-19 severity using generalised linear modelling (GLM) and recursive decision trees. Bivariate analyses were employed to investigate the specific burden of chronic asthma on COVID-19 severity within each geographic subset.

Generalised linear modelling identified asthma as one of the main factors (along with severe obesity) explaining all three categories of COVID-19 severity. The impact of asthma was most predictive for ICU admission (OR 7.467; CI 6.592-8.841), followed by hospitalisation (OR 4.504; CI 3.906-5.210) and mortality (OR: 1.676; CI 1.362-2.071). Similarly, asthma was reported within the final decision trees for both hospitalisation and ICU. Bivariate analyses on geographic regions revealed that the impact of asthma was particularly pronounced in urban areas. Asthma among patients in urban and rural areas was 7 (p<0.001; OR: 6.7754; CI: 5.3665- 8.5213) and 5 (p<0.001; OR: 5.256; CI: 3.428-7.948) times more likely to result in hospitalisation. While the percentage of asthma sufferers among all symptomatic cases in rural areas (1.5%) was greater than in urban and commuter areas (1%), results suggest that this condition is associated with more severe outcomes in urban areas. This specific finding highlights the potential importance of environmental factors on COVID-19 severity especially in urban areas characterised by high particulate matter concentrations due to vehicular traffic and higher population exposure (person to person transmission).

**Engaging with Nature during the Covid-19 Pandemic:
A European Perspective based on a Pan-European survey approach**

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The physical and mental health benefits of nature are increasingly supported by robust scientific evidence (Bratman et al., 2019, Donnelly and MacIntyre, 2019). Nature connectedness and one's proximity to nature has been proven to be beneficial when socially isolated (Cartwright et al., 2018). Despite this evidence, during the planning of protective measures against the coronavirus pandemic, nature and its mental health benefits seems to have fallen to the background of the discussions. The WHO (2017) recommends that all individuals have easy access to at least two hectares of green space no further than 300m (a five-minute walk) from their home. This is not the case for many residents of urban area. Access to green space was made increasingly challenging during the pandemic due to restrictions on travel. In Ireland the implementation of the 2km travel restriction made accessing natural space impossible for a significant portion of the population. A citizen survey conducted on the Irish population suggests that individuals wanted the removal of the travel restrictions to take part in activities other than socialising (OneCore, 2020), such as access to nature. A collaboration between Horizon2020 projects: Renature and GoGreenRoutes, saw the development of a Pan-European city survey. The survey sets out to examine the natural space habits of urban citizens before, during and after the lockdown measures, with a focus on the Maltese Archipelago and Limerick City. Measures such as WHO-5 for wellbeing (WHO, 1998), NR-6 to measure nature connectedness (Nisbet et al., 2013) and questions based off of the European Commission's Eurobarometer surveys were used to measure nature usage and biodiversity preferences. Consistent with contemporary research from North America, the United Kingdom, Europe and Australia, nature proved to be a means of socialising for many, while for others it was a way to "escape" their home environment and "get breathing space" during the pandemic. Much is still unknown of the long-term effects of the pandemic, yet it is understood that the quality of green space has improved with a reduction in noise pollution and greater soundscape suggesting the benefit of spending time in natural spaces being amplified. Likewise, it is yet to be determined if the lockdown scenarios all over the world gave us a window into a carbon neutral world. All that is certain is the inequalities in high quality green spaces must be considered for the implementations of lockdown restrictions and beyond.

Co-designing solutions to protect our recreational water quality: The PIER PerspectiveSinead Duane¹, Maeve Louise Farrell², Christine Domegan³, Liam Burke², Dearbháile Morris²¹Ryan Institute, NUI Galway²Antimicrobial Resistance and Microbial Ecology Group,
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Recreational water environments are essential for promoting health however, there can be risks associated with their usage due to complexities surrounding protecting water quality. In the past, legislation and policy reform have played a significant role in improving recreational water quality. However, as the environmental pressures impacting recreational water ecosystems evolve and intensify, the adoption of integrated, and cross-sectoral approaches is vital. Activities that bring multiple stakeholders to the table, have been heralded as effective. PIER (Public Health Impact of Exposure to Antimicrobial Resistance in Recreational water) applies a holistic 'systems thinking' methodology to better understand the barriers and facilitators to improving recreational water quality from a multi-stakeholder perspective. Systems or ecosystems comprise people, institutions and resources, and their interactions. Systems are dynamic and are constantly adapting to change. 'Systems' thinking promotes inclusion and collective action by all stakeholders across levels within a system (micro – the individual, meso- community engagement and macro- policy reform) and between the sectors present within that system. Stakeholder identification and engagement is therefore central to this approach. Each stakeholder represents different sets of values, relationships and perspectives within a system. In the context of recreational water every citizen has the potential to be a stakeholder in this issue. This session presents the methods and findings from the formative qualitative research phase which was undertaken in preparation for a national stakeholder survey and systems mapping workshop as part of PIER. The aim of the formative research is to identify the key features of the recreational water quality system. Firstly, a stakeholder analysis was undertaken to identify and classify the stakeholders (incumbents, challengers or regulating agencies), secondly, fifteen qualitative in-depth interviews were conducted with stakeholders across the recreational water system. Sectors that contributed to this research included; public health, agriculture, environmental protection, public sector and non- governmental agencies. Findings suggest that poor water quality is a recognized issue and that the majority of stakeholders are conscious of how their actions can impact on water quality. A more strategic coordinated approach across all levels of the system- from water users to community groups to legislators is required for sustainable change to manifest. There is an opportunity for stakeholders from across the recreational water system to co-design innovative solutions so that integrated multi-stakeholder approaches to strategy development is embraced. This research reports the methodology and the main findings from the first step in the systems mapping process.

**Development of lab-on-a-chip detection system for environmental monitoring
of Polychlorinated Biphenyls (PCBs) in soil**Samia Alsefri¹, Eric Moore²

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Polychlorinated biphenyls (PCBs) are a highly toxic family of synthetic chemical compounds. PCBs widely spread in the environment and their toxicity induces serious damage to living organisms and cause cancer and therefore, developing device for detection PCBs in environment is significant. 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. Also, an electrochemical immunosensor for the determination of Aroclor 1254 was fabricated by immobilizing Polyclonal primary anti-PCB antibodies onto a screen-printed gold electrode that was modified with 11-mercaptopundecanoic acid by N-(3-dimethylaminopropyl)-N'-ethyl carbodiimide hydrochloride/N-hydroxy succinimide cross-linking. cyclic voltammetry and linear sweep voltammetry were used for optimizing the assay. 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 it will use the Impedance Spectroscopy (EIS). The outcome of this project will provide a portable device for PCBs detection in soil, also the result will integrate immunoassay techniques in a lab-on-a-chip application for high specificity and sensitivity.

**The influence of various starches on the physico-chemical properties
and water solubility of thermoset bioplastics**Jade Stanley¹, Adriana Cunha Neves¹, David Culliton², Jonay Sancho³¹Department of Science and Health, Institute of Technology Carlow,
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Plastics have seen a considerable rise in use over the past few years all over the world. Single-use plastics are made from non-renewable materials and are seldom recyclable. They end up in landfills or our ecosystems, posing a threat to both animal and human health. Different bioplastics, such as starch-protein blend thermoset bioplastics (SPBB), have recently been developed to replace single-use plastics. SPBBs currently on the market use non-sustainable starches like potato, which compete with food processing. They lack the physico-chemical properties to be viable alternatives to the plastics currently in use. As a result, other starches like Swamp Taro and Sago should be researched as a long-term bioplastic source. To assess how mechanical properties of generated SPBBs change when different starches are used in their formulation. According to preliminary findings, all starches have identical profiles with differences in the 1,400-1,600 cm⁻¹ spectrum. Colour tests revealed that Swamp Taro and Sago starches developed darker bioplastics with more red tones than other starches such as Cassava and Wheat, which produced bioplastics with whiter tones. The roughness test also revealed that Swamp Taro and Potato starches produced significantly rougher SPBBs than Sago and Tapioca starches, which produced significantly smoother SPBBs. Water solubility tests revealed that the potato bioplastic was the first to begin breaking down in a stream, while Kuzu was seen to be the last to break down. Finally, results show that the starches studied have the potential to be used as raw materials in the production of SPBBs in a variety of applications. More research is needed to determine what other bioplastics properties are altered by adding these starches into the formulation of the SPBBs.

Biodiversity & Ecosystems 1**Management of the invasive Nuttall's pondweed (*Elodea nuttallii*) using jute matting in Lough Arrow, a Natura 2000 designated lake in Western Ireland**

Darren Garland¹, William Earle², Joe Caffrey², Nicolas Touzet¹, Sara Meehan¹, Frances Lucy¹

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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 (EU) Habitats Directive (92/43/EEC). Lough Arrow, a CANN project site is a designated SAC, containing a representative example of the Annex I habitat Hard oligo-mesotrophic waters with benthic vegetation of *Chara* spp. The Lough's primary features of interest are charophytes, benthic macroalgae that form dense perennial beds under favourable lake conditions. *Elodea nuttallii*, a canopy forming invasive macrophyte indigenous to N. America, is a recent arrival to the lake, and identified as a driver of habitat degradation under the Lough's most recent Article 17 conservation condition assessment due to negative impacts on the indigenous charophytes. The aim of this research was to trial a control mechanism for *Elodea nuttallii* that simultaneously promotes the rehabilitation of native charophytes. Jute matting, a biodegradable geotextile, which acts as a benthic barrier that excludes light inhibiting plant growth, was selected for treatment due to its previously proven capacity to permit charophyte regeneration in other lakes. Two experimental areas covering 800 m² were treated by covering the invasive weed and substrate with jute textile, using a single and double layer respectively. The trial was successful in controlling *E. nuttalli* for both single (P=0) and double layer treatments (P=0.002). Treatments resulted in a reduction of the mean percentage cover of the invasive plant by >60% for both treatments. Post-treatment mean percentage cover of *E. nuttallii* did not exceed 6% for either treatment. Furthermore, the mean percentage cover of indigenous charophytes present pre-treatment was not significantly impacted due to the application of jute in either the single (P=0.165) or double treatment (P=0.353). The treated transects were placed in close proximity to the bay's pier and slipway and marked with navigational buoys to provide a biosecurity corridor for boats entering and exiting the lake.

Biodiversity & Ecosystems 1**Rodenticide resistance in rat and mouse populations in Ireland**

Anthony Murphy¹, David O'Neill¹, Andrew Harrington¹, Conor F. McGee², Catherine O'Reilly², Gerard Kelly³, Dermot Sheridan³, Alan Byrne⁴, Colm Moore⁵, Bernard Hannon⁶, Denise O'Meara¹.

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Brown rats (*Rattus norvegicus*) and house mice (*Mus musculus*) harbour pathogens that can crossover to humans and cause serious illnesses. Rodents also consume foodstuffs and create further spoilage with their droppings and hair. The prevailing method of control is application of anti-coagulant rodenticides, but rodents are evolving genetic resistance in an ongoing arms-race. Anticoagulant rodenticides work by preventing an enzyme co-factor (vitamin K reductase, VKOR) from reducing vitamin K epoxide to Vitamin K. A deficiency of Vitamin K prevents blood from clotting and leads to death. The genetic basis for resistance are specific single nucleotide polymorphisms (SNPs) in the *Vkorc1* gene. The aim of this study is to determine the prevalence of genetic resistance associated with rodenticides in Irish rodents. A national survey involving the collection of rodent tails from locations across Ireland is being conducted, in collaboration with the Campaign for Responsible Rodenticide Use (CRRU). Polymerase Chain Reaction (PCR) and DNA sequencing are being used to generate DNA sequences of the *Vkorc1* gene, and comparisons subsequently made with reference sequences to reveal if the individual contains SNPs associated with resistance. The results of this survey will be used to inform the national evaluation of rodenticides, as required by S.I. 427 of 2013 – European Union (Biocidal Products) Regulations. If resistance is shown to be endemic in Ireland, restrictions on the use of highly potent resistance-breaking rodenticides may be lifted. Ineffective rodenticides can also be identified and delicensed, thereby reducing the risk of secondary poisoning to birds of prey and other predators.

The study will also design real-time polymerase chain (PCR) assays that work on faecal samples, a more efficient method of conducting large-scale surveys. The genetic diversity of populations will be assessed using mitochondrial DNA, giving insight into the colonisation history of these rodents.

Lake-dwelling freshwater pearl mussels (*Margaritifera margaritifera*) - A unique Irish phenomenon?

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The freshwater pearl mussel *Margaritifera margaritifera* L. is critically endangered throughout its range. Direct pressure from pearl fishing and indirect pressures from river pollution and physical modification, has caused a steep decline in almost all populations, leading to extinctions in some countries. The optimal habitat for pearl mussels is almost universally described as well-oxygenated, fast-flowing oligotrophic rivers and streams. Although adults can tolerate a range of habitat conditions, juvenile mussels require extremely clean waters with little or no anthropogenic impacts. Very few if any rivers currently support self-sustaining pearl mussel populations in Ireland due to poor juvenile recruitment. We report here the discovery of a large population of freshwater pearl mussels living at between 1m and 8m depth in an oligotrophic lake in southwest Ireland. Within the lake, pearl mussels were found in two contrasting habitats – a relatively shallow (ca 1m) stretch of lake littoral, and a more extensive benthic area of 2-8m depth. The maximum depth at which a living pearl mussel was found was 9m – to our knowledge the greatest depth yet described for this species. We estimate that the population of *M. margaritifera* in the lake is between 150,000-200,000 individuals. This constitutes a significant proportion of the known pearl mussel population in Ireland. We observed occasional juveniles (ca 1cm length) within the population, indicating that at least some juvenile recruitment is occurring. Our discovery of Irish lake-dwelling freshwater pearl mussels challenges our current understanding of the biology of *M. margaritifera*, and suggests that Ireland may represent a unique and special part of its worldwide range.

Biodiversity & Ecosystems 1

Impact of the landscape on pollinator communities in Europe

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The habitats that are heterogeneous in both their composition (i.e. land use, diversity of habitat types) and their configuration (i.e. spatial arrangement of the lands and their boundaries) are likely to support pollinators' diversity, richness and abundance. On the contrary, the degradation of the habitats is correlated to phenomenon, such as habitat loss and fragmentation, that seem to negatively affect pollinator insect communities. Despite these general trends, pollinator communities respond to the habitats in different ways, depending on many factors (for example taxa, landscape characteristics and scale, weather and climate conditions). Since agricultural landscape in Europe constitutes around 39% of the land cover, it might impact the heterogeneity of the habitat with consequences on pollinators. In this context, the landscape surrounding the cultivated crops can play a role in supporting or hazarding insect communities.

Our study investigates the habitat surrounding mass-flowering crops and aims to evaluate the impact of both compositional and configuration characteristics of the landscape on the abundance of some pollinator taxa.

To investigate this, we collected data on the abundance of five insect pollinator groups (honey bees, bumble bees, solitary bees, syrphids and butterflies) in oilseed rape crops and apple orchards distributed across 8 European countries, characterised by different habitats. We mapped the landscape surrounding each one of the 128 sites (at a 1 km radius), and we collected information about several compositional and configurational aspects, such for example the area and the diversity of the different habitats or the number of patches and their aggregation and isolation.

Our preliminary results show that pollinators respond to the habitat with taxon-specific responses, and suggest a combined effect of both the composition and the configuration aspects of the landscape in shaping insect pollinator communities.

Biodiversity & Ecosystems 1**What, where, and how much: the status of invasive marine macroalgae in Ireland**Marianela Zanolla¹, Dagmar Stengel¹¹National University of Ireland Galway

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This study fills in a knowledge gap in the situation of often-overlooked invasive organisms in Ireland: marine macroalgae (seaweeds). By combining a range of different surveying approaches, such as snorkelling, SCUBA diving and intertidal scavenging, this project aims to provide a updated checklist of seaweed invaders in Ireland. Based on recent observations of space utilisation by invaders and native species, several biodiversity indexes have been calculated for 3 notorious invaders: *Sargassum muticum*, *Colpomenia peregrina* (Ochrophyta, Phaeophyceae), *Codium fragile* (Chlorophyta) and *Asparagopsis armata* (Rhodophyta). Where possible, abundances of each invasive species were estimated using transects. Our results suggest a retraction in the distribution of *Sargassum muticum*, but an expansion of *Codium fragile* and *Colpomenia peregrina*. Additionally, invaded native seaweed communities were characterized. *S. muticum*, at present, appears to be the most impactful invasive seaweed species in Ireland. Large quantities of *S. muticum* biomass impede on growth of native seaweed species, though its impact on micro- and macro-fauna remains to be determined. To date, results indicate that in Ireland *C. fragile* is expanding its distribution south-towards. Regarding *C. peregrina*, individuals found at Galway, Cork and Dublin counties, indicate a wide distribution along the Irish coast and an expansion in eastern and south – eastern regions. Interestingly, *A. armata* seems to have been largely displaced to the subtidal since only tetrasporophytes were detected in intertidal survey. Low evenness values in general indicate that, where settled, these invasive species are modifying native communities in Ireland.

**Redefining wasted nutrients as a resource in coastal systems
with aquaculture using national monitoring data**

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Increasing anthropogenic pressures on coastal systems mean it is vital to understand and forecast biogeochemical dynamics along the land-ocean continuum. In particular, where bivalve aquaculture is practiced, changes to local biogeochemical budgets such as nutrient enrichment can impact its economic viability, harming local communities.

Collecting the required physicochemical data to assess these biogeochemical dynamics over useful timescales can be challenging. However, abundant data exists in national governments' environmental monitoring programmes. By using this resource to construct mass balance models (MBM), we explore the likelihood of dissolved inorganic nitrogen (DIN) being exported from areas of restricted exchange to the open ocean, and estimate the magnitude of this flux in selected Irish coastal system. Impacts of future changes in local biogeochemical budgets, caused for example by changes in the composition and magnitude of watershed inputs, can then be forecasted.

Here, we present our analysis of systems where aquaculture is a key economic activity. We quantify DIN that is exported to the open ocean and show how aquaculture yields could be increased using integrated multitrophic aquaculture. We discuss the usefulness of collecting extant data versus the creation of new data through dedicated field campaigns. We also evaluate the quality of the analysis by contrasting the outcomes of models created using extant data with those using new data created for that specific purpose.

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Establishing a seasonal pCO₂ baseline in Irish coastal waters using underway pCO₂ data from 2020Aedin McAleer¹, Rachel Cave¹, Sheena Fennell¹¹National University of Ireland Galway

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CO₂ uptake and cycling has been widely studied in the open ocean but are less well understood in coastal and shelf waters. Approximately 30 % of all anthropogenic CO₂ is found in the oceans at depths < 200 m. The extensive shelf seas surrounding Ireland, mostly < 200 m depth, have the potential to act as both a source and sink of CO₂ at different seasons. This study shows for the first time the changes from source to sink of CO₂ over a year (2020) around the Irish coast, providing a baseline for future research. An autonomous underway pCO₂ system was installed on the RV Celtic Voyager. pCO₂ in seawater was sampled every 2.5 minutes for 4 hours at 3 m depth using an infrared gas analyser (LICOR 7000), followed by a standardisation of 5 calibrated gases. It then measured 10 atmospheric pCO₂ samples from an intake on the vessel's top deck. Four study areas are considered here - West/Southwest, South, East and North. In winter the West/Southwest and South coast had greater fCO₂ in the surface water (410-550 µatm) than in the atmosphere (~ 405 µatm) thus acted as a source of CO₂ to the atmosphere. The East and North coast surface water fCO₂, (370-405 µatm), was less than the atmospheric pCO₂ (~ 410 µatm) therefore acting as a sink of CO₂. In spring the West/Southwest and South coast surface fCO₂ were in equilibrium with the atmosphere (~ 410 µatm) except for a small area acting as a sink (380 µatm.) The North and East coast continued to be a sink of CO₂. In summer the West/Southwest coast switched to a sink of CO₂. The South coast was switching between source/sink. The East coast became a source (surface water fCO₂ > 470 µatm). Data were unavailable for the North coast in summer 2020. In autumn the West/Southwest coast surface fCO₂ was once again in equilibrium with the atmosphere (~ 410 µatm). The South and East coast surface fCO₂ (~ 400-475 µatm) was greater than the atmosphere (~ 395-410 µatm). The North coast was a sink by the coastline (~ 350 µatm) but a source further to the North East (~ 420 µatm). This study shows how highly variable the Irish coastal waters are throughout a year and therefore why it is important to create a baseline for these changes as they are relevant to Ireland's 'Blue carbon' inventory.

**Natural variation in pH in contrasting coastal sites on the west coast of Ireland
– implications for adaption and mitigation**Rachel Cave¹, Aedin McAleer¹, Sheena Fennell¹, Dagmar Stengel¹, Janina Buescher¹¹National University of Ireland Galway

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Global ocean biogeochemical changes related to the ocean uptake of anthropogenic CO₂ are expected to have significant impacts on marine biogeochemistry and ecosystem services in coastal waters. Coastal marine ecosystems are and will be exposed to combined impacts of global warming and acidification, in addition to the effects of local drivers such as fresh water and nutrient inputs. Northward migration of more warm-water and opportunistic species is already being seen in Irish waters, but ocean acidification effects are as yet unquantified. Understanding and predicting the impacts of changes in pH and temperature in regional seas and coastal waters is essential for developing strategies for adaptation and mitigation. An objective of the VOCAB project is to determine the natural variability in pH in different Irish coastal water settings, and to compare it with Irish shelf waters and global ocean projections. pH controls calcium carbonate saturation, key for shell formation, and affects both the availability and toxicity of many dissolved substances. Two sites were chosen, one within a natural kelp bed at Carraroe, Co. Galway, and the other at a commercial rope mussel installation in Bantry Bay, Co. Kerry. Both areas have minimal freshwater input, and the local geology is volcanic rather than limestone, minimising the effects on pH of fresh water runoff. At each site a suite of instruments was deployed on a mooring to measure pH (SeaFET), temperature and salinity (SBE-37 or Hobo-TS) and dissolved oxygen (Hobo-O2), at 15 minute intervals. Spot sampling was carried out for carbonate parameters, salinity and nutrients to ground-truth the instrument data. At Carraroe in summer, pH in the kelp bed varied between 8.04 and 8.21, with a variation between 0.1 and 0.15 of a pH unit on a daily basis, driven by photosynthesis/respiration. Deployment in Bantry Bay in summer showed no such marked daily variations in pH, but rather variations of up to 0.1 pH units over much longer periods, related to the spring/neap cycle, while a winter deployment showed similar small variations but also influenced by increased rainfall. Salinity changes in both bays were very small over the deployment periods (> 1 psu) particularly in summer. This demonstrates the need for localised mitigation strategies, related to local ecosystems and local conditions, due to the high temporal and spatial variability of pH in coastal waters compared to the open ocean, where changes of 0.1 pH unit are expected only over a decade.

Characterization, replication and testing of designed micro-textures, inspired by the Brill fish, *Scophthalmus rhombus*, for the development of bioinspired antifouling materialsChloe Richards¹, Adrián Delgado Ollero¹, Fiona Regan¹¹School of Chemical Sciences, Dublin City University, Dublin 9, Republic of Ireland

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Biofouling is the process in which any materials submerged in water undergo fouling from organic matter, leading to the growth of significant biomass, associated with huge economic losses for the marine industry [1]. Growing concern about the natural environment has accelerated the search for non-toxic, but at the same time, economically reasonable, antifouling materials. The term 'biomimetics' is used to describe biologically inspired design. Bioinspired surfaces, due to their nano and micro topographical antifouling capabilities, provide a hopeful approach to the design of novel antifouling surfaces [2]. Biological organisms are known to have highly evolved and complex topographies, demonstrating antifouling potential [2], i.e. shark skin [3]. Previous studies have examined the antifouling ability of topographic patterns, textures and roughness scales found on natural organisms [2].

In this study, an attempt to characterize the microtopography of the common brill fish, *Scophthalmus rhombus*, will be undertaken. *Scophthalmus rhombus* is a small flatfish of the family *Scophthalmidae*, inhabiting regions from Norway to the Mediterranean and the Black Sea [4]. They reside in shallow sandy and muddy coastal areas at depths of around 70 – 80 meters [4]. The replication of the brill scale using a number of methods (i.e., 3-D printing, soft lithography and RepliSet-F5) will be carried out. Biofouling assessment will then be carried out using the best replication method observed by means of a cell settlement assay using model diatom species, *A. coffeaeformis* and *N. ovalis*.

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Managing blue growth: A qualitative case study on the mechanisms that influence the sustainable development of marine sectors in coastal regionsJessica Giannoumis¹, Lawrence Dooley², Valerie Cummins³¹University College Cork and Marine and Renewable Energy Centre Ireland²Cork University Business School, University College Cork³Simply Blue EnergyCorresponding Author Email Address: jessica.giannoumis@ucc.ie

The management of marine and coastal regions requires a strategic approach that ensures minimal tension between the desire of regional economic development and the sustainable development of the coastal region. This research investigates how blue growth mechanisms that develop and manage marine sectors can balance these opposing forces. While the concept of blue growth has been used as a mechanism for the management of marine sectors, no concise universally adopted definition of blue growth exists which has resulted in the mismanagement of marine resources. This research defines blue growth as the sustainable development of marine resources, generating livelihoods, and securing well-being, from innovation in emerging marine sectors. With this definition of blue growth in mind, this research asks what are the influencing factors that nurture blue growth? To answer this question, this research leverages the findings of consultative stakeholder workshops in coastal regions with representatives from Cork (Ireland), Las Palmas (Spain), Porto (Portugal), Brest (France), and Orkney (Scotland). The research shows that some of the nurturing factors include geography and access to marine resources, the regional marine and maritime-related legacy, and stakeholder ambition which translates to visionary regional development strategies. Other nurturing factors include the absorptive regional capacity and the commercial opportunity to develop marine sectors, and the collaboration and synergy between the representatives of the triple helix (industry, government, and academia). Effectively utilising blue growth strategies by targeting these antecedent factors could ensure a balanced approach to economic development and the sustainable development. This approach to marine and coastal management and development could support the processes of capacity building and knowledge transfer across sectors and regions targeting the triple helix collaboration. This research also addresses issues of legitimacy and equity in maritime planning and policies to effectively govern and manage marine sectors.

Introducing Circular Thinking into a Small to Medium Sized Construction Company in Ireland

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Construction & Demolition (C&D) waste is an issue across all European countries. It accounts for 35% of all the waste produced each year. The European Commission has introduced a number of policies and legislation on how to manage and reduce C&D waste. In the last number of years there has been a shift in policy to move away from just managing C&D waste. Policies are now looking at material and resource management, with an emphasis on moving towards a more circular economy.

C&D waste is the largest waste stream in Ireland. In 2018, it accounted for just over 6.2 million tonnes, an increase of 1.5 million tonnes on the previous year of 4.7 million tonnes (Source: EPA 2021). Almost 80% of the C&D waste collected is from soil and stone. The remaining 20% is made up of blocks, bricks, timber, glass, metal and plastic, and other building materials. A 2019 report carried out by the Regional Waste Management Planning Office predicted that by 2022, C&D waste in Ireland will be over 6.9 million tonnes - with 5.4 million tonnes of that coming from soil and stone, and the remainder 1.5 million tonnes made from other materials.

According to the Central Statistical Office (CSO) in Ireland, over 90% of Irish Construction Companies are considered Small to Medium Sized Enterprises (SME). Case studies undertaken with a Construction SME Company aimed to reduce waste, manage materials and resources efficiently during construction phase by doing the following:

- Develop a Resource Management Plan for each project
- Segregate waste on site – separate skips for different waste streams
- Monitor fuel usage in plant and machinery
- Connect to a mains electrical supply at construction stage as soon as possible
- Engage with suppliers about reducing packaging, material take back schemes
- Engage with subcontractors at tender stage about managing resources
- Site accommodation – install energy efficient equipment
- Material selection – use materials with a higher recycled content
- Transport/ delivery to site – maintenance of vehicles, just on time deliveries
- Site induction and training

**A Literature Analysis of the Barriers preventing Design for
Deconstruction in the Construction Industry in Ireland**

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Ireland produced 6.2 million tonnes (Mt) of Construction and Demolition Waste (C&DW) in 2018, an increase of 1.5Mt compared to 2017, which corresponded with an increase in construction activity nationally (EPA, 2020). Despite the current Covid-19 pandemic delaying construction projects, construction activity is likely to continue to increase in the coming years, resulting in an increase of C&DW. C&DW has a low value recovery rate and traditionally, in Ireland, C&DW has been sent to landfill, energy recovery or downcycled.

The number of landfills in Ireland is decreasing rapidly from over 200 in the 1980's to just 3 in operation today (EPA, 2020). This is inevitably causing the construction industry to consider alternative methods of waste prevention and management. There is a consensus in the literature that designers have a decisive role to play in helping to reduce waste by focusing on designing out waste (Osmani et al., 2011; Ajayi et al., 2017). Designing for Deconstruction (DfD) offers a potential opportunity of reducing waste sent to landfill by creating a market for reusable materials. DfD looks at how decisions made at the design stage can increase the quality and quantity of materials that can be re-used at the end of a building's life (BRE Group, 2017). However, in comparison to other countries, DfD has not yet been implemented in the Irish construction industry as a whole, prompting the Irish Government to develop a Waste Action Plan for a Circular Economy in September 2020 which outlined the need to develop a market demand for recycled products (DoCCE, 2020). This study will therefore aim to identify the barriers preventing DfD in the Irish construction industry, through conducting a literature analysis.

To identify the barriers, three key objectives need to be achieved. First, the literature documenting the rationale for DfD implementation in the construction industry is discussed. Following this, the research explores the barriers to change within the industry. Having identified the barriers to change and rationale for DfD implementation, the final step analyses the barriers to change which effect DfD implementation in Ireland. The study concludes that traditional organization of the construction process, conservative industry culture; financial concerns and short-term focus are the main barriers preventing DfD in the Irish construction industry. Future research can focus on possible solutions to overcome such barriers, thus enabling the implementation of DfD in the Irish construction industry.

Chemical Recycling/Upcycling of Waste Polyester FabricsKarzan H. Zangana^{1,2} and Justin D. Holmes^{1,2}¹School of Chemistry, University College Cork, Cork, T12 YN60, Ireland.²AMBER Centre, Environmental Research Institute, University College Cork, Cork, T23 XE10, Ireland

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Polyethylene terephthalate (PET) is not only one of the most used plastic packaging materials, but it can also be found in 60 % of fast fashion clothing items as polyester fibers ^[1]. We have developed a new energy-efficient, chemical approach for recycling colored and multi-layered polyester fabrics that would otherwise end up in landfilling or be incinerated^[2]. Our technology converts polyester into PET starting materials (or monomers), such as bis-hydroxy ethylene terephthalate (BHET), that can be reused to make new fabrics or packaging materials such as drink bottles and food trays. Moreover, using appropriate catalysts and solvents we have successfully converted waste polyester into the 'higher value' (upcycling) monomers used to produce the biodegradable plastic polybutylene adipate terephthalate (PBAT), which is used commercially in compostable food packaging and plastic bags, and the thermoplastic polybutylene terephthalate (PBT), used as an insulator in the electronics industry. Unlike other chemical recycling approaches, our technology uses microwave irradiation coupled with a cheap, non-toxic and recyclable catalyst to degrade PET, reducing both the reaction time (improved energy efficient) and the number of purification steps required to form monomers such as BHET. We hope that our technology will contribute towards stopping resource depletion, landfilling and the incineration of valuable resources by providing an economic incentive for the chemical recycling/upcycling of waste PET.

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Development of real-time control strategies for the optimisation of nitrogen and phosphorus removal in Intermittently Aerated Sequencing Batch Reactor technologyPeter Leonard¹, Sean Mulligan¹, Eoghan Clifford¹, Xinmin Zhan¹¹School of Engineering, National University of Ireland Galway, University Road, Galway

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In recent years, increased pressure has been applied to wastewater treatment facilities to improve treatment processes and adhere to more stringent regulations for the discharge of treated wastewater. In particular, nitrogen and phosphorous removal can be challenging to achieve efficiently, and in the case of phosphorous removal, can often necessitate the use of expensive chemicals (Clifford et al., 2010). There is a major drive globally to improve wastewater treatment quality, whilst simultaneously reducing the carbon footprint of the process (Zhan et al., 2018). Additionally, wastewater treatment is an energy intensive process constituting up to 3% of a developed country's electricity requirements (Mulligan et al., 2019). Real-time control (RTC) strategies have been shown to increase the treatment capability of a wastewater treatment plant (WWTP) by up to 50%, increasing the removal efficiency of nitrogen and phosphorus whilst reducing the treatment energy expenditure and cost (Yang et al., 2010). The intermittently aerated sequencing batch reactor (IASBR) offers a modification of the well-known sequencing batch reactor (SBR) process which has been revised to offer a more comprehensive treatment system, requiring lower power input than the conventional SBR process and enabling enhanced nutrient removal capacities not possible with conventional systems (Li et al., 2008). This study explores the IASBR system by proposing and evaluating via a case-study, control techniques in terms of treatment efficiency, energy efficiency and overall capability of maximising the available capacity within the IASBR. Across the study, high treatment capacity and flexibility has been recorded with COD removals averaging 95%, NH₄-N removals averaging 99% and PO₄-P removal averaging >95%. The focus of this analysis was to assess the impact of implemented control strategies on treatment performance. Treatment end-point determination, in parallel with phase changeover detection, increased the throughput of the system by allowing RTC to shorten treatment time, where possible allowing larger volumes to be treated at the same power input, whilst maintaining the high standards required. This research has demonstrated the characteristics of IASBR technology at scale to effectively achieve biological nutrient removal. In addition, the study demonstrated when effectively implemented, RTC strategies can both improve the robustness of treatment and allow energy savings to be made. The novelty in this study is the capacity to incur savings in a full scale IASBR system using advanced RTC strategies, which to the knowledge of the , has not been implemented before at this scale.

**Simultaneous determination of pesticides from soils:
A comparison between QuEChERS extraction and Dutch Mini-Luke extraction methods**

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The increasing scale of the agricultural sector fuels the intensification of pesticide used to combat pests' detrimental impact on crop yield. However, with the cumulative usage of pesticides, it is unavoidable that these synthetic chemicals contaminate multiple environmental components. Among those environmental components, the soil is one of the matrices that can experience irreversible damage from extensive pesticide usage. Due to the complex nature, soil matrix can present a significant challenge to quantifying pesticides due to various soil components that retain pesticides or multiple co-extractants that could interfere with the analytical analysis. Hence, a more selective extraction is vital in quantifying all the targeted pesticide analytes precisely. Comparison of two well-known extraction methods, QuEChERS and Dutch mini-Luke, were carried out to establish the best method to extract all of the targeted pesticide analytes from the soil samples. The HPLC-UV conditions were optimised to separate the seven pesticides, where both extraction methods present good linearity of procedural calibration of $r^2 < 0.9$. The limits of detection (LOD) and limits of quantification (LOQ) in blank soil samples ranged between 0.56-0.85 ng μL^{-1} and 1.7-2.58 ng μL^{-1} , 0.2-0.42 ng μL^{-1} and 0.6-1.27 ng μL^{-1} , for QuEChERS and Dutch mini-Luke, respectively. Recoveries of the targeted pesticides (except for fluroxypyr and prothioconazole) in the blank soil samples ranged from 85 to 97% using QuEChERS. As for the Dutch mini-Luke extraction method, all the seven targeted analytes' recovery was successful, with the range of 59 to 115%. Reproducibility and precision were reported in the form of RSD, and all the RSD obtained from both extraction methods are reported below or equal to 20%, except for prothioconazole under the Dutch mini-Luke method had RSD above 20%. In terms of matrix effect, it is noted that Dutch mini-Luke gives extracts lower in matrix co-extractants than QuEChERS. However, it is observed that prothioconazole experiences a higher matrix effect with Dutch mini-Luke. The comparison results show that Dutch mini-luke presents lower sensitivity in LOD and LOQ, better recovery, and lower matrix effect towards most analytes. Hence, Dutch mini-Luke is the preferred extraction method that suits our matrix and targeted analytes.

**Moving From the Lab into the Field: A CRISPR-Cas Lateral Flow Approach
|to Environmental DNA Monitoring**Molly Williams¹, Fiona Regan², Anne Parle-McDermott¹¹School of Biotechnology, Dublin City University, Dublin 9²School of Chemical Sciences, Dublin City University, Dublin 9

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In Europe, *Salmo salar* represents the primary farmed fish in terms of biomass and economic value since aquaculture production was established in the 1960s. However, although under a high level of protection, numbers continue to fall. In 2020, the Standing Scientific Committee on Salmon reported that only 45 % of Ireland's salmon rivers are meeting biologically based conservation limits, highlighting a need for simple and rapid species monitoring system. Management and conservation of *S. salar* requires knowledge of distribution, traditionally gained through visual detection and counting, methods that are expensive, time consuming and potentially harmful. Environmental DNA offers a solution to this through detection of DNA shed into the environment.

We recently adapted an isothermal RPA-CRISPR-Cas based detection assay for single-species assessment of *S. salar* as a route to a cost-effective biosensor device. We subsequently showed its comparability to qPCR, when assessing detection/non-detection, in sampling sets from eastern Canada.

To simplify our assay further, we have adapted our method to allow lateral flow visualisation (RPA-CRISPR-Cas-LF). The system utilises the same isothermal Recombinase Polymerase Amplification coupled to CRISPR-Cas12a detection as previously published, however, instead of using an ssDNA fluorophore-quencher reporter for fluorescence readout, the RPA-CRISPR-Cas-LF method employs a dual-labelled FAM-Biotin reporter (ssDNA-FB). This alteration ensures the specificity of the RPA-CRISPR-Cas methodology is maintained, whilst enabling a rapid detection/non-detection assessment of the species of interest. The lateral flow method uses commercially available lateral flow strips (Milenia Biotec) which utilise gold nanoparticle technology to detect the cleavage of the ssDNA-FB reporter when target DNA is present. This means, the sensitivity and specificity of the assay, determined by RPA-CRISPR-Cas, is unaffected. We demonstrate the RPA-CRISPR-Cas-LF method allows detection of *S. salar* tissue at 0.046 pg/μl in an hour at 37 °C and only requires an incubator. This further progresses the field of eDNA towards field-based applications, by removing the need for complex instrumentation and allowing rapid species detection.

Development of Multi-Parameter system sensing 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 as heavy metals have been increasing reported in the environment over the last few year, especially in developed countries. According to the World Health Organization (WHO), the United States, Germany, and Russia—with only 8% of the world's population, use about 75% of the world's most widely used metals. The United States, with 4.5% of the world's population, uses about 20% of the worlds metal supply and accounts for 25% of fossil fuel combustion each year. Heavy metals such as lead (Pb) and cadmium (Cd) 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, carbamates are widely used in grains. Carbamate exposure has 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 sensors 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 integrating theses sensor into a multi parameter system, it is possible to get real time quality control update during water processing.

Determination of NSAID drugs by Capillary electrophoresis with capacitively coupled contactless conductivity detection in wastewater

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Non-steroidal anti-inflammatory drugs (NSAIDs) are one of the most extensively used analgesics and antipyretic drugs to treat mild and moderate pain. Capillary Electrophoresis (CE) has become an increasingly popular technique due to its rapid method development, powerful separation capacity, low reagent consumption, short analysis time, simple operation, and high separation efficiency. Recently, capillary electrophoresis (CE) has been developed for the determination of a variety of chemical substances. The present work describes the development of analytical methods for the determination of NSAIDs in wastewater using UV and capacitively coupled contactless conductivity detections (C4D). Separation conditions including buffer (type, pH, and concentration), organic modifier concentration, injection size and separation voltage were studied during development and optimisation of the method. The method was successfully applied for the determination of selected drugs in wastewater treatment plant (WWTP) in Cork, Ireland.

Electrical Detection of Atmospheric Radicals

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Air quality and climate change are among the biggest societal challenges that we face today. Atmospheric radicals, particularly hydroxyl and nitrate, are the drivers of chemical processes that determine atmospheric composition and thus influence local and global air quality and climate. However, the detection of atmospheric radicals is far from routine, and only a few labs worldwide can accurately measure their concentrations in air. Current techniques for measuring radicals are based on spectroscopic and mass spectrometric methods, which although sensitive and robust, are technically complex, cumbersome and expensive. This presentation will provide an overview, and a discussion of the latest results, from the recently funded EU project 'RADICAL' which aims to develop small, low-cost sensors to electrically detect short-lived atmospheric radicals. Although challenging, RADICAL sensors not only have the potential to be rolled out on a global scale but can also be adapted to detect other important atmospheric gases.

Integrating climate change adaptation and disaster risk in the Irish emergency planning systemPeter Medway¹, Martin Le Tissier¹, Dug Cubie²¹UCC MaREI Centre²UCC School of Law

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Climate change induced emergencies, including floods and storms, cause significant loss and damage in Ireland and are projected to become more frequent and intense over time. The negative consequences will disproportionately affect the most vulnerable and undermine progress towards sustainable development and healthy communities. Ireland's policies and planning frameworks to tackle climate change clearly articulate the ambition to integrate adaptation and disaster risk reduction at national, sectoral and local levels to build community resilience. Despite the clear policy direction and investment in, among other things, information systems, early warning and nature-based solutions, the implementation of such policies and plans continue to lack coherence and retain a predominantly response-focused posture. This is primarily a result of three inter-related issues:

1. A bifurcated governance and coordination mechanism at national level with climate change adaptation led by the environment ministry whilst emergency management is conducted by both the defense and housing / planning /local government departments;
2. A lack of effectively sequenced policy-making, planning and research which makes it more difficult for initiatives at different levels of government to be coherent, mutually reinforcing and, consequently, easier to implement and more impactful; and
3. A lack of detailed focus in planning on the six pathways to integration, namely for sharing knowledge, harmonizing capacity, institutionalizing coordination, engaging stakeholders, leveraging investment and developing communications.

University College Cork, funded by Ireland's Environmental Protection Agency, has undertaken qualitative research involving policy makers and practitioners in central government, key sectors and local authorities exploring ways to improve the integration of climate change adaptation and emergency management systems within Ireland. Drawing on the outputs of the Horizon 2020 ESPREsSO project, the research used the six pathways to integration as the analytical lens to identify key recommendations and the elaboration of an action-oriented roadmap for integration. While noting that some progress has been made in all six areas, the research found that investment and capacity issues were the most commonly cited barriers to further integration, while a lack of vulnerability focus in hazard analysis and an insufficiently strategic approach to stakeholder engagement and support also challenge the achievement of the resilient society, with healthy communities, envisaged by the SDGs.

Going back to the drawing board: The revision of Ireland's climate lawDiarmuid Torney¹, Sadhbh O'Neill²¹Dublin City University²University College Dublin

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Ireland is an interesting case in the comparative climate policy literature. With stubbornly high emissions per capita and an atypical emissions profile, that has steadily increased in line with GDP growth Ireland has been justifiably described as a 'climate laggard'. Nonetheless, recent policy developments suggest a shift in Irish climate policy is underway. A notable feature of this shift is an ongoing process to revise and strengthen Ireland's 2015 climate change law. In March 2019 cross-party consensus was reached on the principal elements of this revision. A draft of the amending legislation was published by Government and subject to Pre-Legislative Scrutiny by the Joint Oireachtas Committee on Climate Action in autumn 2020. A revised and strengthened draft of the legislation was published by Government in March 2021 and is expected to be enacted in the coming months. The revised climate law is modelled loosely on the UK's Climate Change Act. This is a surprising development, because the UK model was considered in detail and clearly rejected during the framing of the 2015 climate law. This paper examines how this change of direction came about. We use Kingdon's Multiple Streams Framework to analyse how the problematisation of climate change since the publication of the IPCC Special Report on Global Warming of 1.5°C in October 2018 increased the perceived urgency of climate action, leading to new pressure group activity and shifts in public and electoral opinion. This instability and movement in the 'problem' stream opened a window of opportunity in the policy and political streams providing a unique opportunity for policy entrepreneurs to craft and propose solutions, resulting in a cross-party consensus on revision of the climate law that was firmly reflected in the Programme for Government and is to be enacted in law in the coming months. The Irish case is interesting from a comparative perspective as it is one of the first cases of significant amendment of an existing framework climate law from a country that has performed comparatively poorly on climate action.

**Assessing the impact of exceptional climatic conditions
on the net ecosystem carbon balance at Clara Bog**Ruchita Ingle¹, Shane Regan², Matthew Saunders¹¹Department of Botany, Trinity College Dublin²National Parks and Wildlife Service (NPWS)Corresponding Author Email Address: ingler@tcd.ie

Worldwide, peatlands are estimated to store around 30% of soil organic carbon on only 3% of the land area. In Irish context, peatlands cover ~20% of the land area with a capacity to hold up to 75% of the soil organic carbon stock. However, 92% of these ecosystems have been degraded due to anthropogenic activities such as agriculture, forestry and extraction for horticulture or energy. There is a growing realisation of the role that peatlands in near-natural condition or undergoing rehabilitation can make to emission savings from the land use sector, however exceptional climatic events influence the net ecosystem carbon balance by altering the rates of gross primary production (GPP) and ecosystem respiration (Reco). Therefore, it is crucial to understand the impact of inter-annual variation in climate on the key biogeochemical processes and carbon and greenhouse gas exchange. Eddy Covariance techniques are being used to assess net ecosystem carbon dynamics at Clara bog and these measurements began in 2018. In 2018, exceptional drought and heatwave conditions were observed across North-western Europe. For the year 2018, precipitation was 33% lower compared to 2019 and 15% lower when compared with 2020 while the average mean annual temperature was 0.5°C higher than 2019 and 0.4°C higher than 2020. Due to varying meteorological conditions and its influence on the hydrology, the study area acted as a net source of carbon of 53.5 g C m⁻² in 2018 but switched to a net sink of 125.2 g C m⁻² in 2019 and 95 g C m⁻² in 2020. This study highlights both the vulnerability and resilience of a raised bog in its natural state to exceptional inter-annual climatic variability and importance of long-term monitoring of these ecosystems to enhance our understanding of the impacts of exceptional climatic events on the carbon sink strength of these important ecosystems.

Climate Change

Daylength-dependent regulation of the TOR signaling pathway modulates plant growth responsesFerga Hamilton¹, Leah Erwin¹, Carolina Monte Bello², Camila Caldana², Rossana Henriques¹¹School of Biological, Earth and Environmental Sciences, Distillery Fields, University College Cork²Max Planck Institute of Molecular Plant Physiology, Am Muhlenberg 1, 14476 Postdam-Golm

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Plant growth occurs through cell growth and proliferation, which are high energy demanding processes. Therefore, plants need to coordinate growth responses with their environmental conditions to ensure the best use of their resources. This accurate regulation depends on the circadian clock, an internal self-sustained time keeping mechanism that informs the plant of day length duration (photoperiod). External cues such as light, temperature, as well as photosynthetic sugars act as inputs that entrain the clock, setting in motion different feedback networks which in turn will generate 24hr biological rhythm. The TOR (Target of Rapamycin) kinase pathway is a central hub where cellular energy levels are perceived and translated into specific growth responses across kingdoms. In plants, the TOR pathway has been associated with rapid growing tissue including embryos, shoot and root meristems. Downstream of TOR, the 40S ribosomal protein S6 Kinase 1 (S6K1) modulates both cell growth and proliferation. Lack of S6K is lethal, whereas imbalances in S6K levels result in developmental defects. We identified a connection between the circadian clock and the TOR pathway in the plant *Arabidopsis thaliana*. We investigated in detail how daylength changes typical of Winter (short days, 8h light/16h dark) and Summer (long days, 16h light/8h dark) would modulate TOR-dependent plant growth responses and metabolism using plants accumulating higher levels of S6K1 (S6K1-Ox) or mutants lacking this protein (*s6k1.1*). Since S6K1 accumulation is modulated by the circadian clock, we investigated how changes in S6K1 levels would affect plant growth when the clock function is impaired by mutation in *ZTL* (*ZEITLUPE*) which encodes a F-box protein that targets for degradation several components of the *Arabidopsis* clock. Plants lacking both *ZTL* and *S6K1* showed worse seedling establishment and decreases growth responses than their parents. In addition, overaccumulation of S6K1 in *ztl-3* mutants also affected seedling development and growth, suggesting that circadian regulation of this pathway is critical to control plant growth responses. Our findings show that de-regulation of TOR signaling pathway components impacts plant growth and development. This negative effect is reinforced by a defective circadian function, suggesting that plants require a running clock to match the TOR pathway activity with specific environmental conditions. Climate change will disrupt typical seasonal conditions specifically the match between environmental variables. Understanding how these will impact plant growth signaling pathways will help predict changes in plant yield and biomass in a future climate.

How can we understand the diffusion of sustainability in an ongoing regional transition project?

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Dingle Peninsula 2030 emerged as a framework through which initiatives and projects could be developed and delivered under the core vision of working towards a more environmentally and economically sustainable future for the Dingle Peninsula, in the South-West of Ireland. The diffusion of sustainability-related actions, initiatives and projects in light of the development of *Dingle Peninsula 2030* has been interpreted through this research. During the first 3 years of the *Dingle Peninsula 2030* project (2018-2020), a range of different initiatives have emerged at the local and national level through a process of diffusion. Within this, a wide range of actors and organisations have become involved in the project. Seven key diffusions have been outlined in this research. Due to the action research approach, whereby the research project is working alongside a 'live' project, it must be noted that all seven of these diffusions are ongoing and any conclusive statements on their success cannot be given. What is represented, however, is the role that sustainability initiatives can have in bringing about the wider diffusion of sustainability in regional and national contexts. This presentation will provide an outline of the *Dingle Peninsula 2030* project, a definition of the diffusion of sustainability, an overview of the seven diffusions emerging through the project, and the implications of this for policy on climate action in the Irish context. Our findings suggest that rural development projects should be more closely aligned with climate action. Top-down led national approaches to bring about climate action within the citizenry can be informed by the diffusion of sustainability as illustrated through *Dingle Peninsula 2030*. While sustainability is often intrinsically linked to rural regeneration there is a need to more explicitly develop the importance of vibrant communities in responding to climate action. Vibrant communities are the precursor to societal action in meeting the challenges faced, as highlighted through the diffusion of sustainability emanating from *Dingle Peninsula 2030*.

Promoting Sustainability in Organisations

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Improving the energy performance of organisations is a crucial component in meeting climate targets in Ireland and across Europe. To date, the primary focus has been on decarbonisation of supply and improved energy efficiency, although several studies point out the necessity of considering behavioural change towards more sustainable practices. Nonetheless, the majority of initiatives take a top-down approach and the users' perspective is often neglected. As a result, energy management systems tend to focus on technical solutions and behavioural insights are poorly integrated. In order to address this shortcoming, this research aims to answer the following question: "How can energy management systems better incorporate users' perspectives to promote pro-environmental behaviour and sustainable practices across different organisations". The study considers three case studies (organisations) in Ireland and Northern Ireland: industry, university and post-primary school. Data collection and analysis primarily focuses on users' perspectives and experiences. Through questionnaires, interviews, sensor/meter data and analysis of the current energy management systems, the research intends to assess: (1) the users' awareness and risk perception regarding environmental issues; (2) the users' current pro-environmental behaviours and sustainable practices; (3) the influence of the organisations' pro-environmental campaigns/teaching on the users' practices (spill-over effect); (4) the role of energy management systems in tackling the users' pro-environmental behaviours; (5) how the users' perspectives could be incorporated to improve the organisations' sustainability performance. So far, a questionnaire was administered in four post-primary schools in Ireland and Northern Ireland. This survey has been filled in by 306 students. A bespoke analytical tool was developed using R programming language and applied to the dataset. Results demonstrate that there is evidence of divergent environmental views among different cohorts in relation to issues such as self-efficacy and responsibility to act. Further results from this survey along with proposed approaches for future work will be presented.

Environmental Management 1**Multi-Actor Eco-Sustainability HUBs for supporting community transitioning to low carbon economy and for accelerating Green Innovation – Quo Vadis?**Neil Rowan¹, Sinead Mellett¹, Ronan Cooney², Eoghan Clifford²¹Athlone Institute of Technology²NUI Galway

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Background: the drivers for this research and innovation originated in the current global debate on climate change. The rapid population growth and rapid increases in per capita consumption have led to an extraordinary increase of people's ecological footprint. By 2030, it is predicted that the world will need 30% more water, 40% more energy and 50% more food to survive. Fisheries and seafood have many benefits for human health and contributes to a healthy diet linked to a promising source of protein and of omega 3 fatty acids. In 2015, the global population consumption of fish accounted for about 17% of animal protein, and 7% of all proteins. However, the seafood industry faces a number of challenges, including climate change, marine debris and the reduction of resources.

Rationale and position: in order to meet the future demand of seafood the seafood industry require a green innovative approach that will ensure the viability and growth of the seafood sector and meet the sustainable development goals. This research explores the Triple helix model (academia-industry-authority) of research, innovation as a valuable resource for green innovation as it relates to enabling and accelerating the fisheries sector. The triple helix model of innovation refers to a set of interactions between academia (the university), industry and government, to foster economic and social development, this research looks at open knowledge transfer and knowledge and access.

Aim and impact: of this presentation is to describe factors underpinning the use of this triple helix approach using the Irish midlands 'Empower Eco HUB' as a test case that has been provisionally funded by the Just Transition. It will specifically address community transitioning and enterprise to low carbon economy, such as using freshwater aquaculture as an exemplar. This has been informed by transnational socioeconomic and technological models that cross cuts *inter-alia* the creation of a chain of environmental responsibility and strategies for fostering of seafood resource management to introduce nutrient recovery strategies. This study is important for a number of reasons; this research will provide strategies for resource efficiency incorporating all stakeholders comprising producers, policy-makers and consumers in the decision making process. The triple helix approach will assist in the cohesive transition to a circular economy by providing opportunities that will benefit a healthy planet, healthy communities and contribute to sustainable business goals. This will also facilitate pivoting for businesses given key challenges and opportunities presented by Brexit and COVID-19 pandemic.

Investigating effects of Alltech® soil health products on plant defence mechanisms against root-knot nematode infestationAnusha Pulavarty¹, Karina Horgan², Thomais Kakouli-Duarte¹¹Institute of Technology Carlow²Alltech Bioscience CentreCorresponding Author Email Address: anusha.pulavarty@itcarlow.ie

Root-knot nematodes (RKN) are widely spread and highly damaging species of nematodes that are currently a serious constraint for global food security. These are widespread with a broad host range causing yield loss of about 30% in susceptible crop varieties annually. This work is part of larger collaborative project between IT Carlow and Alltech, on sustainable nematode management alternatives. Two formulations of Alltech®, a proprietary blend of fermentation products and plant extracts with micronutrients (ACS-5075) and a microbial based product (ACS-3048), were evaluated against the RKN *Meloidogyne javanica*. Tomato plants pre-treated with ACS5075 and ACS3048, were found less sensitive to *M. javanica* infection. The ACS-5075 treatment caused 2.04 and 1.4 folds reduction in egg masses at 1% and 3% concentrations ($p \leq 0.05$), respectively, compared to egg masses in the untreated control plants. Similar observations were recorded with combination of 3% ACS-5075 and 3gms ACS-3048. Subsequently, expression of six key pathogenesis related (PR) genes were monitored via RT-PCR at 3, 5, 15 and 30 days post treatment (dpt). After treatment with both products, the PR genes, *PR1*, *ACO*, *CAT* and *JERF*, were found overexpressed in leaf tissues of treated plants compared to untreated plants. In case of root tissues, *PR3* and *ACO* expression levels were found increased at 15dpt in plants treated with ACS5075. Additionally, a significant increase in expression levels of *PR1*, *PR3*, *PR5T* and *ACO* genes in root tissues were recorded in ACS3048 treated plants compared to untreated control. Results indicate ACS5075 and ACS3048 treatments systemically primed *ACO* and *PR1*, and the *ACO* gene expression, respectively, against pathogen attack. These findings demonstrate the role of these products in triggering an immune response in the treated plants to protect them against pathogen attack. Therefore, these products could serve as a sustainable solution for RKN management.

Environmental Management 1

**Stakeholder Dimensions of Ireland's Eye:
Participation in Conservation Resource Management of the Natura 2000 site**

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The Natura 2000 initiative is an ecological network of protected sites, which have been designated from selected species and habitats listed in the 1979 Birds Directive and the 1992 Habitats Directive. The island of Ireland's Eye, off north-Dublin is a protected Natura 2000 site and the subject of this action research. Ireland's Eye currently holds a Special Protection Area, Special Area of Conservation, and a proposed Natural Heritage Area designation, is included as part of the Howth Special Amenity Area Order and is covered by the Dublin Bay Biosphere. Until recently, Fingal County Council (FCC) has managed the conservation of the site since its SAAO designation in 2000. This was a more unusual agreement, compared to the usual operations for Natura 2000 sites, which are designated on private lands.

Ireland's Eye was sold in 2019 to hotelier group Tetrarch Capital, following a historical ownership of Howth Castle Estate by the Gaisford-St. Lawrence family. Ireland's Eye is the first piece of land in the Tetrarch portfolio with a protected designation. Ireland's Eye, as a privately-owned site with free public access, has engaged stakeholders including public bodies, key conservation managers, scientific bodies, NGOs, economic actors and civil society. Whilst stakeholders have benefited from accessing the site, the informal approach of managing the network over the years has now culminated in weaker conservation management, whereby barriers and delays in meeting Natura 2000 objectives have occurred.

The aim of this study is to fully understand the stakeholder dimensions of Ireland's Eye and an emphasis is placed throughout on the proprietor transition. An analysis of the site's usage and conservation management was undertaken. This assessment found the likelihood of the site's future conservation objectives being met by the new landowner depends on the continued cooperation of its stakeholders. During research undertaken, concerns for environmental degradation have been voiced by experts and recommendations on how new landowners can approach the conservation objectives have been made. Statements collected from stakeholders illustrate that there are opportunities for improved communication within the network, and that there is potential for collaboration to access funding and skills.

This study outlines relevant recommendations from the Institute for European Environmental Policy framework, highlights theories from case studies, and presents data to develop the stakeholder dimensions. These results aim to highlight the best practices of engaging stakeholder participation with conservation management and intends to inform and encourage Tetrarch to develop an effective engagement strategy.

Farmers' attitudes towards agricultural plastics – management and disposal, knowledge and perceptions of the environmental impactsClodagh King¹, Caroline Gilleran Stephens¹, Joseph Lynch¹, Siobhán Jordan¹¹Dundalk Institute of Technology

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Understanding the perceptions, attitudes and behaviours of farmers in relation to farm plastic waste management is scarcely documented in the literature but is key for developing effective solutions and initiatives to tackle one of the most challenging environmental pollution issues of the 21st century. This study involved the dissemination of a survey questionnaire through a variety of agricultural networks, collecting both qualitative and quantitative data from a sample size (N = 432) representative of the Irish farming community. The main aims of the survey included assessing the usage and disposal methods of plastics on Irish farms, and investigating the attitudes, perceptions, knowledge and awareness of farmers towards the environmental impacts associated with plastic and microplastic pollution. The results show that the majority of respondents are recycling farm plastics; however, this depends on the type of plastic with a greater number of respondents recycling silage bale wrap (58%) and netting (41%) compared to those recycling twine (21%). Farmers reported various other waste management strategies including on-farm disposal methods or finding alternative uses for these materials. In relation to farmers who do not recycle their farm plastic waste, many stated there are a lack of facilities available to them, they are unaware of how to recycle certain farm plastics or that the financial costs associated with recycling discourages them from doing so. Additionally, most respondents (82%) agree that the disposal of farm plastics is a big environmental problem, and many (81%) stated they would likely adopt biodegradable plastic alternatives, depending on their availability, affordability and reliability in terms of both strength and durability. Overall, Irish farmers have a high level of awareness on both plastic and microplastic pollution; however, the negative impacts of these issues are perceived by farmers to be more prevalent in marine and freshwater ecosystems instead of the terrestrial ecosystems.

Observing and Intervening

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Observing as-found conditions of ground and substrate can fine-tune our appreciation of secondary-raw-materials, as they interact with ecological processes. My work in this field, as illustrated by my landscape design practice for a new public park in Dublin's city centre, is a response to the *EU Waste Framework Directive* (2008) and the *EU Construction and Demolition Waste Protocol and Guidelines* (2018); a response from the realm of aesthetics which is practical and sensible. I am concerned with foregrounding and backgrounding the use of secondary-raw-materials in public realm, in a way that allows for natural processes such as ecological succession to play out. It is a useful thing that ecosystems can be encouraged to develop on novel substrates by the manipulation of the type and grain of those substrates, in such a way that is artistic, composed, partly determined by geometry and even geometric. It is useful because it encourages biodiversity, thereby making our settlements more resilient, but the work is also useful because it makes explicit the idea that waste can host heightened biodiversity when compared to more conventional substrates and that the nature of that biodiversity is not always fully predictable, leaving openness for change or the unexpected. The work is expressed through drawings, trials and mock-ups. The outcome of the work endures not only within the physical matter and processes of the site, but in modified drawing types which have the capacity to encourage others to invest in the unexpected. A hint of ambiguity in the drawing is enough to engage mirror neurons which trigger embodied cognition so that people become more active participants in the design process, feel part of it, and are more likely to make a contribution, rather than passively receive drawn information. This neurological phenomenon, which links the observation of an action with the performance of an action, may be potent in eliciting an investment by others in uncertainty, so that the course of the conversation is shifted toward a more nuanced understanding of our nature.

Environmental Management 1**A study on the ecological impact of recycling derived fertilisers (RDFs) using nematodes as environmental bioindicators**Anna Karpinska¹, Thomais Kakouli-Duarte¹¹Institute of Technology Carlow

Soil is the main source of nutrients needed for plant growth. The three main such nutrients, phosphorous (P), nitrogen(N) and potassium (K), are routinely applied by farmers via artificial mineral fertilisers. Phosphate rock, a non-renewable source of the element, is geographically concentrated within five countries (Morocco, China, Algeria, Syria and Jordan), controlling 85-90 % of the world's remaining reserves. The global demand for recycled phosphorus is increasing due to the growing human population and food consumption. It is estimated that the world phosphorous resources will be depleted within the next 200 years. Nutrient recovery technologies are employed to produce recycling derived fertilisers (RDF) from waste streams, sewage sludge, food waste and manure, in the form of ash or struvite, that can replace conventional mineral fertilisers in farms. However, before these RDF are applied to the soil, it is essential they undergo an ecological risk assessment. Nematodes are the most abundant soil animals, 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 the terrestrial nematode communities in field trials located 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, the 18S rRNA gene was sequenced using suitable primers from Bhadury et al. (2006), and further bioinformatic analysis were employed to reveal any significant differences between the treatments. Nematode relative abundance expressed in molecular operational taxonomical units (MOTUs) was examined using Nematode Indicator Joint Analysis (NINJA) to exclude any adverse effects of RDF on soil nematode species compared to those in control plots. A two year Irish field trial revealed a significant difference between the poultry ash, sewage ash, cattle slurry and the controls indicated by sensitive to pollution nematode orders and species. Both ashes negatively affected nematode communities, by reducing the abundance of sensitive to environmental disturbance dorylaimids. At the same time, a significant increase in abundance of food opportunistic nematodes was noted when compared with that in the controls. These alterations within the faunal profile negatively affect terrestrial nematode food web complexity and biodiversity. In Ireland, grasslands occupy the largest share of the agricultural areas and the soils are relatively low in phosphorous. Therefore the Irish field trials focus on phosphorous, encouraging farmers to replace mineral fertiliser with RDF in the near future.

Trees as teachers: a living tree collection as a teaching, research and engagement tool

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It has been previously argued that arboreta should leverage their living collections to become more actively engaged in promoting the societal understanding of environmental topics. Indeed, the individual living organisms contained within arboreta have been equated with those in modern zoos and their role as ambassadors for their, often endangered, wild relatives have been emphasised. Education, research and outreach within such settings offer opportunities to examine the complex relationships between humans and other species. The University College Cork Arboretum contains a living collection of more than 2,500 trees across 42 acres, with more than 120 species represented. Established c. 1849, it is the earliest public engagement tool in the university. As part of the 'UCC Open Arboretum Project' and the Science Foundation Ireland-supported "Tree Explorers" project, we have re-established the academic link to the collection for teaching, research and outreach. Through a range of face-to-face and virtual tours (necessitated because of prevailing health restrictions) and other events, the arboretum has become a central focus for discussion around biodiversity, climate change mitigation and adaptation, the role of trees in urban areas and the importance of plants in providing valuable services from mental and physical health to reducing food insecurity globally. One such virtual event, hosted on Twitter, attracted over eleven thousand direct interactions. A virtual tour of the collection hosted as part of National Tree Week attracted 137 participants. A majority (62 %) of participants were very likely to attend another virtual tour while over 90 % were likely or very likely to visit the UCC Arboretum in the future. This emphasises the important role that virtual events have at this time, without replacing the real experience itself. As one respondent commented: "[I] can't wait to get back on campus and explore with my new knowledge of the trees that I have passed so many times".

**Nature, Networks and Bridging the Perception Gap between Science and Society:
An Action Research Study of the Primary Attention Groups of Urban Citizens**

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Establishing nature-based solutions projects that reconnect urban citizens with nature and facilitate social learning is highlighted as a research and innovation priority in the European Union's commitment to achieving the United Nations Sustainable Development Goals by 2030. Further research is necessary to effectively facilitate and maintain the individual social interactions which underpin the underlying emergent system ability hidden within the social networks of urban citizens, in order to adequately co-create transition knowledge, initiate change and catalyse social transformation to achieve transition outcomes in cities.

Previous studies in the field of transitions research have concentrated on observing and engaging particular social groups based on traditional community structures which are not wholly representative of the complex communicative ecology in which urban citizens socially engage. As a consequence, future analyses could benefit from utilising a unified, transdisciplinary community construct grounded on interaction frequency between persons within a social network where the starting point of the community's communicative ecology is the individual, which acts as a shared heuristic device for citizens and researchers in order to improve participatory design, communication flow and amplify the impact of public problem solving.

The Primary Attention Group (PAG) is a form of community centred on an individual and exists in both geographic and virtual space, using both face-to-face and electronically mediated communications. PAGs offer a possible basis for exploring novel development opportunities with regards to establishing network initiatives that enable shifts in mindsets and behaviours, as well as facilitating a greater sense of community and project ownership in cities at the local level. As such, the aim of this research is to enable urban citizens to develop and visualise their PAG by mapping their communicative ecology through action research in order to support them to participate in positive activities that reconnect them with nature and improve their health in a self-organised manner.

Benchmarking urban greenspace nationally and subsequently determining the associations between urban greenspace, health and socio-economic variables

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Globally, the number of people living in urban areas has increased in recent years. It is predicted that the world's urban population will continue to rise over the coming years, posing enormous challenges to future cities and society. There is an urgent need to minimise the adverse environmental health impacts associated with this trend, including those related to climate change and air pollution. An analysis of empirical studies was undertaken including a review of relevant health, environmental and economic benefits of greenspace. Greenspace removes air pollutants from the atmosphere, reduces noise pollution and can also enhance the thermal environment. This has a positive impact on the health of residents, both physically and mentally. In addition, it promotes interaction between residents, creating an integrated and cohesive society. It also contributes to an aesthetically pleasing landscape and helps build vibrant and sustainable cities. As such, it is a priority to improve our understanding of the science of urban greenspace.

This innovative research utilises street-view imagery, artificial intelligence and computer vision methods to develop a compelling new approach to the study of urban greenspace in unprecedented resolution, accuracy and scale for Dublin, Cork and Galway cities. Our novel metric captures the profile view of green vegetation as perceived by pedestrians, cyclists and other road users including motorists. Furthermore, our research examines the relationship between urban greenspace, self-reported health and socio-economic variables.

As the population of cities continues to grow, the development of greenspace will become more and more contested. Existing greenspace may be threatened by future commercial and residential developments. The potential for harnessing the 'data revolution' to develop sustainable, healthy and liveable cities has not yet been fully realised. Government officials and local authorities must recognise the importance of incorporating greenspace into future developments. Our study shows that we must prioritise greenspace development as we strive to become global leaders in innovation for sustainable cities, economies and societies.

A Point Prevalence Study of faecal carriage of extended spectrum β -lactamase producing and carbapenem resistant Enterobacterales in Irish water users

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Exposure to antimicrobial resistant (AMR) bacteria in natural recreational water may represent a substantial public health risk through gut colonisation and onward transmission to vulnerable individuals. We aimed to compare the prevalence of gut colonisation in regular water users (WU) and non-water users (NWU) in Ireland, with carbapenem-resistant Enterobacterales (CRE) and extended spectrum beta-lactamase producing Enterobacterales (ESBL-PE).

Between September and December 2020, 141 faecal samples were collected from 70 WU and 71 NWU and cultured on CHROMagar mSuperCARBA™ and Brilliance ESBL to screen for CRE and ESBL-PE respectively. Colonies of interest were identified by MALDI-TOF and antimicrobial susceptibility testing (AST) was performed according to EUCAST criteria. Real-time PCR was used to detect *bla*_{CTX-M} group 1, *bla*_{CTX-M} group 2, *bla*_{CTX-M} group 9, *bla*_{VIM}, *bla*_{IMP}, *bla*_{OXA-48}, *bla*_{NDM}, and *bla*_{KPC} genes.

Of 56 suspect CRE/ESBL-PE that grew on selective agars, AST phenotypically identified 5 CRE, 10 presumptive ESBL-PE and 1 isolate with combined CRE/ESBL-PE phenotype. PCR confirmed *bla*_{CTX-M} in 8 isolates; 6 *bla*_{CTX-M} group-1 *E. coli* (all in NWU) and 2 *bla*_{CTX-M} group-9 *E. coli* (all in WU). No carbapenemase gene was detected amongst the 6 CRE isolates.

This ongoing study found that 8% and 4% of participants are colonised with ESBL-PE and CRE, respectively. There was no significant difference in ESBL-PE/CRE colonisation rate between WU (7%) and NWU (15%), ($P=0.12$). Colonisation of healthy people with CRE is particularly concerning. Genomic analysis may reveal the resistance mechanisms involved. Further sampling and participant survey analysis may identify significant risk factors for colonisation.

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Detection of carbapenemase producing Enterobacteriales in sewage and aquatic environments in the Republic of Ireland, 2019-2020

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Antimicrobial resistance (AMR) is a significant global One Health challenge. The One Health concept recognises that the health of humans, animals and the environment are interlinked. There is an increasing need to better understand the complex role of environmental reservoirs in the dissemination of A The aim of this study was to examine sewage sources and water bodies across Ireland for the presence of antimicrobial resistant Enterobacteriales. Samples were collected on a seasonal basis across four local authority areas in the West (Galway city & Galway county council), East (Fingal county council) and South (Cork county council) of Ireland. Sampling took place between July 2019 and November 2020. This included 118 water samples (30L) and 36 sewage samples (200mL). Water samples were filtered using the CapE method, followed by enrichment and subsequent culturing on selective agars (CHROMagar mSuperCARBA™ and Brilliance ESBL agar). Sewage samples were directly cultured on these agars. Colonies were identified by MALDI-TOF and antimicrobial susceptibility testing was performed following EUCAST criteria. Selected isolates were examined for *bla*_{CTX-M'}, *bla*_{VIM'}, *bla*_{IMP'}, *bla*_{OXA-48'}, *bla*_{NDM'} and *bla*_{KPC} by real time PCR. A total of 18 water and 5 sewage samples harbored one or more carbapenemase producing Enterobacteriales (CPE). The most common carbapenemase gene detected was *bla*_{OXA-48} (n=18), followed by *bla*_{NDM} (n=13) and *bla*_{KPC} (n=4). Widespread dissemination of extended spectrum beta-lactamase (ESBL) producers was evident in 93/118 (79%) waters and 18/36 (50%) sewage samples. Many of these samples tested positive for more than one ESBL producer which encompassed 186 Enterobacteriales that harbored *bla*_{CTX-M-group1} and 59 that contained *bla*_{CTX-M-group9}. Carbapenemase producing Enterobacteriales are considered a public health emergency in Ireland and so their detection in the environment is a significant public health concern. The carbapenemase genes detected reflect those most commonly identified through diagnostic and surveillance screening in hospitals, indicative that similar resistance types are circulating in the clinical and natural environments. These results highlight the need for regular monitoring of the aquatic environment for the presence of antimicrobial resistant organisms to adequately inform policies to protect public health.

Towards smart energy cities – empowering residential building energy retrofit: An Irish contextYonghua Zhu¹, Angela Wright¹¹Munster Technological UniversityCorresponding Author Email Address: angela.wright@cit.ie

Smart cities are the future and the provision for smart energy will be at their core. To that end, buildings within a smart city must embrace smart technologies for a smart future that is utterly efficient.

Developing a smart energy city is challenging without first empowering the building sector in energy upgrading. The European Commission considers that the biggest energy savings can be made in the building sector, with approximately 27%-30% potential for energy saving in this sphere. Residential buildings are the biggest players in the building stock, accounting for 75% and more than 60% of energy consumption; however, they are outdated and not efficient in energy performance. It is challenging however, to upgrade residential buildings to fit them into a smart energy city.

Investigations (Kelly, 2009; Hyland, *et al.*, 2013; He *et al.*, 2019) attempt to address critical problems in retrofitting residential buildings, however, gaps in knowledge remain to provide feasible solutions. To bridge these gaps, a post-positivistic approach was applied, and ten qualitative interviews were conducted among expert contributors from sectors in academia, energy service suppliers, construction and consultancy.

This research finds a lack of awareness of the value of residential building retrofit to improve energy performance. This retrofit requires joint efforts from all stakeholders, including users, governments, local authorities, constructors and suppliers. The government should not only offer direct economic incentives, but also provide more resources on education and training, such as raising people's awareness and workforce training. This study has found insufficient skills and resources to do large-scale residential building retrofit in Ireland. The government holds the responsibility to train, foster the market, and encourage private investment to make the market profitable and sustainable. Findings reveal that a one-stop shop concept is promising to address issues homeowners face when retrofitting. Pilot projects have demonstrated that the one-stop shop concept minimizes the risks (low quality) while maximizing the benefits (high energy efficiency) through close collaboration among all actors. This research also finds that pre-fabrication and digital technologies will find wider applications in residential building retrofit in the future. Also, this research captures a highlighted call from expert contributors that people should change their mindset to reduce their use of fossil fuel, retrofit their homes, embracing small changes such as installing a smart meter which can translate into a change of behaviour to environmentally friendly. The findings will benefit policy makers, government planners, environmentalists and agents for change.

Cascading bio-electrochemical systems for biogas upgrading to biomethane in a circular bioeconomyXue Ning¹, Richen Lin¹, Richard O'Shea¹, David Wall¹, Jerry Murphy¹¹MaREI Centre, Environmental Research Institute, University College Cork, Cork

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There is an onus on all countries to transition to more sustainable low-carbon emission economies; a key element of this transition would be the development of advanced biofuels (such as biomethane). Anaerobic digestion (AD) has been proven feasible in producing biogas, the upgrading of which can lead to the production of biomethane suitable for fueling heavy-duty vehicles in circular economy systems. However, the efficiency of biogas production and upgrading has to be improved in an optimized system when considering the significant challenge of deep decarbonization. In this study, three bio-based systems are established and compared, including power to gas-AD (P2G-AD), microbial electrolysis cell-AD (MEC-AD) and AD-microbial electrosynthesis (AD-MES). Representative feedstocks are divided into three categories in a European context: on-farm feedstocks (such as animal slurry and grass silage), on-farm coastal feedstocks (such as seaweed and microalgae) and municipal waste (such as food waste). The results show the integration of renewable electricity in AD systems can greatly improve the efficiency of resource utilization. Synergies between bio-electrochemical and AD technologies show promises in accelerating the degradation of recalcitrant lignocellulosic biomass, enhancing the methanogenesis and increasing the net energy output. Detailed assessment on mass and energy flows indicates that all three systems of P2G-AD, MEC-AD and AD-MES can gain positive energy outputs by the use of electricity that would have been curtailed or constrained. The MEC-AD system may be the most efficient pathway amongst the three systems. The analysis aids in the design of future cascading circular biosystems

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towards the production of advanced gaseous transport biofuels.

What can more walking and cycling achieve for Ireland's climate targets?

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Globally, transport is responsible for 25% of all energy related CO₂ emissions. As part of meeting its commitments under the Paris Agreement, Ireland has committed to a 7% p.a. reduction in GHG emissions by 2030, which translates to a 51% reduction by 2030 in emissions compared to current levels. This study investigates the range of CO₂ emissions reductions possible from passenger transport in Ireland with "active travel" targets and policies.

The 2020 Program for Government stated a commitment to support active modes of transport by committing to a million per day spend on walking and cycling infrastructure. The 2009 "Smarter Travel" policy document committed to a target of 450,000 trips by walking and cycling per day by 2020, and that 10% of all work and education-based trips would be completed by bike by 2020.

This study highlights the current profile of passenger transport in Ireland, by trip distance, trip purpose and trip transport mode. It examines what achieving the targets set out by the "Smarter Travel" policy document could mean for Ireland's passenger transport emissions. We also look at uptake in global leaders in active modes of travel such as the Netherlands and examine how improved walking and cycling uptake rates could impact Ireland's passenger transport emissions up to 2030.

The have developed the Irish Passenger Transport Emissions and Mobility (IPTeM) model which provides a snapshot of passenger transport demand by trip distance, trip purpose and mode type from 2009 – 2019. The IPTeM model, combined with the energy systems LEAP Ireland model, can simulate scenarios for walking and cycling uptake in Ireland, and the respective change in CO₂ emissions.

The active mode scenarios, which focus on increased walking and cycling achieve a 0.2 – 1 MTCO₂ reduction in annual passenger transport emissions by 2030 when compared to 2019. For the passenger transport sector, this translates to between a 0 – 10% reduction on 2019 passenger transport emissions by 2030. The study highlights the level of ambition and transformation in the transport sector required to achieve our targets of a 51% reduction on average across all greenhouse gas emitting sectors, and the potential contribution of increased walking and cycling in contributing to our climate targets.

Public Participation within Project Authorisation for Renewable Energy InfrastructureAlison Hardiman¹¹UCC School of LawCorresponding Author Email Address: alisonhardiman@gmail.com

The goals and specific targets for the development of renewable energy output within the European Union are increasingly ambitious. Each Member State has stringent individual targets leading towards zero carbon output in 2050. In Ireland, our policies are dynamic and under consistent review to reflect our increased ambition. Meeting Ireland's EU imposed mandatory targets within the electricity sector is dependent upon the development of individual, legally robust and operationally reliable renewable energy infrastructure projects within tight deadlines. This infrastructure will include expansion of the electricity grid, the development of large scale windfarms in on shore and offshore locations and the development of extensive solar farms, for instance. It is argued that the lack of procedural clarity regarding pre-planning public participation requirements jeopardises Ireland's ability to meet our climate energy targets, the achievement of which will become legally binding in Ireland pursuant to the Climate Action and Low Carbon Development (Amendment) Bill 2021. At present, we fail to achieve either effective public participation from the perspective of the third-party participants or certainty and predictability of process for prospective developers. This paper provides:

- Analysis of the legislation governing the grant of planning permission for renewable energy infrastructure projects requiring an EIA from the perspective of public participation.
- Analysis of selected academic literature is provided in order to understand the aims and objectives considered to underpin the right to public participation. This is done in order to assess both the purpose envisaged for this process and the potential for it.
- A proposed template for the conduct of pre-planning public participation is proposed that has been designed with multiple aims: to specifically fulfil the aims of the Aarhus Convention with regard to public participation, to provide for effective consultation between the developer and the host community at the earliest design phases of the project when the public can influence the project detail without significantly delaying its implementation and also, to provide transparency of process designed to facilitate developers in performing pre-planning public participation to a standard that is legitimate and predictably defensible.

There is an opportunity to de-risk the process and to give better effect to the principles of early and effective public participation that underpin the Rio and Aarhus Conventions through better utilisation of these mandatory but currently ill-defined pre-planning public participation process and this paper proposes a template designed to help achieve this based on careful analysis of relevant law and

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academia.

Planning healthy communities for a healthy planet

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A key novelty of the present study is that it was conducted as part of a transdisciplinary research project with local/national stakeholders from the Dingle peninsula, under the banner 'Corca Dhuibhne 2030'. In particular, this analysis draws on the experience of collaborating with the local community development organisation (NEWKD) to bring together the seven parishes that make up the region to develop a strategic plan for the area. Although the primary research interest was to understand people's energy system preferences, it was decided to take an integrative approach in order to reach a broader audience and ensure the research supported the goals of NEKWD. For rural communities, such as the case study region, a sustainable future means long-term social, economic and environmental resiliency. Community meetings were held in each of the parishes over two rounds throughout November 2019 and February 2020 to map out and understand the concerns and priorities of the residents.

Under Ireland's new Climate Action and Low Carbon Development (Amendment) Bill 2021, each local authority will be given a mandate to develop Climate Action Plans addressing both mitigation and adaptation measures. A successful implementation of the plans will require widespread support for the proposed measures. Thus, it is vital that the development of the plans is evidence-based and facilitates discussion/deliberation on the best path forward. Reflecting on the findings from the Dingle peninsula community meetings highlights that the planning of climate action and community development are inseparable, particularly in rural areas. We will not have a transition to a low carbon energy system if we do not have healthy, vibrant communities. Firstly, being able to worry about climate change is a privilege, and one that is not afforded to rural communities facing grave socio-economic challenges. Secondly, current social, economic and environmental (un)sustainability issues are exasperated by the fact that regional, county and indeed local development plans do not adequately reflect the concerns and priorities of the community. In fact, in some cases the current challenges facing the Dingle peninsula in overtourism and population decline could be seen to be a direct consequence of regional

and county objectives.

Volatile organic compounds from *Bacillus*, *Serratia* and *Pseudomonas* promote growth and alter the transcriptional landscape of *Solanum tuberosum* in a passively-ventilated growth system

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The interaction of plant growth-promoting bacteria with their host plants has become a major research spoke in the area of plant-microbe interactions. These interactions can provide many alternative solutions to the use of synthetic plant protection products which can often have environmentally harmful effects. In particular, the emission of bacterial volatile organic compounds (BVCs) has been intensely investigated in recent years for their plant growth-promoting potential and biocidal effects on phytopathogens. This study investigated the use of a passively-ventilated growth system via Microbox® growth chambers to determine the effect of BVCs on plant growth in *Solanum tuberosum* L. cv. 'Golden Wonder'. Solid-phase microextraction GC/MS determined the BVC profile of six bacterial isolates, of which five are from Irish potato soils, from the genus *Bacillus*, *Serratia* and *Pseudomonas* when cultured in three different growth media, each with varying carbon content. 70 BVCs were identified in total, with alcohols and alkanes being the most abundant. When cultured in tryptic soy broth, all six isolates were capable of producing 2,5-dimethylpyrazine, however BVC emission associated with this media were deemed to have negative effects on plant growth. Murashige & Skoog and methyl red-voges proskeur (MR-VP) media were not found to induce emission of 2,5-dimethylpyrazine and were selected as the bacterial growth media for plant co-cultivation experiments. BVC-mediated plant growth-promoting effects were observed among all bacterial isolates tested and BVC emissions of *Bacillus* and *Serratia* isolates cultured on MR-VP induced alterations in the transcriptional landscape of potato across all treatments with 956 significantly differentially expressed genes identified. Genes associated with photosynthesis and plant cell division were upregulated while, surprisingly, genes associated with plant defence were largely downregulated. The literature often reports the increased upregulation of many defence-related genes in response to BVC exposure, however the particular blend of BVCs, the novel experimental setup or the interaction of both of these may be responsible for the results obtained in this study. The results of this research can be exploited to better understand the interaction of plant growth-promoting bacteria and their associated BVCs with food crops and the potential application to sustainable agriculture for a healthier planet.

Towards a Transformative Food Crop System in Ireland – addressing the Sustainable Development Goals

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The sustainable development goals are a series of 17 actions (each with multiple targets) which whilst not perfect, act as a blueprint for improving our planet and addressing inequalities across the board. The goals are inter-connected and many can, at a basic level, be linked to the efficient functioning of an effective food system globally. The United Nations as part of the 'Decade of Action' are convening a Food Systems Summit in September of 2021 which will bring together stakeholders with a view to transforming food systems globally. The summit will give a voice to governments, business, scientists, farmers, indigenous people, consumers and many more key stakeholders including Irish citizens. With increasing urgency we need to look at how we can transform our food systems in Ireland in a holistic and integrated way to take account of climate, disease, nutrition, food waste, land, water, health and the environment. Food systems refers to the full range of activities involved across the food chain up to the consumption of the product. This talk will focus at the level of the producer and will make particular reference to traditional and novel crop production systems in Ireland and how innovations in agricultural biotechnology can help transform and build a resilient crop food system. Newer plant breeding techniques hold great promise for the Irish agricultural sector. Globally, innovations in agricultural biotech crop production have led to farm income gains of \$150 billion, helped to conserve biodiversity, reduced pesticide spraying by 583.5 million kg over a 20 year period and have led to reduced CO₂ emissions, equivalent to removing 12 million cars from the road in 1 year. This innovative technology is timely in an Irish context.

The impact of sward composition and management on the productivity of herbage

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Lolium perenne (PRG) has many positive traits including the ability to yield high levels of good quality forage and to recover quickly following defoliation. However, it is a nitrogen (N) demanding species. N fertilisers represent a significant direct cost to farmers and can contribute to wider environmental problems. Multispecies grasslands, containing different plant functional groups and managed at reduced N levels have been shown to have a production potential comparable with high N input PRG monocultures. Yet, persistency issues from intensively grazing these grasslands have been reported, and there is little information regarding their appropriate management e.g. defoliation interval and residual to ensure their persistency and yielding capacity. A 3 × 2 × 2 blocked factorial experiment was established at UCD Lyons Farm, in June 2019, with 3 sward types, two rotation lengths (21 days vs. 28 days) two defoliation heights (4 cm vs. 6 cm) and 4 blocks of replicates. The purpose being to investigate the effect of different management practices on dry matter (DM) production from different sward types: 1) PRG monoculture receiving 250 kg N ha⁻¹ year⁻¹; 2) PRG and *Trifolium repens* (PRGWC); 3) Multispecies sward containing PRG, *Phleum pratense*, *Trifolium repens*, *Trifolium pratense*, *Plantago lanceolata* and *Cichorium intybus* (MSS). PRGWC and MSS received 90 kg N ha⁻¹ year⁻¹. The plots measured 1.25 × 7 m and were harvested according to treatment from March – November annually. They were cut and weighed by a Haldrup harvester and a sample was taken for DM determination at each harvest. Rotation length had a significant impact on yield in the early (March – May; P<0.05), mid (June – August; P<0.0001) and late stage (September – October; P<0.0001) of the grazing season with swards on the 28-day rotation outperforming those on the 21-day rotation. Sward type had a significant effect on DM production mid-season (P<0.0001), whereby both MSS (2751 +/- 128 kg DM/ha) and PRG (2715 +/- 128 kg DM/ha) yielded more than PRGWC (2018 +/- 128 kg DM/ha; P<0.001), and late in the season (P<0.0001), whereby both MSS (1827 +/- 79 kg DM/ha) and PRG (1845 +/- 79 kg DM/ha) yielded more than PRGWC (1549 +/- 79 kg DM/ha; P<0.001). There were no two- or three-way interactions observed. These results highlight the importance of sward composition and defoliation management on DM production.

Carbon sequestration of a native woodland on a cutaway peatland site in Ireland

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Peatlands in their natural state have the capability of storing vast amounts of atmospheric Carbon, accounting for a third of the global soil carbon stocks on just 3% of the land surface. Industrial peat extraction alters the hydrological and physical properties of peatlands and when exploited they become a strong source of carbon to the atmosphere. Following the recent closure of all industrial peat extraction sites across Ireland, cutaway peatlands are in abundance. There is an urgent need to understand optimal management practices going forward to utilise these cutaway peatlands, in order to sequester carbon, remediate degraded environments, and help achieve our carbon targets by 2050. This project will examine carbon fluxes from a cutaway peatland site located in Lullymore, County Kildare. Harvesting peat ceased over two decades ago from the site and it has since become naturally revegetated with birch and scots pine tree species. With the installation of an Eddy Covariance tower reaching above the tree canopy, carbon emissions from the site will be monitored continuously using a sonic anemometer and an open-path gas analyser. Other meteorological instruments will also be installed at the site to monitor environmental conditions. In conjunction with this, the soil adjusted vegetation index (SAVI) and Normalised difference vegetation index (NDVI) will be estimated using remote sensing techniques from the growing season. On analysis of data from both methods, an estimation of annual carbon storage in biomass will be determined and later this data will be upscaled to ecosystem level. This site offers an excellent opportunity to investigate the potential to sequester carbon emissions through biomass and may be a sustainable management strategy for reaching net zero carbon emissions by 2050.

Primary production food waste and losses in IrelandJennifer Attard¹, Tracey O'Connor², Rosanna Kleemann²¹Munster Technological University²University College Dublin

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Food can exit food supply chains (FSCs) at any FSC stage, from primary production, i.e. agriculture and fishing, to consumption. Such losses occur at immense cost to society and the environment, considering the material, financial, and human resource inputs for food production and food waste management, and associated pressures on environmental systems, e.g. habitat availability and quality. Despite these costs, global food losses are substantial, while food insecurity persists, and global population growth is expected to increase food demand. From 2022, The European Union Waste Framework Directive requires member states, including the Republic of Ireland, to report annual food waste from each FSC stage, distinguishing between "waste", i.e. food that enters FSCs but is not consumed and is processed as waste, e.g. harvested crops that rot in storage, and "losses", i.e., food intended for FSCs that doesn't enter them, e.g. livestock culled due to zoonotic diseases. Irish data providing an overview of food losses and waste (FLW) in the primary production stage is lacking, while comprehensive FLW data exists for other FSC stages. This novel study addresses that knowledge gap. This research aimed to understand the nature and extent of FLW from primary production in Ireland, creating a starting point from which Irish primary production FLW can begin to be identified, understood, and mitigated. Causes of FLW, and FLW as a proportion of total production were determined through interviews with stakeholders within primary production, including producers and producer support organisations, such as Teagasc, and using national FLW data where available, e.g. fish discard records, cattle deaths. Quantities of FLW were estimated using annual production data. The FLW was described for each primary production sector (animal husbandry, horticulture, tillage, fisheries, and aquaculture). The total annual FLW from Irish primary production was 189,500 tonnes. The main source of FLW was the vegetable sector, particularly potatoes (72,838 tonnes) and other field crops. Meanwhile, FLW was lowest in fisheries, although this sector is affected by reduction in food production potential due to decline in fish stocks and habitat quality, and environmental changes, e.g. climate change. These results have implications for FLW mitigation in Irish primary production, indicating the need to prioritise horticulture and tillage, especially vegetables. Potential mitigation actions, e.g. improving soil health and increasing animal welfare standards, offer the opportunity to reduce FLW and contribute to national agricultural development goals, with positive implications for food production potential in fisheries and aquaculture.

A carbon budgeting tool to compare Ireland's policy options for agriculture, land use and forestry (AFOLU) in support of effective societal climate actionPaul R Price¹¹Dublin City University (Energy and Climate Research Network)

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This presentation describes the use and initial findings of a new open-source spreadsheet tool to enable quantitative inclusion of agriculture, forestry and land use (AFOLU) greenhouse gas (GHG) emissions in comparison of society-wide climate action options. Clarity in carbon budgeting for national policy assessment is needed because global and national climate action is *not* currently aligned with global carbon budgets to stay within the Paris Agreement temperature goals of limiting to “well below 2°C” above pre-industrial and making efforts to limit to 1.5°C. In global and “fair share” national climate action, CO₂-only carbon budgets, constraining total future fossil fuel use, critically depend on also achieving reductions in non-CO₂ climate pollution, particularly methane (CH₄) and nitrous oxide (N₂O). Inclusion of non-CO₂ gases and land use CO₂ is therefore crucial to assessment of Ireland's climate action policy alternatives because of an emissions profile with a comparatively large fraction of AFOLU emissions, increasing N₂O and CH₄, predominantly due to beef and expanding dairy agriculture, and substantial and rising net CO₂ land use emissions (unlike other EU nations that have substantial net removals). The spreadsheet tool now in development leverages the recently developed GWP* methodology to calculate cumulative CO₂ warming equivalent (CO₂we) AFOLU emissions by gas and in aggregate. Comparing illustrative scenarios for effective society-wide climate change mitigation reveals that Ireland's AFOLU policies have crucial implications for Paris-aligned climate action. Complex but critical trade-offs between GHGs and sectors are clarified, including the effect of AFOLU's carbon budget on the total future budget available for fossil fuel energy. Supplementing the primary requirement for radical measures to limit fossil fuel and cement emissions, substantial and sustained cuts in total national AFOLU emissions, particularly through methane reduction, likely requiring reductions in total ruminant output, appear to be critical to the feasibility of achieving net zero CO₂we by 2050. This likely means that the AFOLU sector must become “climate negative” for the next several decades, in the specific sense of achieving substantial negative CO₂we emissions. This would correspond to an overall reduction in AFOLU annual mass emissions rate (CO₂eq) by 35–60% by 2050. Large scale land use interventions to limit carbon losses by timber harvest and from organic soils are also important. Review comments on the draft AFOLU carbon budget tool are welcome, download draft tool here: <https://tinyurl.com/AFOLU-CB-tool-DCU>,

An Examination of the Non-Traded Residential Solid Fuel Market

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Research by the Environmental Protection Agency has highlighted issues surrounding poor air quality in our cities, towns and villages, with emissions of particulate matter a cause of concern. One of the leading contributors to emissions of particulate matter in the residential sector is the burning of solid fuels, such as coal, peat and wood. There are therefore clear motivations for encouraging the transition away from the use of solid fuels to more sustainable space heating alternatives. With the success of the smoky coal ban and its recent extension to all large towns, there are renewed calls to broaden the restrictions to other smoky solid fuels and to facilitate a nationwide extension on the ban. A recent public consultation has also been opened by the Department of the Environment, Climate and Communications on the development of new solid fuel regulations.

The transition from the use of solid fuels to more sustainable space heating alternatives faces some obstacles. One is the level of non-traded solid fuel use or the grey market. Up to now there has been little research on the extent of this market and the characteristics of the participants in this market. This research project, funded by the EPA, uses a survey of a sample of residential solid fuel users to examine these issues. The survey asked the households to identify the sources of their solid fuels and then categorised them into trade (e.g. local fuel retailer) and non-trade (e.g. branched wood) sources.

Analysis of the survey data indicated that non-trade sources account for approximately one-third of the total quantity of solid fuel consumed by the sample of solid fuel users with peat (sod turf) and waste, branched or foraged wood being the biggest contributors to non-trade consumption. Solid fuel users who source the majority of their solid fuels from non-trade sources are predominantly on low-incomes and low education and located in rural areas and the Border, Midlands, West and Mid-West regions. These findings highlight the extent of the non-traded solid fuel market as well as the relative ease in which they are sourced. Ensuring access to smoky non-traded solid fuels is prevented, either on the demand or supply side, would be crucial for the effectiveness of any new solid fuel regulations.

Characterisation and atmospheric reactions of Volatile Organic Compounds emitted by Sitka Spruce

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Trees emit a wide variety of volatile organic compounds (VOCs) into the atmosphere where they undergo chemical reactions to form secondary organic aerosols (SOA) that have a large impact on Earth's climate. Sitka spruce (*Picea sitchensis*) is the most commonly planted tree species in Ireland; however, the VOC emissions are not well characterised. As a result, the aerosol formation potential and climate impacts of the species are also undetermined. Two 3-year old Sitka spruce trees were housed in a plant growth chamber with 14 hours daylight at photon flux density $350 \mu\text{mol}^{-1}\text{m}^{-2}\text{s}^{-1}$ at 24°C and 10 hours darkness at 18°C. Teflon enclosures surrounding some branches were supplied with purified ambient air to carry the emissions into a Time-of-Flight Chemical Ionisation Mass Spectrometer (ToF-CIMS) for real-time chemical analysis. Air samples were also collected using adsorbent tubes and the VOCs subsequently analysed using off-line thermal desorption gas chromatography-mass spectrometry (TD-GC-MS). Over 60 individual compounds were detected using this combination of on-line and off-line analyses. The emissions consisted of a mix of hydrocarbon and oxygenated compounds, that were dominated by $\text{C}_{10}\text{H}_{16}\text{O}$, monoterpenes ($\text{C}_{10}\text{H}_{16}$) and oxygenated terpenoids ($\text{C}_{10}\text{H}_{18}\text{O}$). A series of experiments were performed to assess the atmospheric reactivity and SOA formation potential of the Sitka spruce emissions. Air containing the emitted VOCs was transferred to an atmospheric simulation chamber, and hydroxyl (OH) radicals were generated to initiate the atmospheric oxidation of the VOCs. The decay of the VOCs was monitored by ToF-CIMS and SOA formation and growth were characterised using a scanning mobility particle analyser (SMPS). Analysis of the chemical composition of the SOA produced is ongoing.

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Online Characterisation of Organic Compounds in Wintertime Air Pollution in CorkNiall O'Sullivan¹, Julien Kammer¹, Elena Gomez Alvarez¹, Stig Hellebust¹, John Wenger¹¹School of Chemistry and Environmental Research Institute, University College Cork

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Emissions from domestic solid fuel burning are the major source of wintertime air pollution in Ireland and strongly impact on human health. However, the chemical composition of these gaseous and particulate emissions is not well characterised, and can vary with location and the type of fuel burned. Furthermore, the volatile organic compounds emitted from domestic solid fuel burning can react with atmospheric oxidants (OH, O₃, NO₃) leading to the formation of secondary organic aerosol (SOA). The contribution of domestic solid fuel burning to ambient SOA is still unclear, due to the complexity of the chemical processes involved. To address this question, a field measurement campaign was conducted during winter at an air quality monitoring station in Cork City where atmospheric pollutants, namely ozone, nitrogen oxides and PM_{2.5} are continuously monitored. A time-of-flight chemical ionisation mass spectrometer (ToF-CIMS) was used to characterize the chemical composition of the gas phase in real-time.

During the 12-day campaign, there were regular evening time pollution events characterised by elevated levels of PM_{2.5} and NO₂. During one event, PM_{2.5} concentrations reached 180 µg/m³. The ToF-CIMS detected over 400 gas phase organic species during the campaign, many of which were wood burning markers that also peaked during the evening hours. Wind direction and wind speed data, indicate that these emissions originated in local residential areas, confirming that wintertime pollution events in Cork are dominated by domestic fuel burning emissions. A range of nitro-organic species were also detected, which may be indicative of night-time atmospheric processing of the primary emissions by nitrate radicals (NO₃). During the campaign, a more sustained increase in PM_{2.5} concentration coincided with the arrival of a chemically processed air mass, dominated by small organic acids and other oxidized species. Thus, while solid fuel burning produces significant amounts of primary PM_{2.5}, secondary particle formation is also important and can affect air quality in regions far away from the initial source. Finally, advanced statistical analysis (Positive Matrix Factorisation) was performed to help identify which of the hundreds of species detected by ToF-CIMS were associated with local solid fuel burning or the processed air mass.

Acknowledgements

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Assessing the value of urban trees: lessons from the South Parish

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The value of trees in an urban setting have been widely demonstrated providing, as they do, a range of ecosystem services including visual amenity, carbon sequestration, air filtering, flooding reduction and biodiversity enhancement. This is all the more important given that 60% of the world's population is expected to live in cities by 2030. As part of a Community-Academic Research Links (CARL) initiative, trees in the South Parish area of Cork city centre were surveyed and mapped between 2019 and 2021. To-date, 968 trees have been surveyed across c. 1.15 km² and these data allow us to draw conclusions as to the value of trees in an urban setting in Ireland as well as their impact in aesthetic terms and their carbon storage and sequestration ability. The visual amenity value of the trees was estimated to be in excess of €712,224 using the Helliwell system, with some minor adjustments. As expected, larger, older trees had greater visual amenity values. The rates of carbon storage and sequestration were estimated using the i-Tree Eco tool. Annual carbon sequestration of the trees was found to be approximately similar to the amount of carbon which a single Irish person's activities produce in one year. This was found to be in line with international studies. These results suggest that carbon sequestration, while relevant, should not be the main focus campaigns promoting the planting and protection of urban trees.

**Can community engagement in wind energy help to achieve a social license to operate:
results from a national survey**

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Wind is the cheapest form of renewable energy in Ireland. Although the Renewable Energy Support Scheme offers the opportunity to increase the technical diversity in renewable energy projects in Ireland, wind farm development is crucial to meet national and EU renewable energy targets. Policy is evolving quickly. Recent developments include support for community-led energy projects, compulsory community benefit funds for new projects. A scheme to provide citizen investment in developer-led projects is in the pipeline.

Our paper is aimed at better understanding the ways in which community participation in wind energy can be improved through combined measures focused on the themes of i) community engagement, ii) direct investment and co-ownership in projects by the public and iii) enhancing current practice by developers in establishing community benefits schemes. We are examining these themes by reviewing international experience, developing databases and surveying stakeholders in the Irish context.

We are not aiming to develop a one-size-fits-all methodology but a dynamic framework with core components and adaptable components. Community participation should be designed to leverage favourable contextual factors and overcome unfavourable ones – for all actors. The results will provide a framework for engagement in Ireland to promote the 'social licence' to build, own and operate wind energy projects from the communities in which they are located.

We are conducting a national survey to get a comprehensive view of the issues and preferences of the public relating to the three aspects of community participation: engagement, co-ownership and community benefit funds. The survey includes choice-based conjoint analysis where the trade-off between the different aspects are examined together as well as individually. In this presentation we present the results of the national survey.

The science of the precautionary principle in environmental lawRhoda Jennings¹¹School of Law, University College Cork, Ireland

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Uncertainty is inherent in science and the scientific method. It is more prevalent in complex systems such as those of the natural world. The precautionary principle is a legal rule used to address scientific uncertainty for the purposes of legislative action. There is no one clear definition of the principle. At a European Union level, a communication paper on the principle was drafted by the European Commission (the "Communication")^[1] in order to give clarity to its application. The Communication placed responsibility on the European Courts to elaborate on and define the parameters of the precautionary principle. According to the Communication recourse to the principle begins with a scientific evaluation. At a practical level, the application of the principle is triggered by scientific endeavour and at a risk analysis level, the precautionary process is rooted in science.

As science and scientific evidence are at the core of the precautionary principle, the boundaries and application of the principle are intrinsically linked to science. This study analyses how the science of the precautionary principle has been interpreted by the European Courts in environmental law cases and the consequences this has for the definition and ultimately the effectiveness of the principle in safeguarding the environment.

The findings indicate that the European Courts are cognisant of the importance of scientific data in decisions concerning the precautionary principle and are willing to engage with the scientific evidence. However, in most instances the courts are reluctant to scrutinise the data adequately. This may lead to a situation where the court is not in a position to determine whether the scientific evidence objectively justifies taking precautionary measures. The courts are also inconsistent in defining the parameters of the science underlying the application of the principle. This brings no clarity to the type of science that informs the principle nor to the definition of the principle itself.

As the precautionary principle is intended to guard against potential negative impacts that may arise due to scientific uncertainty, an ineffective and ill-defined principle leaves the environment open to unnecessary risks. The study further explores how the principle itself and the science informing its application can be developed in a more effective manner in order to develop trust in the precautionary process and to address the uncertain nature of scientific knowledge for the purposes of environmental policy and legislation.

[1] Communication from the Commission on the precautionary principle COM(2000) 1 final.

Integration of ecosystem services and natural capital within the Irish policy landscapeAndrew Neill¹, Cathal O'Donoghue², Jane Stout¹¹School of Natural Sciences, Trinity College Dublin, College Green, Dublin 2, Ireland²National University of Ireland Galway, Galway, IrelandCorresponding Author Email Address: anneill@tcd.ie

Ecosystem service and natural capital concepts connect socio-economic systems to nature and propose a common framework for environmental decision-making. These concepts have become commonplace within academic literature and embedded within high-level environmental policy discourse, including EU environmental directives. As a member state, Ireland is subject to EU environmental directives but also shapes its own environmental policy and reporting. This study addresses the knowledge gap regarding the integration of ecosystem service and natural capital concepts within the Irish policy landscape and explores how this differs over time and between policy domains. We applied mixed-methods content analysis to a purposeful sample of 50 Irish policy documents spanning primary producing sectors (agriculture, forestry, and the marine), biodiversity strategies, and environmental reporting from 1996-2020. First detected in 2008 and subsequently increasing in occurrence, a total of 442 explicit references to the term "ecosystem service" were found, compared to only 92 references to "natural capital". Biodiversity policy and environmental reports contained 70% of ecosystem service references, and 87% of natural capital references. Explicit use of these terms was linked to themes of biodiversity, conservation, societal benefits, EU and international policy influences, degradation of nature, and valuation—including economic valuation. Qualitative analysis revealed 34 ecosystem services described within the sample documents of which biodiversity, biomass production, habitats, recreation, and energy were the most common. Implicit language describing ecosystem services such as "public goods", "non-market benefits", "environmental benefits", and "environmental services" were found throughout the sample. This study shows that inclusion of cultural services and nature's socio-cultural benefits predate the formal ecosystem service framework within Irish policy, especially relating to biodiversity and habitat conservation. While the ecosystem service framework has crossed the science-policy interface in Ireland beginning in 2008, this has occurred more readily in policy domains more closely connected to nature such as biodiversity policy. This incomplete, fragmented, and unequal integration raises questions about cohesion with EU and international policy trajectories and downstream implementation and impact. Ireland must address these gaps if it is to meet the EU mandate for all policy to conserve and restore Europe's natural capital.

Climate empowerment and participation in Ireland: lessons learned from the National Dialogue on Climate ActionYairen Jerez Columbié¹, Barry O'Dwyer¹, Pádraig Hogan¹, Marguerite Nyhan¹¹SFI Research Centre for Energy, Climate and Marine (MaREI), Environmental Research Institute (ERI),
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In recent years, concern over the impacts of climate change has risen in the public sphere, with global and national calls for emission abatement along with the need for increasing public participation and climate empowerment to co-develop effective and fair policies. Action for Climate Empowerment (ACE) is a term adopted by the United Nations Framework Convention on Climate Change (UNFCCC). It refers to Article 6 of the Convention's original text, which focuses on six priority areas: education, training, public awareness, public participation, public access to information, and international cooperation (UNCED, 1992). The implementation of these six areas has been identified as the pivotal factor for inclusive public participation in climate action (UNESCO, 2016). Consequently, an improved ACE agenda is expected to be adopted at the Conference of the Parties (COP) 26 in Glasgow in 2021, building upon the Doha Work Programme on Action for Climate Empowerment (2012–2020) (FCCC, 2012). In this light, the EPA-funded project Connecting People to Climate Change Action: Longitudinal Analysis for Informing Participatory Frameworks in the National Dialogue on Climate Action (C-CHANGE) (2020–2021) aims to improve our understanding of environmental participation to specifically support the implementation of Ireland's National Dialogue on Climate Action (NDCA) and future environmental and climate dialogues. The NDCA is a forum for engagement, capacity building and local action, connected to the Climate Action Plan and the National Adaptation Framework. The research combines the methods of a critical review, critical discourse analysis and ethnographic research through focus groups, surveys and interviews, in order to provide impact indicators and guidelines to assess the NDCA pilot process and to better understand and implement environmental and climate dialogues in Ireland.

A Digital One Stop Shop to Engage Citizens in Sustainable DevelopmentAnnie Duffy¹, Ger Kelly¹, Martin Hill¹¹Munster Technological UniversityCorresponding Author Email Address: annie.duffy@cit.ie

Awareness of climate change and biodiversity has grown exponentially in recent years. Many targets outline decarbonisation and biodiversity goals that seek to mitigate the existing and predicted devastating effects of our current trajectory. Citizen engagement in community projects can directly involve groups with these mitigation activities through sustainable transport development, biodiversity growth or the energy transition by introducing efficiency measures and reducing fossil fuel dependency. Citizen engagement can also raise awareness about emissions abatement requirements, leading to the acceptance of sustainable technologies and fostering respect for the environment. Pursuing community citizen science projects have many positive economic and social benefits for communities, including creating local employment, improving social cohesion and the community environment. Despite the substantial co-benefits of such local sustainability initiatives, the process of developing a community project can be complicated and time-consuming, often deterring groups from pursuing such an endeavour due to a lack of a clear pathway, resources and guidance. A digital platform that provides connections between communities focusing on similar topics and enables them to support each other is proposed to remedy this. Creating such an online environment can empower interested parties to collaborate and facilitate project growth while inviting other groups to participate in existing or emerging ventures. This shared community space can enable groups to learn from existing projects and be inspired by their progress and success. The Interreg project ECCO, which is focused on developing community energy projects across Europe by utilising the knowledge and experience of thriving projects to define support structures and guide younger groups towards success, has developed and is testing such a platform. The project proposes a 'Community Readiness Level' to determine project maturity and commissioning options. Creating a structured maturity matrix enables the project development process to be described in sequential detail, identifying distinct phases in the process. This structured pathway can guide emerging groups at each development phase when they may be unsure of the next steps. Furthermore, specialised support mechanisms can be developed for each stage to increase readiness level and promote local action. These mechanisms can consist of financial guidance, educational masterclasses or tools to aid further development. Citizen engagement is the crux of growing community energy projects, ECCO strives to facilitate a digital 'community of communities' to inspire and guide groups through the development process while increasing knowledge and acceptance of renewable technologies and other sustainable activities.

Urea-derived Graphitic Carbon Nitride (u-g-C₃N₄) Films for Photocatalytic Water RemediationAmit Kumar Singhal¹, Pilar Fernandez-Ibañez, Patrick Dunlop, John Byrne¹NIBEC, Ulster University, Newtownabbey, BT370QB

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Population growth accelerated industrialization and modern development have an adverse effect on water quality with various kinds of chemical and microbiological pollutants/contaminants. The consumption of contaminated water can communicate diseases such as diarrhea, cholera, dysentery, typhoid, and polio due to presence of pathogenic microorganisms. Semiconductor photocatalysis has been reported to be effective for the degradation of a wide range of chemical pollutants in water and for the inactivation of a range of microorganisms. Graphitic carbon nitride, a visible light active photocatalyst has been reported to be a narrow band gap semiconductor (~2.7 eV), physically and chemically stable, and earth abundant in nature. In this study, exfoliated g-C₃N₄ was prepared using urea as a precursor by two step synthesis through thermal polymerization. The prepared samples were analysed for physicochemical properties like surface area, porosity, morphology, crystal structure etc. by BET surface area analyser, FESEM, XRD and FTIR. The photocatalytic performances were evaluated by the degradation of phenol as a model organic pollutant and *E. coli* inactivation. Analysis of XRD and FTIR spectra confirms the polymerisation of the precursor to g-C₃N₄. BET nitrogen adsorption-desorption isotherms confirm the significant increase in specific surface area from 52.7 m²/g to 183.9 m²/g because of exfoliation. The photocatalytic results present that exfoliated urea assisted g-C₃N₄ shows improved photocatalytic activity than its bulk counterpart probably due to a higher surface area. Exfoliated carbon nitride gave additional 15% phenol removal and 1.5 log *E. coli* disinfection compared to bulk carbon nitride in 5 h of solar simulated irradiation. This work provides an investigative insight for the future work to be done in the development of carbon nitride as a photocatalyst.

An Economic Analysis Tool for Assessing Benefits from Dredging ProjectsBrano Batel¹, Joe Harrington¹, Ross O'Sullivan¹, Alasdair Hamilton²¹Munster Technological University²Scottish CanalsCorresponding Author Email Address: branislav.batel@cit.ie

The EU Interreg-funded SURICATES project aims to increase sediment use for erosion and flood protection by providing port and waterway managers with new large-scale solutions for sediment use. The management of dredged sediment is a major challenge globally for ports and waterways. As part of the SURICATES project, an economic modelling and analysis tool has been developed to inform stakeholders of the potential economic benefits associated with beneficially using dredged material. The model developed allows analysis of financial costs and benefits associated with the use of dredged sediment. It analyses the economic impacts of beneficial use of dredged sediment in terms of Gross Domestic Product (GDP) contribution and jobs created for sediment management projects in the SURICATES partner countries (Ireland, Scotland, France, and the Netherlands). The methods for estimating the direct/indirect/induced impacts on GDP and jobs created are based on industry specific Type I & Type II multipliers and coefficients, derived for each country using Symmetric Input-Output Tables with the economic impacts downscaled to NUTS2 and NUTS3 region levels using Simple Location Quotients (Carey & Johnson, 2014)[i]. The model is designed to cover complex processes involved in beneficial use of dredged sediment in erosion & flood protection scenarios including beach nourishment, dyke construction, land reclamation and wetland creation. The model allows the user to select the region where the dredging project is located, allowing the corresponding regional coefficients to be applied. Inputs include a wide range of relevant project specific processes and characteristics for dredging and placement operations. The model uses a range of pre-defined unit costs based on data gathered from a wide range of national and international sources. The model outputs include the direct, indirect and induced effect on GDP and jobs created. The model has been satisfactorily validated with application to completed dredging projects in Castletownbere, Co. Cork, Ireland and Falkirk Canal, Scotland.

[i] Carey M.A., Johnson T.G., 2014, 'Ireland's Input-Output Framework – Where Are the Regions?', *Bordelands*, Issue 4.

Phosphorous recovery from Irish municipal wastewater effluent using locally sourced recycled calcium productsCiaran O'Donnell¹, Joe Harrington¹, Denise Barnett¹, Niamh Power¹¹Department of Civil, Structural and Environmental Engineering and Sustainable Infrastructure
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Phosphorus (P) is a vital life-sustaining nutrient, that cannot be substituted or artificially produced. Mineral P fertilisers are critical to sustain modern farming practices and subsequent global food production. Mineral P fertilisers are typically derived from finite phosphate rock, there is much uncertainty over the long term sustainability of phosphate rock reserves. In recent years, numerous technologies have been developed to recover P from municipal wastewater, approximately 1,475t of P is available for recovery from Irish municipal wastewater effluent annually. The recovered product can be used as an indigenous and renewable P fertiliser. A number of P recovery technologies have been developed to recover P using calcium (lime) precipitation. Lime increases the effluent's pH and calcium content, inducing favourable conditions to encourage precipitation and crystallisation of calcium phosphate. A prevalent issue affecting the long term sustainability of this recovery process, are concerns surrounding hydrated lime's high carbon footprint. The terminal process of converting calcium carbonate CaCO_3 (limestone) to calcium oxide CaO (lime) is regarded as an extremely energy-intensive process, coupled with the fact that large quantities of CO_2 are released from the thermal degradation of the limestone. To enhance the sustainability of the P recovery process four potential sources of waste calcium products produced at a sustainable scale within 100km of the Munster Technological University Cork campus were investigated. The products selected for possible inclusion in existing P recovery systems include bone char, oyster shell char, gypsum (plasterboard) and wood ash. The bone char and oyster char were produced by pyrolysis, using a muffle furnace at 650° . The P removal analyses was conducted on a series of Jar tests using artificial effluent with a PO_4^{3-} content of 4.5mg/l. All recycled products required additional pH adjustment using NaOH, to induce P removal. The recycled gypsum was the most successful waste calcium product, reducing the effluent PO_4^{3-} content from 4.5 mg/L to 1.05 mg/L (76% removal) at a dose of 0.325 mg per jar. Based on this removal efficiency 1,121tP could be recover from Irish municipal wastewater effluent annually. This was followed by wood ash which produced a linear P reduction trend over the incremental dosing rates, reducing the overall effluent PO_4^{3-} content to 1.52 mg/l, both of which are below the urban wastewater treatment directive requirements of 2 mg/l. Recycled gypsum was the most suitable recovered calcium product which will be further tested in the large scale P recovery pilot plant.

Experimental and numerical investigation on fire performance of cross-laminated timber panelsMuhammad Yasir¹, Andrew Macilwraith¹, Kieran Ruane¹, Des Walsh¹¹Munster Technological University

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Cross-laminated timber (CLT) is a sustainable and environmentally friendly construction material which is durable and recyclable. The supply of timber to the construction industry from Irish forests is predicted to increase by almost 100% by 2035. In addition, the population of Ireland will grow by almost 20% by 2040. Ireland will require 550,000 new homes and supporting infrastructure such as schools, hospitals, etc. to meet this population demand. The research project discussed here is focused on the development of sustainable buildings to meet Ireland's future building demands using CLT produced from Irish grown timber as the main construction material.

The main concern about CLT is its safety and performance on exposure to fire. Eurocode-5 provides a simplified methodology to determine the fire resistance of mass timber elements. However, CLT is not explicitly discussed in the Eurocode-5 and, therefore, research is required to study the fire performance of CLT.

In this research project, an experimental study of CLT floors and walls exposed to a standard fire was performed. The CLT floors and walls were manufactured from Irish timber. Fire testing of the CLT panels was undertaken at the test kilns at Munster Technological University. Finite element (FE) models of CLT panels were developed using Ansys and Abaqus FE software. The results of FE analysis were compared with the experimental results which showed that the FE analysis gave sufficiently accurate results to allow for the development of full-scale computational models of a prototype CLT building.

The research reported here is funded by DAFM (Department of Agriculture, Food and the Marine) as part of the MODCONS (Modular Mass Timber Construction for the Circular Economy) Project which is being undertaken by NUI Galway and Munster Technological University. The MODCONS project will provide a strong foundation to develop and test a sustainable building solution using Irish timber to support national needs while creating export opportunities in the sector.

Keywords: CLT, finite element analysis, fire testing, sustainable material, Irish timber

Analysis of factors influencing road transport CO₂ emissions – A case study of Dublin and Stockholm.David Demilade Onireti¹¹School of Civil and Structural Engineering, Technological University Dublin

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Climate change and GHG emissions have drastically increased awareness globally due to its threat to sustainable human development. Since the Kyoto Protocol in 1997, countries have increased efforts to strengthen the global response to the growing threat of climate change. In Ireland, the transport sector is a significant driver of the challenge of mitigating CO₂ emissions. Specifically, road transport accounted for 95.8 per cent of CO₂ emissions in the Irish transport sector. Rapid urbanisation and economic development have resulted in the increasing demand for transportation. With the global urban population now exceeding 50 per cent, the inhabitants of cities are recognised as significant agents of CO₂ emissions. Achieving a deep reduction in urban transport emissions increasingly moves into the spotlight for mitigating climate change. Formulating possible deep carbon-reduction strategies requires a clear understanding of the evolving emission trends in urban areas. Thus, this study employs an additive logarithmic mean Divisia index (LDMI) decomposition technique to analyse the driving determinates of the road transport CO₂ emissions in Dublin and Stockholm during 1998-2018. Dublin experiences the highest share of CO₂ emissions in Ireland, resulting from a large population and high traffic volume. Sweden has continuously decreased its transport CO₂ emissions for years while maintaining its economic growth; thus, it is an excellent case study for a comparative study. Hence, in this study, Stockholm, a Swedish city with a relatively similar urban area and population density to Dublin, is assessed. First, the CO₂ emissions from five motorised transport modes: vehicles, buses, heavy-duty vehicles (HDV), light-duty vehicles (LDV), and motorcycles, are calculated for both cities. Subsequently, the additive LMDI technique is used to decompose changes in CO₂ emissions into six driving determinants: population, economic activity, traffic intensity, modal share, energy intensity, and energy mix. The decomposition analysis should identify critical drivers to achieve low-carbon transportation. Then, the results of the decomposition in Dublin are compared with that in Stockholm. Based on the results, certain effective carbon-reduction strategies from Stockholm can be developed for Dublin.

Assessment of microplastics in Irish freshwater river sediment

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Microplastics (MPs) are environmental pollutants of growing concern. Awareness of MPs pollution in marine and freshwater environments has increased in recent years. However, knowledge of MPs contamination in freshwater sediment is limited. To improve this in relation to Irish river sediments, we collected and analysed sediment samples from sixteen selected sites along the river Barrow (RB). Microplastics were extracted through density separation method, after which their size, colour, and shape were analysed under a stereo microscope (Optica SZM-2). Attenuated total reflection Fourier transform infrared (ATR-FTIR) spectroscopy was used to identify polymer types. The total recovery of MPs from the selected sites was 690, with fibers as the dominant MP type. The highest concentration of MPs was 155 MP fibers per kg of sediment found in samples collected from Graiguenamanagh, Co. Kilkenny (GK). The majority of the recovered MPs were polyethylene (PE), polypropylene (PP), nylon, and cellulose acetate fibres in all the samples. Overall, this study highlighted the presence of MPs in Irish river sediments and provided a baseline for future studies on MPs pollution. Further research is needed to better understand sources, distribution, and effects of MPs to freshwater ecosystems,

Investigating the association between fluorescent constituents of dissolved organic matter and disinfection byproduct formation in drinking water sourcesElena Fernandez Pascual¹, Jean O'Dwyer¹, Connie O'Driscoll², John Weatherill¹¹School of Biological, Earth and Environmental Sciences, University College Cork²Ryan Hanley Ltd, Innovation House

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Fluorescence excitation-emission matrix spectroscopy coupled with parallel factor analysis (EEM-PARAFAC) has been widely applied to evaluate dissolved organic matter (DOM) precursors of disinfection byproduct (DBP) formation during water disinfection with chlorine. Many studies have indicated close correlations between DOM PARAFAC components and DBPs. However, it remains unclear whether individual PARAFAC components are associated with specific DBP classes. The present work is the first global scoping review to investigate correlations and associations between DOM PARAFAC components and the potential formation of specific DBP classes in twenty-eight studies. A total of 10 different DBP classes were associated with 71 PARAFAC components of which 69% had humic-like characteristics, 24% were related to protein-like compounds and 7% were classified as microbial humic-like components. Overall, recurrent relationships between PARAFAC components and DBP classes could be observed. While carbonaceous DBP classes (trihalomethanes, haloacetic acids, haloacetaldehydes and haloketones) were most frequently associated with humic-like components (78%, 67%, 89% and 80%, respectively), nitrogenous DBP classes (haloacetonitriles and N-nitrosamines) were largely related to components of the protein-like group (57% and 67%, respectively). The outcome of this review highlights the need for further research on the association between DBPs and fluorophores to provide deeper insights into the use of EEM-PARAFAC components as surrogates for predicting DBP formation potential in drinking water sources. Efforts need to be strengthened in the evaluation of emerging and potentially more harmful DBP groups (e.g. haloacetonitriles) and poorly investigated PARAFAC components (i.e., microbial humic-like components).

Water Quality & Resources 1**Method development and monitoring of Watch List chemicals in Irish surface waters over a three year period**

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Contaminants of emerging concern (CECs) which do not have adequate data on occurrence in the environment are being added to the Watch List under the Water Framework Directive. The WL contains multiple CECs or groups of CECs with differing chemistries which can make analysis of surface water samples increasingly complicated due to the multiple extraction and analysis methods needed^{1,2}. Because of the low levels (ng.L⁻¹ range) at which WL chemicals may occur in surface waters, reaching the detection and quantification limits needed to monitor these micropollutants presents a challenge. In this work, an analytical approach involving solid phase extraction (SPE) and liquid chromatography tandem mass spectrometry (LC-MS) was developed for monitoring 2nd Watch List substances in Irish surface waters. This is the first time data for the full expanse of the Watch List has been generated in Ireland. Conditions from extraction to analysis were optimized for recovery of this broad range of compounds at the ng.L⁻¹ concentration level. It was found that the pesticide metaflumizone was not compatible with the evaporation and solvent exchange step of SPE, and therefore analysis of the direct eluent was performed for this compound prior to blow down. Two LC-MS methods were used for detection of the full suite of 15 analytes, in which estrogens were determined separately to the other analytes due to inefficient ionization of these analytes when used in the main method. Matrix-matched calibrations were used resulting in good linearities ($R^2 < 0.99$) for the majority of compounds excluding the estrogens. Detection limits were in the low ng.L⁻¹ range. All studied analytes aside from estrogens are below the EU stated target LODs. The methods were applied to 21 field samples taken from surface waters across Ireland over a three-year period from 2018-2020. Frequently detected analytes from the second Watch List, occurring in approximately 50% or more Irish samples, were the three estrogens, three macrolide antibiotics and four out of five studied neonicotinoid pesticides. The majority of these detections were below quantifiable levels. This work represents the first data on monitoring of all Watch List chemicals in Ireland.

[i] R. N. Carvalho, et al, 'Development of the first watch list under the environmental quality standards directive', 2015.

[2] J. C. G. Sousa, et al, 2019, **649**, 1083–1095.

Water Quality & Resources 1**Evidence of a 'critical zone' of uptake and transformation of nitrogen, carbon and phosphorus in a contaminated headwater stream**Simon Harrison¹, John Weatherill¹¹School of Biological, Earth and Environmental Sciences, University College Cork

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Many small headwater streams in Irish catchments are contaminated by carbon-, nitrogen- and phosphorus-rich inputs from agricultural and municipal sources. Substances in these inputs may be transformed or uptaken by instream heterotrophic and/or autotrophic processes within the headwater streams themselves, and it has been suggested that these systems may function to improve water quality downstream, in the manner of 'catchment kidneys'. We investigated the concentrations of key pollutants, on three occasions in 2019/2020, in a small headwater stream in County Cork, contaminated by carbon- and nutrient water flowing into it from an agricultural drainage channel. Carbon, ammonium, nitrate and SRP concentrations were measured along the length of the artificial drainage channel, and then at spatial intervals along the length of the headwater stream, until the point where it joined a larger downstream tributary. We found little evidence of any attenuation of any parameter within the length (250m) of the drainage channel. Once drainage water flowed into the turbulent, high gradient headwater channel, dissolved oxygen levels increased greatly, and there was evidence of rapid decrease in ammonium concentrations and a concomitant increase in nitrate concentrations, indicating a zone (approx. 500m) of intense nitrification downstream of the input. Phosphorus concentrations also declined within this zone, but the decrease was less than observed for ammonium. The same pattern of nitrogen transformation was seen in winter and autumn, but to a lesser extent. Nitrate and SRP concentrations showed barely any reduction in concentration along the remaining length of the headwater stream, despite abundant instream macrophyte cover. Our results suggest that 'critical zones' may exist downstream of heavily contaminated carbon and nutrient inputs into headwater streams, that may function to partly attenuate carbon, nitrogen and phosphorus concentrations at some times of the year, potentially driven by benthic microbial processes within the stream channel. Our results also suggest that macrophyte-mediated autotrophic uptake may in fact contribute only weakly to nutrient uptake in small headwater streams. Further research is needed to elucidate these processes and to determine more precisely the pathways of nutrients within the stream.

Water Quality & Resources 1**Effect-based monitoring approaches for assessment of pharmaceutical occurrence
in surface water in Ireland**

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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 potentially toxic effects on both humans and aquatic organisms such as rising antibiotic resistance and abnormal reproductive behaviours in aquatic animals. The unavailability of effect-based bioassays to test for the biological activities of pharmaceuticals in surface waters hinders water quality assessment.

The EMPIRE project aims to develop an effect-based monitoring system using a combination of *in vitro* and *in vivo* bioassays for the determination of pharmaceutical pollution in Irish surface water. A list of thirteen chemicals including trimethoprim, sulfamethoxazole, carbamazepine, diclofenac and amoxicillin have been identified from Environmental Protection Agency (EPA) watch list and NORMAN list of Emerging Substances as they are commonly found in European surface waters with low elimination efficiency from wastewater treatment plants. A list of mode of actions (MOAs) including estrogenicity, androgenicity, oxidative stress response, and algal growth inhibition assay is currently employed to test contaminants' biological activities. Preliminary findings from YES and YAS assay for estrogenic and androgenic activities have indicated estrogenic activities for diclofenac (100 mg/L), gemfibrozil (> 100 mg/L), and erythromycin (200 mg/L). Furthermore, gemfibrozil was found to have anti-estrogenic activity at the above concentration, indicating a dual agonist-antagonist effect. Interestingly, gemfibrozil (> 100 mg/L) also induced an androgenic effect. In addition to these, we will also look at the effect of the pharmaceuticals on the life cycle and global gene expression of *Daphnia magna*.

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 the generation of data on the environmental impact of the selected pharmaceuticals.

*The EMPIRE project is funded by Environmental Protection Agency (EPA).

What are Irish Stakeholders' Opinions of Phosphorous Recovery from Rural Wastewater in Ireland?

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Phosphorous (P) is an essential constituent of mineral fertilisers and a valuable resource. Unfortunately, mineral reserves of rock phosphate are depleting on a global scale. As a result, the European Commission has recently added rock phosphate to its critical raw materials list to ensure the security of supply. P cannot be substituted with any other mineral and therefore, it is of high economic importance. It is important to investigate alternative and sustainable sources of P including P sourced from wastewater. A stakeholder survey was conducted to capture the views of key stakeholders in Ireland on the recovery of P from wastewater systems in rural areas. The survey aims to explore their knowledge, views and opinions on the importance of P recovery and identify the positive outcomes and possible challenges in the future, in a rural context. Developing alternative sources of P actively closes the nutrient cycle-loop and contributes to the circular economy. This work is currently ongoing.

Environmental Management 2**Community Engagement with environmentally sustainable planning: insights on stakeholder perceptions of implementing geodesign**Brenda McNally¹, Chiara Cocco¹¹University College Dublin, School of Architecture, Planning and Environmental PolicyCorresponding Author Email Address: brenda.mcnelly@ucd.ie

Community engagement involving knowledge co-production processes are recognised as producing more effective and actionable knowledge needed to address environmental sustainability challenges. These transdisciplinary methodologies value local knowledge and prioritise approaches that enable stakeholders, researchers and members of the public to work together to produce solutions. Within environmental planning, similarly collaborative approaches, drawing on co-creation processes and the application of the geodesign framework are an emerging area of practice. Geodesign facilitates effective co-creation in multi-system and multi-stakeholder decision situations. It provides tools and methods to engage communities and local authorities in collaboratively developing ideas and strategies through negotiation. As a result, local authority interest in co-creation processes such as geodesign workshops is growing. However, while the broader benefits of involving local knowledge alongside expert knowledge are known, stakeholder views on the impact of such processes and insights on how to implement co-creation in practice are also needed. Therefore, this paper sheds light on local authority views on implementing geodesign through qualitative analysis of a focus group discussion with planning practitioners and related staff in Fingal County Council. Stakeholder perceptions are an important starting point for understanding the effectiveness of co-creation processes as these approaches are highly dependent on the attitudes of the initiators. The paper presents findings on i) the benefits of digital participatory technologies over traditional in-person consultation processes, ii) the role of geodesign as a community engagement approach, iii) the opportunities geodesign provides for achieving climate actions at the local scale and iv) the challenges of implementing geodesign in practice. In doing so, the paper contributes to understanding of how co-creation processes for engaging citizens in future planning can contribute to the development of a healthy planet and healthy communities. The research is part of The Coastal Communities Adapting Together (CCAT) project which explores the use of a range of digital technologies, including geodesign, to engage communities in observation, learning and co-creation of local responses to climate change. CCAT is a €1.3m Ireland-Wales INTERREG project (www.ccatproject.eu) aimed at increasing knowledge of climate change adaptation amongst businesses and communities in the Irish Sea region. As coastal communities are particularly at risk of climate impacts due to coastal change, the findings provide an important case study of implementing digital participatory technologies to engage communities in climate responses.

Climate Change in the Irish Mind

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There is now a strong scientific consensus that global climate is changing, that these changes will continue and intensify into the future with a wide range of social, economic and environmental impacts. Responding to the challenges posed by climate change requires significant changes in individual and collective human behaviour and decision-making.

Over the past decade substantial efforts have been made to rectify this situation by engaging with the public through various means such as deliberative democracy and national dialogues. One of the key emerging findings is that audience segmentation is of paramount importance when communicating climate change issues to the public. Different cultures and communities require substantially different messages for effective climate change communication.

In light of this we conducted a study investigating how different sections of society understand and respond to the climate change issue, with a particular focus on the perception of climate change in Ireland. We did this primarily by conducting a systematic review of existing surveys and data such as the Eurobarometer series on climate change. We also examined past literature, government-led initiatives on climate change such as the Citizens' Assembly and we performed a longitudinal, cross-sectional and comparative analysis of the data.

We were able to build a comprehensive profile of climate change understanding and behavioural responses in the people of Ireland, stratified by age, occupation, socioeconomic factors, political affiliation and more. Our results indicate that some parts of society are aware of climate change but their own behavioural responses are lacking, others are well-intentioned but engage heavily in optimism bias. We found Irish people have much in common with their EU counterparts, but there are also many distinct facets to Irish society that must also be taken into account to promote effective dialogue on climate change.

Environmental Management 2

Evaluation of behaviour in early stages of training as an indicator of the success of guide and assistance dogs

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Working dog training programmes worldwide have high percentages of fail rates caused by behavioural issues. Behaviour tests capable of assessing the dog's suitability for these roles may be a solution to this. The IGDB is a national charity committed to helping visually impaired people and children with autism. Guide and assistance dogs at IGDB take part in a rigorous training programme, consequently, not every dog succeeds.

The fundamental aim of the Guide Dog 4.0 project is to identify factors that may indicate the dogs' success in the program at early stages of training. This poster showcases the following aspects of that research: the novel (1) behaviour test, (2) ethogram and scoring system developed with the goal (1) systematically present different stimuli and (2) objectively assess the observed behaviours. Trainee dogs at IGDB undertake such behaviour test at two data collection (DC) sessions, DC1 on their third and DC 2 on their tenth week of training. These allow the identification of the most appropriate time for assessment and observation of change in behaviour as a result of training. Trainee dogs are assessed based on reactions (ethogram and scoring system) to different stimuli presented in a systematic way (behaviour test) via video recordings. 94 dogs participated in DC1 and 56 dogs participated in DC2. Statistical analysis has been performed to test for associations between all behaviours and outcome in the training programme. Preliminary results indicate the value of behaviour test for selecting the most appropriate dogs to be used in the programme.

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Humanities for the Anthropocene: Report from a new network

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The rapidly destabilising ecological context demands new ways of conceiving research in the humanities disciplines. The paradigm of the hypermobile global researcher addressing an audience consisting chiefly of their peers might be usefully queried and supplemented by an intensified focus on local, regional and national networks and initiatives which embed ecological awareness at every stage of the research process. To this end, a network of researchers is currently forming across the arts and humanities disciplines at all higher education institutions on the island of Ireland (North and South) whose research is concerned with the human and cultural dimensions of climate crisis, environmental destruction, biodiversity loss, and the wider issues associated with the Anthropocene. The aim of the network is to provide a strong base in the humanities in Ireland for interdisciplinary research that can help to confront the multiple entangled predicaments of our time. We focus on rapid mobilisation of new critical perspectives and methodologies; incubation of new research partnerships; development of effective outreach, engagement and activism strategies; and initiation of discussions on implications for pedagogy, within and beyond the Environmental Humanities (as they are sometimes called). The Humanities for the Anthropocene initiative sees itself as part of the wider global effort to 1) bring the critical and creative energies of humanities research to bear on the pressing contemporary concerns of climate crisis, biodiversity loss and ecological degradation; 2) explore the extent to which ecological / climate crisis is also a crisis of values, ideologies, and symbolic systems; 3) harness and foster daring and ongoing rethinks of foundational oppositions such as 'local/global', 'online/offline', 'present/future', 'subject/object', 'human/non-human'; 4) release the critical energies of feminist, decolonial / postcolonial, post-anthropocentric and degrowth / postgrowth perspectives, combining discourse analysis and other core humanities methodologies with critical cultural theory to explore transformative awareness of the Anthropocene.

Mitigation of private groundwater contamination risk in the face of extreme weather: a decision-tree analysis of maintenance decisions among Irish well usersSimon Mooney¹, Jean O'Dwyer², Paul Hynds¹¹Environmental Sustainability & Health Institute, Technological University Dublin, Ireland²School of Biological, Earth and Environmental Sciences & Environmental Research Institute, University College Cork, Ireland

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The rising global incidence of extreme weather events (EWEs) has been widely demonstrated to short-circuit transport of microbial, potentially pathogenic contaminants into poorly maintained private domestic wells. As the Republic of Ireland (ROI) is characterised by high private groundwater reliance (approx. 16% of the national population) and significant rates of VTEC infection associated with supply exposure, EWEs pose a particular threat to the health of Irish well owners. With private wells in the ROI neither regulated nor inventoried, the onus to mitigate contamination risk lies with well owners themselves. However, the absence of national guidance pertaining to supply maintenance and climate change adaptation poses a major potential barrier to voluntary stewardship; moreover, determinants of well user maintenance and information seeking behaviours are largely unknown. Accordingly, the current study comprised a nationwide survey of 515 private well users, and employed decision tree analysis to model predictors of supply risk mitigation. Two binary dependent variables or "root nodes" (adoption of post-EWE behaviour and guidance-seeking behaviour) were analysed alongside a suite of demographic, supply-specific and cognitive variables. The Chi-square Automatic Interaction Detector (CHAID) algorithm was used to determine which variables best merged to explain the modelled outcome; the post-EWE behaviour model provided a predictive accuracy of 68.8% and identified EWE risk perception ($p < 0.001$), length of household tenure ($p = 0.030$) and gender ($p = 0.047$) as significant determinants of post-EWE supply risk mitigation. The guidance-seeking behaviour model returned an accuracy of 64.4%, with supply knowledge ($p = 0.021$), supply inheritance ($p = 0.011$), climate change concern ($p = 0.015$) and age ($p = 0.009$) being the most significant predictors. Study findings demonstrate the mediating role of demographic and cognitive factors in determining private well maintenance and provide a basis for future communication efforts to convey supply contamination risk due to EWEs.

Environmental Management 2**Effect of environmental factors on size and fecundity of field populations of *Impatiens glandulifera***Calum Sweeney¹, Astrid Wingler¹¹School of Biological, Earth & Environmental Sciences, and Environmental Research Institute, Distillery Fields, University College Cork

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Impatiens glandulifera has become a problematic alien invasive species across Europe, North America, Asia and parts of Oceania where it successfully competes with native species and destabilises riverbanks. In Europe, *I. glandulifera* is the tallest annual species where it forms dense stands which smother native vegetation. This study explored between- and within-site trait variation in the invasive range of *I. glandulifera* to identify trait relationships that underlie the large size and local invasion success of this species. Leaf chlorophyll content, vegetative growth traits (plant height, leaf length, leaf width, number of side branches, leaves and nodes), the number of reproductive units (sum of flower buds, flowers and seed pods) and seed pod length were determined for five *I. glandulifera* stands in the south-west of Ireland. Plant vegetative growth traits and the number of reproductive units were positively correlated, with the highest trait values observed at a shaded site with high disturbance. Chlorophyll content in the upper leaves declined with an increasing number of reproductive units at sites with low soil nitrogen, suggesting that nutrient allocation to the reproductive sinks is prioritised over photosynthetic capacity of the upper leaves. The study has shown that the ability to grow to a remarkably large size under shaded, disturbed conditions contributes to the invasion success of *I. glandulifera*. This has implications for *I. glandulifera* control globally by highlighting environmental conditions which can produce higher vigour.

Biodiversity & Ecosystems 2**Marginal abatement costs of farm-based biodiversity enhancement measures
using a scorecard approach**

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The economic and environmental efficiency of publicly funded 'action-based' agri-environment schemes (AESs) and measures have been questioned by researchers and policy makers. Among the most critical weaknesses identified in AESs across EU Member States are the lack of incentives for achieving actual results and insufficient targeting. This study proposes a flexible approach for the appraisal of the cost-effectiveness of biodiversity improvement measures. Specifically, a total of 10 measures from the biodiversity literature have been selected for evaluation. For the purposes of this study, 16 types of farms were modelled to assess the potential of selected measures to enhance biodiversity in farm semi-natural grassland habitats. These farms provide the baseline against which the abatement potential of measures are modelled. The cost-effectiveness analysis is based on the calculation of cost-benefit (CB) ratios on a per hectare basis. CBs are calculated by dividing the change in habitat quality due to farmer adoption of a measure by the associated change in family farm income. Thus, the analysis involves measuring the ecological impact of a proposed measure as well its economic impact. The assessment of the ecological impact of proposed measures is based on extensive field survey data, the use of tailored ecological scorecards, and expert judgement. We consider that our approach is highly relevant and useful tool for the cost-efficient delivery of biodiversity benefits by farmers to the public.

A genomic assessment of the genetic integrity of Irish *Bombus terrestris audax*Sarah Larragy¹, Joe Colgan², James Carolan¹, Jane Stout³¹Department of Biology, Maynooth University, Co. Kildare, Ireland²Institute of Organismic and Molecular Evolution, Johannes Gutenberg-Universität Mainz, Mainz, Germany³School of Natural Sciences, Trinity College Dublin, College Green, Dublin 2, Ireland

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Bombus terrestris audax is an important pollinating bumblebee species that is native to Ireland and is also imported for crop pollination. Imported bumblebee colonies may pose risks to native pollinator populations through hybridisation with locally adapted populations. Evaluating the genetic diversity, distinctness, and signatures of selection in the Irish *B. t. audax* population is essential to identify and protect our native genetic resources.

Individual-based, whole-genome sequencing (WGS) was used to evaluate an immense range of biomarkers across the bumblebee genome. The genomes of 32 wild, Irish male *B. t. audax* bumblebees from 27 sites across Ireland were sequenced, alongside German, Turkish and commercial representatives. Pair-ended sequencing (150bp) was performed on an Illumina NovaSeq6000. The raw genomic data were quality assessed, filtered, and aligned prior to variant calling which identified biallelic single nucleotide polymorphisms (SNPs). We used a principal component analysis (PCA) and cluster analysis to assess population structure. Signatures of selection in the Irish and between the Irish and commercial populations were identified through nSL and F_{ST} analyses, respectively. Gene ontology mapping was performed to identify enriched biological functions among genes with the highest signatures of selection.

Both PCA and cluster analyses indicate that the Irish *B. t. audax* population is genetically separated from non-Irish and commercial bumblebee groups. Males collected in Eastern counties in Ireland show the highest proportion of non-native alleles, suggesting potential admixture with non-Irish *B. terrestris* bees. Genes in the top 1% of both the F_{ST} and nSL outputs were associated with morphogenesis, organogenesis, neural development, and sensory perception.

The findings of this study will improve our understanding of native Irish *B. t. audax* evolution and may have implications for future policy development and the management of commercial bumblebee imports.

Biodiversity & Ecosystems 2**Captive-bred Atlantic salmon released into the wild have fewer offspring than wild-bred fish and decrease population productivity**

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The release of captive-bred animals into the wild is commonly practised to restore or supplement wild populations but comes with a suite of ecological and genetic consequences. Vast numbers of hatchery-reared fish are released annually, ostensibly to restore/enhance wild populations or provide greater angling returns. While previous studies have shown that captive-bred fish perform poorly in the wild relative to wild-bred conspecifics, few have measured individual lifetime reproductive success (LRS) and how this affects population productivity. Here, we analyse data on Atlantic salmon from an intensely studied catchment into which varying numbers of captive-bred fish have escaped/been released and potentially bred over several decades. Using a molecular pedigree, we demonstrate that, on average, the LRS of captive-bred individuals was only 36% that of wild-bred individuals. A significant LRS difference remained after excluding individuals that left no surviving offspring, some of which might have simply failed to spawn, consistent with transgenerational effects on offspring survival. The annual productivity of the mixed population (wild-bred plus captive-bred) was lower in years where captive-bred fish comprised a greater fraction of potential spawners. These results bolster previous empirical and theoretical findings that intentional stocking, or non-intentional escapees, threaten, rather than enhance, recipient natural populations.

An Ecosystem Services Approach Applied to Sediment Management

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The ongoing need for improvements in navigable access to, and expansion of, ports and harbours are major drivers of activity in the international dredging and sediment management industries. Sustainable development is a key aspect of this ongoing investment in port and harbour infrastructure.

The application of ecosystem services has become increasingly important as a tool in evaluating the impacts of projects and involves classifying, describing and assessing the value of natural resources and ecosystem services in terms of the benefits that humans can derive from nature. An ecosystem services assessment can inform and provide quantifiable information and data on the development of a project, allowing for more informed decision making and for example allowing for a better comparison between different project options at a planning stage.

An ecosystem services assessment tool has been developed as part of the EU Interreg-funded SURICATES (Sediment Uses as Resources In Circular And Territorial Economies) project to provide an ecosystem services analysis and assessment for sediment management projects.

The ecosystem services assessment tool has been applied to the sediment management aspect of a potential harbour development project. A number of different sediment management scenarios have been analysed including wetland creation, dyke construction and beach nourishment, in addition to the more traditional approach of disposal at sea.

The ecosystem services assessment undertaken demonstrates the value of beneficially using sediment with a 'Building with Nature' solution as opposed to the more traditional disposal at sea approach. This ecosystem services assessment approach can inform clients, stakeholders and policy makers of the benefits of applying 'Building with Nature' solutions to real sediment management projects.

Pesticide residues in pollen and nectar of crops and wild plants from agricultural fields in Ireland.Elena Zioga¹, Blánaid White², Jane Stout¹¹Botany, School of Natural Sciences, Trinity College Dublin, Dublin 2, Republic of Ireland²Analytical Chemistry, School of Chemical Sciences, Dublin City University, Dublin 9, Republic of Ireland

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Most pesticides applied in Ireland, in terms of volume, are Plant Protection Products (PPPs), including herbicides, fungicides and insecticides. When systemic PPPs are applied via spraying or as seed treatments, they get dispersed in soil and water and can be translocated through the plant tissues, contaminating nectar and pollen of both crops, and nearby growing wild plant species. Pollen and nectar are the main food source for bee pollinators and this oral exposure, along with direct contact through spraying, is of concern for their health and for the delivery of pollination services. To determine potential levels of exposure, there is a need to assess the presence and quantify the concentrations of these PPPs found in pollen and nectar, both within and beyond the target plants. This information would contribute to setting a more defined European legal framework for active ingredients that pose a risk to beneficial insects. To address this issue, Ireland was chosen as an example of a European country and the most extensively used systemic PPPs were selected targeted for analysis, as systemic PPPs have potentially negative impacts on pollinating insects. Oilseed rape and field bean were chosen as model crop species since they are the most cultivated and pollinator attractive arable crops in Ireland. Since brambles are so abundant and a valuable food source for bee pollinators in field edges during the summer months, they were chosen as model wild plant species. For a representative sample, several fields in the southeast of Ireland were included and a minimum of 1000 flowers were collected from each model plant in every site, to extract the required amounts of pollen and nectar for chemical analysis (~ 100 mg and ~ 100 µl respectively). For the PPP chemical analysis, extraction protocols including Dutch Mini Luke and QuEChERS were utilised as appropriate. The frequency of detection and the concentration of the target PPPs in nectar and pollen samples from each site were determined by the appropriate validated Liquid Chromatography - Mass Spectrometry (LC-MS) method, to estimate the PPP exposure risk for nectar and pollen feeding pollinators. In this presentation, preliminary findings and future challenges will be discussed.

NEPTUNUS: Closing the gap in life cycle assessment of Irish seafood

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Life cycle assessment (LCA) is a biophysical accounting technique, that has been used to estimate the environmental impact of seafood since the early 2000's. The majority of studies using LCA on seafood have occurred in France, Spain and Norway, with some additional studies originating from Asia. Despite this widespread use around the world, there is a distinct lack of LCA studies and life cycle inventories (LCI) for seafood in an Irish context. To date, the published literature focuses on aquaculture - with an LCA study of perch (*Perca fluviatilis*) production and seaweed (*Saccharina latissima*) accounting for the sum total of Irish datasets.

This knowledge gap will however soon be closed through the Interreg Atlantic Area project, NEPTUNUS. The goals of NEPTUNUS are to develop circular economy strategies for seafood supply chains, investigate the water-energy-seafood nexus and develop a LCI database of seafood for the Atlantic Area. It is this third goal that is making strides to baseline and develop LCIs and LCAs of species of national significance and their production chains. Through NEPTUNUS, LCIs on aquaculture activities such as oyster, mussel and organic salmon production are being developed. The project is also collating the first LCIs of pelagic and inshore fishing activities. Processing and packaging of seafood products such as smoked salmon, mussels and oysters are being benchmarked alongside sites that are valorising the waste streams from these processing activities. The results of this project in Ireland will be the generation of over 15 LCIs and LCAs of seafood products, processes and waste streams paving the way for further development of life cycle approaches and circular economy strategies that may lead to increased sustainability of the sector and aligning with recent EU policies (i.e. Green Deal and Farm to Fork Strategy).

**Life cycle assessment as a tool to boost eco-innovation
and circular economy strategies in the Atlantic Area**

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Eco-innovation and eco-design are currently a trendy way of improvement products, processes and services but it is also the only way to correctly develop a circular economy that avoids or minimizes the use of virgin and limited resources of the planet. Life cycle assessment is one of the main tools applied in this context, due to the involvement of all stages, from the raw material extraction to the final recycling or deposition in the landfill.

The sustainable development of the seafood sector in the Atlantic region requires key actions for resource efficiency based on life cycle thinking, incorporating producers, policy makers and consumers in the decision-making process. Besides, multiple strategies must be carried out and some of them are proposed in Neptunus project: addressing food waste prevention actions linked to the seafood supply chain; implementing the UN Sustainable Development Goals on seafood waste at a multiregional level; applying of a common seafood waste measurement methodology aligned with global standards; creating a seafood waste stakeholder's platform with the involvement of all seafood chain actors and Atlantic countries; clarifying legislation to facilitate food donation, in order to introduce social justice; consumer education and changing public attitudes towards waste minimisation.

Featured Interreg Session**Packaging environmental impact on seafood supply chains – A life cycle assessment review**Cheila Almeida¹¹Instituto Português do Mar e da Atmosfera – IPMA

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Packaging is fundamental for food preservation and transportation but generates an environmental burden from its production and end-of-life treatment that can be different depending on type of packaging used. We assessed packaging contribution to the environmental performance of seafood products by reviewing life cycle assessment (LCA) studies. A selection of 32 seafood LCA case studies including packaging were evaluated by both qualitative and quantitative analysis. The qualitative analysis assessed how direct (e.g. packaging material) and indirect impacts (e.g. influence on seafood loss and waste) have been considered, while the quantitative analysis evaluated packaging contribution to products' weight and climate change impact.

The qualitative analysis revealed that seafood LCAs focus mainly on direct environmental impacts arising from packaging materials, for which some articles conducted sensitivity analysis to assess materials substitution. Recycling was found to be the most common recommendation to diminish direct potential environmental impacts arising from packaging end-of-life. However, recycling depends on many factors, among them, the recyclability rate of materials, and other end-of-life options that avoid packaging production and its disposal, such as reuse, should also be considered.

Quantitative analysis revealed that packaging has a lower contribution when considering freezing, chilling and other post-harvesting processing. It represents on average less than 5% of product's climate change impact (less than 1 kg CO₂ eq/kg seafood) and 6% of product's weight. However, packaging production of cans contributes significantly to the overall climate change impact for canned products. It contributes on average with 42% of product's climate change impact and 27% of products' weight. Packaging material production is more relevant to aluminum, tinplate and glass than for plastic and paper.

Since packaging can contribute significantly to the total environmental impact along the seafood supply chain, we concluded that it is essential to include packaging in life cycle inventories and to describe their associated processes in LCA studies to reach an accurate environmental performance of seafood products.

**Impact of the 2018 European drought on microbial groundwater quality in private domestic wells:
a case study from a temperate maritime climate**Jean O'Dwyer¹, Carlos Chique¹, John Weatherill¹, Paul Hynds²¹Irish Centre for Applied Geoscience (iCRAG), Trinity College Dublin²School of Biological, Earth and Environmental Sciences, University College Cork

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A significant volume of research over the past two decades has highlighted both direct and indirect links between climate change and groundwater quality. However, to date, few studies have sought to explore the relationship(s) between drought conditions and groundwater quality in i) private (unregulated) groundwater sources, or ii) temperate maritime climates not commonly prone to drought events. The Republic of Ireland (ROI) represents an appropriate case-study due to its' high reliance on private groundwater supplies, and while the region is largely unaffected by climatological extremes, modelling studies indicate that drier summers and drought conditions will increase in frequency. Accordingly, the current study sought to quantify the effects of the Summer 2018 drought experienced throughout Europe on private groundwater quality in the southwest of Ireland via an opportunistic field study. A repeated measures sampling campaign comprised of "drought" (June/July) and "post-drought"(October/November) analyses of 74 wells was undertaken, with complementary mapping and statistical analyses. Both Total Coliforms (TCs) and *Escherichia coli* (*E. coli*) were present during both drought (TCs: 42/74; 56.8%, *E. coli*: 7/74; 9.5%) and post-drought (TCs: 42/74; 56.8%, *E. coli*: 18/74; 24.3%) sampling periods. *E. coli* contamination during drought conditions was unexpected due to an absence of recharge or infiltration for microbial transport. Bivariate analyses suggest a hydrodynamic change, with the significance of *E. coli* sources and pathways shown to switch between sampling periods i.e. a shift from a combination of regional and local (site specific) contamination mechanisms, to solely site-specific mechanisms. More specifically, during drought conditions, septic tank density ($p = 0.001$) and local subsoil type ($p = 0.009$) were both associated with the presence of *E. coli*, while neither variable was significant during post-drought conditions. The current study is the first to provide a quantitative comparison of private groundwater quality during and after a large-scale drought event in a temperate maritime climate and may be used to improve our understanding of the effects of extreme events, and thus necessary preventative and monitoring strategies, going forward.

A new tool to resolve heavy metal and sulphur signatures from ombrotrophic peat bogsLucy Blennerhassett¹, Emma Tomlinson¹¹Irish Centre for Applied Geoscience (iCRAG), Trinity College DublinCorresponding Author Email Address: blennel@tcd.ie

Ombrotrophic peat bogs are raised above the ground surface. This makes them excellent archives of atmospheric deposition as they have little to no interaction with groundwater and receive all of their nutrients from the atmosphere. Resolving heavy metal signatures from peat has long served the field of environmental geoscience. Applications include tracking the history of anthropogenic pollution by fossil fuel combustion, mineral exploration and the use of leaded petrol or measuring natural fluxes of heavy metals to the atmosphere. Volcanic eruptions are a natural source of a range of different heavy metals. During eruptive activity, volatile metals combine with sulphur and are transported through the atmosphere as aerosols, where eventually they will be deposited. Therefore, enrichments in heavy metals such as mercury within peat profiles, have been used to track volcanic activity in the past, although most volcanic aerosols are found at the poles in ice cores. Traditionally, metal signatures have been resolved from peat bogs using solution-ICP-MS, which is a technique that digests a sample into solution via a range of different acids. Although this technique is highly sensitive and can detect low element concentrations, it may be precluding the true element signature in peat, as volatile heavy metals and sulphur may be removed during sample preparation. Electrothermal vaporisation-inductively coupled plasma-optical emission spectrometry (ETV-ICP-OES) offers a less destructive way to analyse peat samples for heavy metals by vaporising the solid material directly, thus retaining volatile metals and/or sulphur. This may allow an improvement in efficiency, cost and ease of use compared to previous techniques, while maintaining sensitivity. As such, ETV-ICP-OES offers a range of potential applications in environmental geoscience, such as analysing profiles of anthropogenic pollution in soils or peat or resolving signatures of volcanism that can be compared to the well-established records in ice cores.

Tackling Sustainable Development Goal 13 via carbonate precipitationNiamh Faulkner¹, Juan Diego Rodríguez-Blanco¹¹Irish Centre for Applied Geoscience (iCRAG), Trinity College Dublin

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Sustainable Development Goal 13 is Climate Action. The goal is to “take urgent action to combat climate change and its impacts” (United Nations, 2015). Similarly the aim of the Paris Agreement is to limit the increase in the global average temperature to well below 2°C above preindustrial levels. Ireland’s own Climate Action Plan aims to cut greenhouse gas emissions by at least 30% by 2030. Carbon capture and storage (CCS) is essential in order to achieve these targets. Permanently trapping CO₂ in geological reservoirs via carbonate mineralization is extremely efficient. Basaltic rocks are considered as a great potential repository for CCS because of their Ca²⁺, Al³⁺, Na⁺, Mg²⁺ and Fe²⁺ content, and their abundance on the Earth’s surface (~10%).

An in-depth knowledge of carbonate systems is needed to understand the geochemical conditions under which carbonates form and transform to other non-C-bearing minerals during CCS. The carbonate system is complex and there is still a discrepancy between field data, modelling and experimental work about the conditions under which certain carbonates form e.g. pH and pressure.

Experimental work studying the effects of foreign ions (Al³⁺, Mg²⁺, Ca²⁺, Ba²⁺, Sr²⁺) and variables like temperature, pH, and time on the synthesis of carbonates furthers this understanding. We investigate carbonate synthesis using both solution mixing and calcite seeding in aqueous solution, at ambient and hydrothermal conditions. Powdered XRD is used for phase characterisation for identification and quantification. Crystals are imaged with SEM-EDS, which gives insight on potential orientation of overgrowths. The sensitivity and complexity of certain carbonate minerals & mineral systems is evident in a number of trials. In situ, real time analysis of carbonate formation is monitored using time resolved UV-vis spectrophotometry. It provides further insight into the formation mechanisms and stability pathways of carbonate minerals. The inhibitive effects of certain ions (e.g. Mg²⁺) on CaCO₃ growth are demonstrated using UV-vis. Dawsonite (NaAlCO₃(OH)₂) is considered to be a key carbonate for CCS, yet understanding of its formation. Efforts to synthesize it were impeded by preferential formation of Al-oxides, such as boehmite (AlO(OH)). This highlights that the effect of different foreign ions on carbonate is subject to the ionic potential of the ion.

This knowledge will provide insight into the transformation pathways of injected CO₂ into carbonate minerals and the potential fluid-host rock interactions. Thus, furthering efforts to improve the storage of sequestered CO₂ in geological deposits and CO₂ mitigation.

Systematic review of metal contamination in European urban soils: progress and future directionsHannah Binner¹, Timothy Sullivan², Maria E. McNamara¹¹Irish Centre for Applied Geoscience (iCRAG), Trinity College Dublin²UCC School of Biological, Earth and Environmental Sciences,
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Metal contamination of urban soils is widespread across Europe and is of great concern as it impacts food production and the safe supply of drinking water. Current knowledge of the extent of soil contamination in Europe, however, is limited. Here, we conducted a systematic review of metal contamination in European soils based on 136 peer-reviewed studies spanning 94 cities across 24 European countries. Our results show that over half of all studies are from (in descending order) Italy, Spain, Poland, Portugal and Greece. The top three countries are represented by data from ten or more cities, while most other countries are represented by data from five or fewer cities. No data are available for 20 European countries, and an additional six countries are represented by data from only one city. National background levels were exceeded in almost half of European cities studied, especially those in Italy, Poland and Spain; national guideline levels were exceeded in almost one-quarter of cities, especially those in Italy and Finland. National guideline values are most commonly exceeded for (in descending order) Pb, Zn, Cu, Cr and Ni. Elevated concentrations of metals are usually assigned to anthropogenic sources, primarily traffic, industry, soil history, domestic coal combustion and mining. Geogenic sources are invoked less commonly but are usually linked to the underlying bedrock or parent material. This study has several major recommendations. Future studies should focus on existing knowledge gaps, especially sites in Central and Eastern Europe. We propose a standardised method for the recording of metal data to allow more comprehensive comparison of data from different studies. A dual approach of identifying metal sources and, where possible, reducing metal release, combined with remediation of contaminated soils should be employed in order to maintain soil metal concentrations within guideline levels.

Spatiotemporal assessment of microbiological contamination in Irish groundwater environmentsLuisa Andrade¹, Paul Hynds¹, Martin Boudou¹, John Weatherill¹, Jean O'Dwyer¹¹Irish Centre for Applied Geoscience (iCrag), Trinity College Dublin.Corresponding Author Email Address: luisa.andrade@ucc.ie

Groundwater is the primary drinking water source for approximately 2.2 billion people worldwide, and over 750,000 people in the Republic of Ireland (RoI). However, protection and regulatory policies surrounding these resources are generally lacking and, where present, enforcement is insufficient. This leads to widespread instances of microbiological contamination, the most common cause of health issues related to groundwater consumption globally. In Ireland, for example, groundwater consumption has been associated with the transmission of Verotoxigenic *Escherichia coli* (VTEC); a bacterial infectious disease, for which the RoI continuously displays the highest incidence rates in Europe. As such, identifying and understanding the sources and potential drivers of microbiological contamination in groundwater environments is critical to preventing human health issues. Accordingly, this research analysed groundwater monitoring data collected by the Environmental Protection Agency from 2010 to 2019 to elucidate the prevalence of faecal coliforms (FC, used as indicator of microbiological contamination) in the RoI, and the determinants potentially mediating their occurrence. During this 10-year period, 8,300 groundwater samples were collected and tested for FC, across 284 monitoring wells. Analytical results highlight the prevalence of FC in Irish groundwaters, with 37.8 (2015) to 52.3% (2011) of monitoring wells containing the indicator species at least once per year. Spatial analyses also show that of the three aquifer types sampled, monitoring wells in karst limestone (n=100) exhibited significantly higher rates of FC presence annually (median=62.9%); $23.8\% \pm 4.1$ and $47.7\% \pm 4.7$ higher than rates found in poorly productive (n=149) and fissured bedrock (n=35) aquifers, respectively. This is attributable to the large void spaces, characteristic of karst geomorphologies, which allow microbiological contaminants to enter the aquifer via preferential flow and bypass natural attenuation processes. The results from this study may provide valuable information to relevant custodians, stakeholders and policymakers when developing action plans to protect groundwater resources and safeguard public health.

Trace Analysis of Haloacetic Acids in Environmental Water Samples using High Pressure Ion Chromatography-Mass SpectrometryJanine Boertjes¹, Elizabeth Gilchrist¹¹University College Cork - School of Chemistry

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Disinfection of drinking water is essential for reducing outbreaks of waterborne diseases. The most common chemical disinfection technique used in Ireland is chlorination. This technique also produces disinfection by-products through reactions with natural organic matter present in the source water. One such group of disinfection by-products are the haloacetic acids (HAAs), which are suspected to have adverse health effects, such as carcinogenicity, mutagenicity, and developmental, reproductive, and hepatic toxicity. Therefore, the presence of these HAAs in drinking water is becoming increasingly regulated and the recently revised EU Drinking Water Directive now includes limits for five of the HAAs. Besides their presence in prepared drinking water, the detection of HAAs in environmental waters are also of interest.

The detection of these chemicals can be achieved using ion chromatography (IC), a technique for the analysis of charged inorganic and organic species. Recently, there has been increased interest in coupling IC to mass spectrometry (MS) in order to gather structural information at high sensitivity, especially in the area of trace analysis. A previous limitation with IC was the speed of analysis, as it is generally not run at high pressures due to instrument limitations. However, with the recent emergence of high pressure IC (HPIC), there is great potential to improve separation times, therefore increasing sample throughput, without compromising on resolution and efficiency.

Herein, we present the development and performance of a fast and sensitive HPIC-MS method for the detection of HAAs in environmental water samples. The single quadrupole MS offers excellent sensitivity with limits of detection achieved in the low ppb range. This approach was then applied to water samples collected from various localities in Ireland.

Uncharted Waters: UV Filters in the Freshwater EnvironmentIrene O'Callaghan¹, Timothy Sullivan¹¹School of Biological, Earth and Environmental Sciences, University College Cork, Cork

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Ultraviolet filters (UVFs) are designed to reduce the transmission of UV rays, and are widely incorporated into personal care products, notably sunscreens. They are typically washed off during or after use, offering numerous pathways into the hydrosphere. UVFs have come under scrutiny for both their ecotoxicological potential and their ease of transfer into waterways, but most of this attention has been focused on the marine environment. Not only do freshwaters comprise of a vital ecosystem in and of themselves, they also form an important input into the marine environment, so a comprehensive understanding of the effects of UVFs in freshwaters is essential to our understanding of its impact upon the entire hydrosphere. Existing studies that do consider the freshwater environment have largely focused on the prevalence and direct acute toxicity of UVFs, with some additional work examining indirect effects, such as endocrine disruption, and transformation pathways. To date, the full range of potential reaction mechanisms have not been examined, and little data is available regarding the toxicity of intermediates and products. The preference for acute studies offers little understanding of suspected long-term effects, with known synergistic/antagonistic effects rarely considered. Trophic transfer of UVFs has been identified as a particular threat to the freshwater ecosystem, but it has been insufficiently quantified.

In this contribution, we present a re-evaluation of insights to date regarding the potential impacts of UVFs on the freshwater ecosystem. We offer a comprehensive evaluation of the generation of radical oxygen species (ROS) from photodegradation of nanoparticulate TiO₂, and describe an example of the potential for trophic transfer. Finally, we identify knowledge gaps and conclude with a series of recommendations that we believe would encourage a more balanced approach for future studies.

Application of a centrifugal microfluidic sensing device to enable near real-time monitoring of phosphate in catchmentsJoyce O'Grady¹, Nigel Kent², Fiona Regan¹¹School of Chemical Sciences, Dublin City University, Dublin 9, Republic of Ireland²engCORE, Institute of Technology Carlow, Carlow, Ireland

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Catchment monitoring with an emphasis on water quality is a growing area of critical importance within recent years. [1] Catchments can be extremely complex systems where the quality and quantity of the water is influenced by biological, chemical and physical factors. [2] Monitoring systems are put in place to better understand the key drivers influencing the quality of the water bodies and land surrounding the catchment.

The need for real-time, reliable and robust sensing systems is still at the forefront of monitoring needs for nutrient analysis in freshwater systems. Herein, describes a fully integrated lab-on-a-disc (LOAD) microfluidic device for the detection of phosphate in freshwater catchments. 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 of the molybdenum blue assay within the chambers of the microfluidic disc design. To enable rapid analysis, a customised analysis platform has also been developed to facilitate disc rotation and automated reading on site obtained from the LOAD device.

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Water Quality & Resources 2**A Comparative Risk Assessment Framework For Antibiotic Residues In Surface Waters Originating From Human and Animal Administration**Ciaran Monahan¹, Enda Cummins¹¹University College Dublin, School of Biosystems and Food EngineeringCorresponding Author Email Address: ciaran.monahan@ucdconnect.ie

A proportion of antibiotics administered to both humans and animals can persist through the gut, and be released into the environment after excretion. The presence of antibiotic residues in surface waters can lead to selective pressure, promoting the development of antibiotic resistant bacteria (ARB). ARB, when present in surface waters, can lead to health risks for water users. While this problem is worldwide, recent studies have identified both antibiotic residues and ARB as being present in Irish surface waters. In Ireland, a review of the literature reveals 5 antibiotics that have been observed in surface waters in concentrations high enough to potentially select for resistance. The aim of this research is to use risk assessment to comparatively assess the contributions of human-administered and animal-administered antibiotics to surface water concentrations. A model framework, based on literature data, to simulate the movement of antibiotics, from their initial administration to their environmental release, was created for both antibiotics used in the healthcare and agriculture sectors. Six major antibiotic classes were examined; penicillins, macrolides, tetracyclines, sulfonamides, fluoroquinolones, and trimethoprim. Irish-specific data was incorporated to model the initial amount of antibiotics consumed per year, in human-use and veterinary use. Subsequent modelling steps model the reduction of antibiotics before release. The healthcare model incorporates the following stages: administration, excretion, removal in wastewater treatment procedures, decay, and dilution. The agriculture model incorporates stages administration, excretion, persistence in manure storage, and dilution. Finally, the relative toxicity of each class is incorporated to give a final risk quotient value for each class, in each sector. Provisional estimates suggest that the three highest risk groups overall are human-administered macrolides, penicillins, and fluoroquinolones. Within veterinary antibiotics, the greatest risk is predicted from tetracyclines. This study will be the first to design a risk modelling scenario specifically to compare the risk of antibiotic pollution from each usage type, and will do so from an Irish perspective, detailing the relative risks of antibiotics, by class, and by sector.

Water Quality & Resources 2**The application of Natural Water Retention Measures (NWRM) to attenuate flood and water quality issues in agricultural catchments**Darragh Murphy¹, Simon Harrison¹, John Weatherill¹¹UCC School of Biological, Earth and Environmental Sciences,
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Agricultural catchments are affected by elevated loadings of nutrients and suspended solids, channelization of low-order streams and the presence of complex networks of sub-surface drainage. Such human-driven alterations the hydro-morphological and biological character of agricultural landscapes have the combined effects of inducing both chronic and flood-driven surges of nutrients and suspended solids to receiving water bodies; bringing about not only degradation of habitats for wildlife, but also jeopardizing the quality of drinking waters for humans and livestock. While legislation such as the Nitrates Directive and the Water Framework Directive may, in certain cases, have aided in the reduction of the flux of water quality pressures to receiving streams, rivers and lakes, water quality continues to degrade both in Ireland and internationally at a worrying pace. Temporary retention of surface waters on land is known to reduce downstream flood risk and to encourage the deposition of suspended solids and biological uptake of labile nutrients such as Soluble Reactive Phosphorus (SRP) and Dissolved Organic Carbon (DOC). In-stream structures which help to retain Particulate Organic Matter (POM) and enhance interactions between hyporheic microbial communities and nutrients in the water column have also been shown to aid in attenuation of pollutants including fecal indicator organisms (FIOs), which pose a significant risk to drinking waters. The current study, conducted on a mixed-use farm in Co. Cork is investigating the potential for nature-based solutions, namely Natural Water Retention Measures (NWRM) such as in-stream and offline water retention areas to attenuate floods and entrained water quality pressures. Chemical and hydrological data are being collected from a low-order stream within the farm as it is diverted and temporarily retained on forested and rye-grass dominated retention areas, and as its flow is altered by in-stream structures. Preliminary results indicate that retention of stream water on agricultural grassland for as little as 6 hours can induce significant reductions in stream-borne ammonium and nitrate concentrations. These types of nature-based solutions can be installed at low-cost and can be knitted seamlessly into the agricultural landscape. The adoption of nature-based solutions to flood risk and water quality issues may offer affective protection to rural communities and natural environments, while preserving the physical infrastructure and livelihoods of rural landowners.

**Metagenomic and Physico-Chemical Characterisation of a Novel Microbial Biofilm
in a Deep Ground Water Well in Ireland**Rajesh Mali¹¹Institute of Technology Carlow

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Biofilms are comprised of a community of microbial consortia that adheres to a spatially structured surface. The term biofilm, defined by The International Union of Pure and Applied Chemistry (IUPAC) is "an aggregate of microorganisms in which cells that are frequently embedded within a self-produced matrix of extracellular polymeric substance (EPS) adhere to each other and/or to a surface". Microbial cells in this matrix can target individual interactions as well as multi-cellular processes. One key element responsible for developing biofilms among aqueous surroundings is Sulfur. This element inhabits the ecosystem and exists in bedrock, as either pyrite (FeS_2) and gypsum (CaSO_4) available on the surface of the Earth's crust. Sulfur is one example of an element whose transformation and fate in the environment are critically dependent upon microbial activities, in this case, biofilm formation. Sulfate (SO_4^{2-}) is the key terminal electron acceptor in the sulfur cycle producing an odorous compound known as Hydrogen Sulfide (H_2S). This project aims to focus on a biofilm located within a groundwater well on a farm in Loughavally, County Westmeath. The key questions to address are the overview of the community structure, the major microbes responsible for its formation, and the matrix's chemical composition. These objectives are investigated through a series of metagenomic sequencing and isolation techniques for the dominant microbes circulating the biofilm as well as potential novel species. An isolate obtained from the complex was identified as a single gram-negative microbe, *Rhodanobacter spathiphylli*. Traditional chemical analysis of the well water showed that it had a pH 7, 1000mg/L carbonate, <100 ppm heavy metals, no nitrates, elevated arsenic, 40 ppm H_2S . DNA Extraction of the biofilm is conducted to ensure adequate levels of the key microbes have been harvested to identify the species responsible for the formation and maintenance of this substance. Representative samples have been sequenced to identify those species. Long-term storage of microbial isolates will be used to transcribe the data profiles such as resistance levels to heavy metals, disinfectants, etc. This project is funded by the Presidents Research Fellowship Scheme 2020 at IT Carlow, Ireland.

The effect of sowing method on the establishment of swards with increasing species diversity

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Multispecies swards (MSS) can produce higher dry matter (DM) yields than perennial ryegrass (*Lolium perenne*) swards, while requiring lower nitrogen (N) inputs. To date, the success of various establishment methods for MSS has not been investigated. A replicated 2 x 3 factorial experiment, with two establishment methods (**EM**) and three sward types was established at the Devenish Lands at Dowth, Ireland in July 2020. Establishment methods investigated were direct drill (**DD**) versus plough, till, sow (**PTS**). The three swards investigated were perennial ryegrass monoculture (**PRG**), six species sward (**6S**) (perennial ryegrass, timothy (*Phleum pratense*), white clover (*Trifolium repens*), red clover (*T. pratense*), chicory (*Cichorium intybus*) and plantain (*Plantago lanceolata*)) and a twelve species sward (**12S**) (**6S** plus cocksfoot (*Dactyls glomerata*), greater birdsfoot trefoil (*Lotus pedunculatus*), yarrow (*Achillea millefolium*), sanfoin (*Onobrychis vicifolia*), salad burnet (*Sanguisorba officinales*), sheep's parsley (*Petroselinum sativum*)). Plots were 30 m² and received 30 kg N/ha following establishment. Establishment success was determined two weeks post-sowing; two 0.5 m² quadrats were placed at fixed positions within each plot and grass, legume+herb and unsown species seedlings were counted. Plots were harvested at eight-week intervals on 2 occasions post-establishment. Plots were cut to a sward height of 6 cm above ground level using an Etesia harvester (Etesia UK. Ltd., Warwick, UK) to calculate DM production. A sample was taken at the first harvest and hand-separated to species level to determine the proportion of DM from sown and unsown species. Data was analysed using the GLIMMIX procedure in SAS. Two weeks post sowing, there was no effect of **EM** on the establishment of grass or legume+herb seedlings/m². Legume+herb seedlings/m² in the **12S** were higher than in the **6S** (P<0.001) and the unsown seedlings/m² was lower in the **12S** compared to the **6S** (P<0.05). The number of unsown seedlings/m² was higher in the **PTS** compared to the **DD** plots (P<0.05). Eight weeks post sowing, the percentage of DM accounted for by unsown species was higher in the **PTS** compared to the **DD** plots (6 v's 21%; P<0.05) and the **12S** had a higher percentage of sown species than the **6S** (90 v's 82%; P<0.05). Cumulative DM yield was higher from **PRG** compared to other sward types (P<0.01) and there was no effect of **EM**. In conclusion, **EM** did not impact on DM yield, but **PTS** resulted in a higher proportion of unsown species compared to **DD**.

Greenhouse gas budget of a grassland on drained peat soil extensively managed for silage production in the Irish MidlandsMarine Valmier¹, Matthew Saunders¹, Gary Lanigan²¹Botany Department, School of Natural Sciences, Trinity College Dublin²Environment, Soils and Land-Use Research Department, Teagasc, Johnstown Castle

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Grassland-based agriculture in Ireland contributes over one third of national greenhouse gas (GHG) emissions, and nationally the LULUCF sector is a net GHG source primarily due to the ongoing drainage of peat soils. Reducing carbon (C) losses from drained organic soils has been identified as a key action for Ireland to reach its climate targets, and C storage associated with improved grassland management practices can provide a suitable strategy to offset GHG emissions without compromising productivity. However, research is still needed to assess the best practices and management options for optimum environmental and production outcomes. While grasslands have been widely studied internationally, data on organic soils under this land use are still scarce. In Ireland, despite their spatial extent and relevance to the national emission inventories and mitigation strategies, only two studies on GHG emissions from grasslands on peat soils have been published.

Here we present results from a grassland on a drained peat soil that is extensively managed for silage production in the Irish midlands. Continuous monitoring of Net Ecosystem Exchange (NEE) of carbon dioxide (CO₂) using eddy covariance techniques, and weekly static chamber measurements to assess soil-derived emissions of methane (CH₄) and nitrous oxide (N₂O) started in 2020.

The seasonal CO₂ fluxes observed were greatly dependent on weather conditions and management events. The grassland shifted from a C source during the winter period to a C sink during the growing season, with the Gross Primary Production (GPP) outweighing the Ecosystem Respiration (ER) in the spring. The maximum instantaneous fluxes observed prior to the first silage cut exceeded uptake of 30 μmol CO₂ m⁻² s⁻¹ and release of 10 μmol CO₂ m⁻² s⁻¹. With a biomass harvest of 2.5 and 2.2 t C ha⁻¹ respectively following the first cut in early June and the second mid-September, the biomass export is a major component of the annual budget that has the potential to shift the system to a net C source. However, the site demonstrated a high productivity and efficiency at C assimilation that compensate for its CO₂ export and release, highlighting the capacity of such system to act as a net C sink. While the initial measurements of CH₄ and N₂O fluxes appeared to be negligible, some key management events (i.e. fertiliser applications) were not captured due to national COVID-19 restrictions on movement, which would affected the sink strength of the grassland studied.

Low N₂O emission associated with deposition of sheep excreta in Irish grasslandsAude Mancia¹, Dave Chadwick², Sinéad Waters³, Dominika Krol¹¹Teagasc Crops, Environment and Land Use Programme, Johnstown Castle, Co. Wexford²School of Natural Sciences, Bangor University, UK³Teagasc, Animal and Bioscience Department, Grange, Co. Meath

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Grazing ruminants deposit urine and faeces onto pasture soils, which can cause emissions of a potent greenhouse gas, nitrous oxide (N₂O). IPCC provides default (Tier 1) emission factors EF_{3PRP}s (proportion of nitrogen (N) deposited to the soil through ruminant excreta, which is emitted as N₂O). However, due to great spatial and temporal variation, development of country-specific (Tier 2) EF_{3PRP}s is encouraged. Ireland has already generated a Tier 2 EF_{3PRP} for cattle excreta deposition but no experimental data are available for sheep. Therefore, the aim of this project was to generate Tier 2 EF_{3PRP}s for N₂O emissions from sheep excreta deposition in Irish grasslands, as well as disaggregate emissions by type of excreta, type of grassland (lowland and hill-land) and season of application (spring, summer, autumn). An experiment was carried out on two sites with contrasting soils in the west of Ireland: a well-managed lowland grassland on mineral soil and a rough-grazed hill-land pasture on acid peat soil. For each season, four treatments were applied to the soil in a fully randomized block design: control (C), sheep urine (U), dung (D), and artificial urine (AU). An additional treatment was included for the autumn application at the lowland site: sheep urine with nitrification inhibitor (UNI). Static chambers were used to measure N₂O fluxes for one year after each application. On the lowland site, a peak of N₂O flux was observed within the first days after U and AU application for each season, and there was no significant effect of treatment and season on N₂O emissions. Average EF_{3PRP}s were close to zero: -0.003 and -0.007 % for urine and dung, respectively, thus lower than the 2019 IPCC Tier 1 EF_{3PRP}s (0.4 and 0.04 for sheep urine and dung respectively). Initial results from the hill-land site showed no peak of N₂O following treatments application and near-zero EF_{3PRP}s are also expected on this site. These findings suggest very low N₂O emissions from sheep excreta deposited in Irish grasslands and highlight the importance to develop Tier 2 EF_{3PRP}s. Further research is required to explore the fate of nitrogen in these soils.

Analysis of the Soil Microbiome in Response to the Application of Recycling Produced Fertilisers (RDFs) under Irish Grassland ConditionsDemi Ryan¹, Kieran Germaine², David Dowling², Patrick Forrestal³¹Envirocore, Department of Science & Health, Institute of Technology Carlow²Institute of Technology Carlow³Teagasc, Soils, Environment and Land Use Dept., Johnstown Castle, Co. Wexford

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Phosphorus is an essential plant nutrient routinely applied to soils as an agricultural fertiliser, frequently in inorganic form. However, the world's finite phosphorus resources are depleting, while the global population continues to grow. ReNu2Farm is a North-Western European project aiming to efficiently recycle nutrients from organic sources, such as sewage sludge and food-processing waste, for use as fertilisers. The soil microbiome provides several critical ecosystem services to our planet. Therefore, it is crucial that the application of these recycled fertilisers (RDFs) exhibit no adverse effects on soil microbial diversity or abundance. To explore this in an Irish context, a field trial was executed (Teagasc, Johnstown Castle) in which two struvite and two ash RDFs were applied to soils planted with perennial ryegrass. Soil was sampled on July 7th, 2020 after the second grass harvest after RDF application to allow time for the system to equilibrate to the introduction of RDFs. DNA was extracted and outsourced for sequencing of bacterial 16S V4-V5 and fungal ITS1-5F rDNA. The bacterial and fungal microbiomes were characterised based on OTUs and subsequent alpha and beta diversity analyses were performed in QIIME2. Measurements of alpha (within treatment group) diversity, including observed OTU, Simpson and Chao1 indices showed all treatment groups had highly diverse microbial communities. Statistical tests performed found no significant differences between treatments, including a zero P control and the super phosphate (SP) mineral fertiliser. Beta (among treatment group) diversity was measured by Weighted Unifrac. PERMANOVA statistical procedure performed on Weighted Unifrac scores indicated bacterial ($p=0.001$) and fungal ($p=0.004$) communities differed among groups. Pairwise comparisons discovered several significantly different treatment groups in bacterial and fungal analysis. Interestingly, unfertilised soil exhibited significantly different microbiomes to fertilised soil in only some cases. A cattle slurry SP mineral fertiliser combination was the only treatment significantly different to all other treatments. Further investigation using the Metastat statistical method found several bacterial taxa significantly enriched in soil fertilised with cattle slurry SP mineral fertiliser combination compared to the unfertilised soil, possibly due to the high organic matter and carbon content of cattle slurry. It was found that one of the ash RDFs could potentially be problematic due to significant decreases in abundance of several bacterial taxa at the Class level. Overall, the study showed that most RDFs applied did not affect soil bacterial or fungal community ecological status.

Recycling-derived Phosphorus Fertilizers as a Sustainable Alternative to Triple Superphosphate Fertilizers in Irish GrasslandsLea Deinert¹, Israel Ikoyi², Achim Schmalenberger³¹Department of Biological Sciences, Faculty of Science and Engineering,
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Mineral phosphorus (P) fertilizer is applied to soil to improve plant growth, however approximately 80% of the applied P immobilizes quickly and becomes inaccessible to plants. Mineral fertilizer application can cause soil degradation, affecting the microbial community, which has a significant role in nutrient mobilization for plant uptake. Furthermore, these mineral P fertilizers are produced from non-renewable rock phosphate, only mined in a few sites worldwide and outside of Europe. Thus, recycling-derived fertilizers (RDFs) produced from waste streams need to be evaluated as sustainable replacement for finite mineral P fertilizer. The impact of four RDFs (two ashes, two struvites) on the soil microbiome in comparison with a P-free control and triple superphosphate (TSP) as mineral fertilizer was investigated in a pot trial and a subsequent microcosm trial (subset of samples). For both experiments perennial ryegrass was cultivated for 54 days. The pot trial was conducted at P fertilization rates of 20 and 60 kg P ha⁻¹ in quadruplicates. Struvites displayed highest P bioavailability at high P application rates in the pot trial, also yielding higher biomass on average. Furthermore, bacterial P solubilization from tri-calcium phosphate was enhanced in the rhizosphere of RDFs treatments, while the TSP treatment was negatively affected. After completion of the pot trial, bulk soil from the control, TSP and the two ashes (60 kg P ha⁻¹) were re-used in a microcosm trial. There, most probable number (MPN) analysis showed that phosphonate- and phytate-utilizing bacterial abundance was significantly increased in the poultry litter ash. qPCR of acid (*phoC*) and alkaline (*phoD*) phosphatase gene fragments found significant higher copy numbers in the ash treatments compared to TSP and control. Non-metric multidimensional scaling (NMDS) analysis of *phoD* illumina sequencing data showed significant separations between all treatments of the microcosm trial. Post-hoc analysis of the *phoD* relative abundance data revealed significantly elevated abundances of the genera *Streptomyces* and *Xanthomonas* in both ash treatments compared to TSP as well as the control treatment. RDFs facilitated microbial P mobilization, which resulted in similar plant biomass yields as mineral fertilization after the application, and higher yields on average in the following year. TSP reduced microbial P mobilization and solubilization capabilities and *phoC* and *phoD* gene abundance, however there was no difference in potential soil phosphatase activity. Overall, struvites have shown positive effects on P availability in the pot trial, while ashes demonstrated a sustained P supply that extended into the microcosm trial.

What are the Desired Properties of Recycling-Derived Fertilisers from an End-User Perspective?

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Recycling derived fertilisers (RDFs) are recycled products that come from several different sustainable sources. These products have significant potential for replacing mineral fertilisers. In the case of phosphorous, the supply is at risk and the EU placed phosphorous on its list of critical raw material, therefore alternatives sources are required. RDFs are safe to use, have a high nutrient value and are readily available. However, their uptake by farmers has been limited to date. Thus, it is important from a producer and suppliers perspective to know what are the end-users (farmers) desired properties of RDFs. Knowing this will help to develop RDF products and promote their use.

A survey was conducted across seven different countries in North-West Europe (NWE), the results were collated, assessed and statistically analysed. Over 1220 farmers and stakeholders responded to the survey. Overall, participants in Ireland that currently use or have used RDFs in the past found that a nutrient ratio that fits with crop nutrient demand was the most important quality in RDFs (89%) compared to those in NWE (80%). However, participants in Ireland that never used RDFs before, indicated that price was the most important quality in RDFs (91%) compared to participants in NWE (85%). Both farmers and advisors indicated they preferred RDFs to have a granular texture in comparison to paste and powder which were the least preferred textures. Those in Ireland suggested that a known NPK concentration was important to encourage mineral fertiliser substitution (72%) compared to the NWE countries (57%). On the other hand, those in NWE indicated a nutrient ratio that fits with a crop nutrient demand was an important quality to encourage substitution (45%) compared to Ireland (25%). In addition, both those in Ireland (68%) and NWE (64%) were willing to substitute mineral fertilisers with RDFs if they are subsidised and free of charge.

Conducting a survey is an excellent way to, directly and indirectly, engage with the stakeholders, to determine what they are looking for in RDFs to increase the use and uptake of these products. Using RDFs positively feeds into closing the nutrient cycle-loop which contributes to the circular economy.

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POSTER PRESENTATION ABSTRACTS

Determining the effect of bleaching in corals reefs on fish biodiversity, using secondary data

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Climate change and the associated knock-on devastation which occurs, continues to be a hot topic. Over the past number of decades researchers have been gathering data on the various impacts that climate change has. One such impact is the destruction of tropical coral reefs through the process of bleaching, which can occur when there is an increase in sea surface temperature. There is a symbiotic relationship between the coral host and the algae living within their tissues. Bleaching occurs when the host expels the symbiont from their cells due to stress. This is not a recent discovery and data has been collected regarding bleaching events since the 1980's. Much of this data is readily available in a number of online locations, and if gathered together could have the potential to answer some relevant research questions without the expense of conducting new experiments or the time constraints of conducting fieldwork. With this in mind, we propose to gather together already existing data regarding the bleaching of global reefs and their associated fish assemblages. Using this data, we will determine if bleaching has a significant effect on fish biodiversity. We will analyse the biodiversity present on reefs before, after and during bleaching events. The goal is to determine if there is a change in biodiversity levels on reefs that have been bleached. The various fish species will be noted and we will determine if bleached reefs support different communities from non-bleached reefs. The results from the analysis will result in a large coherent dataset for future researchers and may be useful for future conservation efforts.

The I-SECURE project: screening emerging contaminants in the Irish marine environment

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The I-SECURE project is evaluating sources and occurrence of contaminants of emerging concern (CECs) in the marine coastal and transitional waters of Ireland. This project will directly address the current lack of cost-effective methods to detect low concentration of CECs in marine water by application of advanced mass spectrometry and passive sampling techniques. These methods will significantly increase the capability to detect CECs, which constitutes an essential step in conducting long-term analyses in Irish waters, which will ultimately allow the development of new regulations and policies to protect the marine environment. The project will also identify coastal geographical areas of concern to be targeted for future investigation or management actions.

The main actions of I-SECURE involve:

- Generating novel data and new compound information on the occurrence and fate of CECs in transitional and coastal waters using novel technologies and field studies for risk-selected coastal and transitional locations.
- Studying the impacts of CECs on marine biota, from shellfish to top predators.
- Prioritising monitoring locations and chemical groups by combining the screening and toxicology data in support of national policy objectives and international best practices.
- Identifying risk-based approaches for marine monitoring in areas of concern and propose further investigations.

This project will benefit marine research capacity in Ireland by increasing human capacity in CEC monitoring in coastal and transitional waters, by enhancing the capability to generate marine data on CECs with advanced technologies, and by identifying multiple avenues for future research projects and external funding.

What is the energy balance of advanced transport fuels produced through power-to-fuel integration with biogas facilities?Nathan Gray¹, Richard O'Shea¹, Beatrice Smyth², Piet Lens³, Jerry Murphy¹¹ MaREI Centre, Environmental Research Institute, University College Cork, Cork, Ireland² School of Mechanical and Aerospace Engineering, Queen's University Belfast, Belfast, UK³ Ryan Institute, NUI Galway

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The need to reduce the climate impact of the transport sector means there is an increasing interest in the utilisation of alternative fuels. Producing advanced fuels through the integration of anaerobic digestion and power-to-fuel technologies may offer a solution to reduce greenhouse gas emissions from difficult to decarbonise modes of transport, such as heavy goods vehicles, shipping, and commercial aviation, while also offering wider system benefits. This study investigates the energy balance of power-to-fuel (power-to-methane, power-to-methanol, power-to-Fischer-Tropsch fuels) production integrated with a biogas facility co-digesting grass silage and dairy slurry. A cradle-to-gate (well-to-tank) life cycle boundary was selected to assess the energy flows of the system. Through the integration of power-to-methane with anaerobic digestion, an increase in system gross energy of 62.6% was found. Power-to-methanol integration with the AD system increased the gross energy by 50% while power-to-Fischer-Tropsch fuels increased the gross energy yield by 32%. The parasitic energy demand for hydrogen production was highlighted as the most significant factor for integrated biogas and power-to-fuel facilities. Consuming electricity that would otherwise have been curtailed and optimising the anaerobic digestion process were identified as key to improving the energetic efficiency of the system. However, the broad cross-sectoral benefits of the overarching cascading circular economy system, such as providing electrical grid stability and utilising waste resources, must be considered for a comprehensive perspective on the integration of anaerobic digestion and power-to-fuel.

**An assessment of the environmental impact of renewable energy systems
in developed countries (case study Ireland)**Oladipupo Faleye¹¹Technological University Dublin

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The world has seen rapidly increasing urbanization trends over the last century. As a result, the urban governments have demanded that the expansion of their cities be measured and monitored, as well as the effects that this growth had on the climate, the economy, and community. In these domains, the energy market plays a crucial role in preserving acceptable conditions. The definition of sustainable development tends to be a combination of many disciplines, each of which evaluates it differently. Renewable energy has been labelled the most sustainable source of energy because it is a low-carbon technology with an infinite supply. Since no CO₂-emitting combustion is involved, renewable energy is projected to have a considerably lower greenhouse gas footprint than fossil fuels. However, CO₂ emissions will be generated during the preparation of materials and the installation of renewable energy infrastructure. This research explains how a city's energy supply will benefit from a life cycle assessment. More precisely, life cycle assessment concepts will be applied to an urban energy system (within Ireland), using life cycle software- GaBi which will analyse three separate environmental impacts: global warming potential, resource depletion, and air quality. This analysis explains how a city's energy supply will benefit from a life cycle evaluation. The work presented will explain the emissions inventory as well as the LCA methodology's application to three urban energy systems (wind, hydro and solar energy). When trying to minimize each environmental effect, the Life cycle model will select the most appropriate energy system, demonstrating that a specifically designed energy system configuration will potentially produce a lower average environmental impact within an urban area. The most efficient energy systems for reducing environmental impact will be identified, and special consideration will be paid to stakeholder engagement and how environmental impact interpretation is "vulnerable" depending on which targets are set.

Biofouling studies on marine rated materials and coatings

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Materials immersed in water experience a series of biological and chemical processes, resulting in the formation of complex layers with attached organisms, known as biofouling. Biofouling in the aquatic environment shortens the life-time of immersed structures, increases fuel consumption of ships and affects the functioning and data quality of water instrumentation. All immersed instrumentation, including operational components (membranes, optical windows and electrodes), housings and mooring components are subject to biofouling and prone to irreversible damage. In marine environments biofouling has long been considered a limiting factor and is recognised as one of the main obstacles for long term in-situ monitoring. For a large percentage of deployed instrumentation, biofouling is the single biggest factor affecting the operation, maintenance, and data quality and responsible for high ownership costs to the point where it becomes prohibitively expensive to maintain operational networks and infrastructure.

The selection of materials, and coatings with anti-fouling properties has become an increasingly difficult challenge but one that must be constantly reviewed and updated to advance the development of materials, composites and coatings that can be widely used in aquatic ecosystems and allow devices and structures submerged or in contact with water to last longer and reduce maintenance costs.

In this scoping study, a range of materials commonly used in the construction of marine sensors and 2 anti-fouling paints were deployed for 1 year to test their robustness and anti-fouling performance in the estuarine brackish water ecosystem in Dublin. Exposed panels were assessed using eDNA (16S rRNA, 18S rRNA) and image analysis with microscope techniques, to characterise the biodiversity of both the microbiofouling (i.e., microscopic bacteria and algae) and the macrobiofouling organisms (i.e., barnacles and mussels). Results presented will discuss the biofouling progression on different materials and the role they have in the design of antifouling strategies. In addition, the work demonstrates the benefits of environmental testing in rapid screening of antifouling materials for the marine environment.

Integration of Biomethane into the natural gas network in Ireland

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Biomethane is a renewable gas generated from the decomposition of organic waste residues, such as bio-waste from domestic households, industrial or commercial organic waste, agricultural waste, or manure. Biomethane has a three-fold carbon emissions reduction effect: first by avoiding the natural atmospheric emission due to bio-waste, second by replacing fossil fuels, and third by using digestate, a byproduct of the biomethane production process, as carbon-rich fertiliser.

Biomethane injection in the current natural gas network is one way to reduce carbon emissions. This integration of biomethane into the gas grid is the first step towards the carbon emission reduction in the gas network. There are technical and economic factors in considering the integration of biomethane. The technical factors include biomethane quality and quantity, security of supply, and operational control at both the biomethane production plants and the injection points. The economic factors encompass the costs of biomethane production, its integration, and the resources required to ensure quality. Biomethane integration in the gas grid is a feasible solution to minimize the carbon emission in the Irish natural gas network.

Bioindicators of air pollution impacts on plant biodiversity in IrelandLorna Marcham¹, Thomas Cummins¹¹UCD School of Agriculture and Food Science,
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Deposition of reactive nitrogen (Nr) can alter the physiology of individual plants and the species composition of plant communities. This leads to local extinctions and a decline in diversity of habitats such as bogs and species-rich grasslands protected under the EU Habitats Directive. The main source of Nr in Ireland, and most of Europe, is reduced nitrogen in ammonia gas and particulate ammonium forms, originating from animal urine and faeces and synthetic fertilisers. Both of these can be transported long distances in the air but also vary locally, for example reaching high concentrations close to intensive livestock units. Ireland is party to the EU National Emissions Ceiling Directive which requires member states to reduce air pollution, including Nr deposition. As part of this, there is a requirement to monitor effects on ecosystems.

As ecosystems and the effects on them are complex, one must select certain measurements to indicate the state of the system. Such indicators are widely used in many disciplines, including ecology and environmental monitoring. Well chosen indicators of response to a pressure are reliably sensitive to that pressure while distinct from other pressures. Further criteria have been suggested for a wide range of bioindicator types, but none of these lists are comprehensive. For example some focus on the need for data collection and monitoring to fit within socio-economic constraints, while others only look at the relationship between the proposed indicator and confounding factors. Ideally, an indicator should not only reflect the state of the relevant target but also do this better than other possible indicators.

This study reviews the literature on bioindicators and from that defines criteria needed for bioindicators generally, and with a focus on monitoring nitrogen deposition effects on sensitive habitats. A process is proposed for evaluating diverse types of bioindicator against these criteria so they may be compared. The study feeds into further work to collect data on a number of potential bioindicators of nitrogen deposition. The potential indicators will then be compared so as to present advantages and disadvantages of each for long term monitoring of air pollution effects on ecosystems.

Polyester-degrading enzyme activities in marine bacteria, with potential utility in the hydrolysis of polyethylene terephthalate plastic.Clodagh Carr¹, David Clarke¹, Alan Dobson¹¹ School of Microbiology, University College Cork, Cork

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Biological plastic degradation, which employs microorganisms and their enzymes, has emerged as a promising strategy for the breakdown of synthetic polymers. Many marine bacteria have evolved to produce a range of degradative enzymes which facilitate their growth and survival in the harsh, low-nutrient conditions often present in marine environments. Marine sponge derived *Streptomyces* strains have recently been reported to produce polyesterase enzymes, which are of interest for several practical applications, including the hydrolysis of polyethylene terephthalate (PET) plastic.

Bacteria isolated from sea sponges and seaweed were screened for polyester hydrolysis activities using plate-clearing assays. Lipase and polyesterase activities were initially identified by employing tributyrin and polycaprolactone diol agar-based assay systems, respectively. Polyesterase activity was subsequently confirmed on both polycaprolactone and on PET-nanoparticle agar plates, resulting in the prioritization of six isolates for next-generation genome sequencing.

These include three *Bacillus* spp., isolated from the brown seaweed *Ascophyllum nodosum*, and from marine lake sponges *Stelligera stuposa* and *Eurypon major*, together with a *Maribacter* strain again isolated from *S. stuposa*, and *Brachybacterium* sp. and *Micrococcus* sp. isolates of deep-sea sponges *Pheronema* sp. and *Inflatella pellicula*, that were sampled at depths of 2129m and 2900m, respectively. Genome mining and comparative genomic analysis of these isolates is currently underway to identify genes encoding the observed activities and to assess homology with well-characterised PET hydrolase enzymes.

Microbes found living in association with filter-feeding sponges may have increased exposure to the plastics and microplastics that widely contaminate our marine ecosystems, thus representing a promising source of degradative activities towards synthetic polymers that could contribute to new plastic waste management strategies. The leakage of plastic into both marine and terrestrial ecosystems has been linked to several adverse health effects, further highlighting the need for solutions that help minimise the accumulation of these materials in nature.

Co-benefits for biodiversity and hydrological integrity from a results-based agri-environment scheme, the Pearl Mussel Project

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The Pearl Mussel Project (PMP) is a European Innovation Partnership where farmers, researchers and agricultural advisors are working together for the benefit of the endangered Freshwater Pearl Mussel (FPM). Within eight priority FPM catchments the PMP uses a results-based payment system to reward farmers for managing land with the aim of improving water quality. This current research is investigating the co-benefits of the novel PMP results-based approach for biodiversity and hydrological integrity of terrestrial habitats.

At plot level the PMP uses a ten-point indicator scoring system to assess farmed habitat quality. Result indicators assessed include the presence and cover of positive plants in addition to habitat structure and management. Those plots with limited ability to support FPM populations attract low scores, while plots which have a greater capacity to support good water quality attract higher scores (up to a score of 10).

Within three PMP catchments in Mayo/Galway the co-benefits of the scoring system for other elements of biodiversity were investigated. Carabid beetles and wider plant diversity (both considered good indicators of a range of habitat conditions) were sampled from peatlands and grasslands across the range of habitat conditions; poor (PMP plot score <3), medium (PMP plot score 4-7) and good (PMP plot score 8-10). Using a pulsating pitfall trap method (2 weeks open, 2 weeks closed), 555 samples were collected from 37 plots between May and September encapsulating the optimal period for carabid beetle activity. Vegetation was sampled in 111 relevés (three per plot), the placement of which coincided with the pitfall traps to inform the understanding of drivers of beetle communities.

A total of 10,225 individuals and 52 carabid species were collected and 117 plant species recorded. To date notable findings include good populations of *Carabus clatratus* (considered to be a scarce species) on peatlands and a record of *Elaphrus uliginosus*, whose known distribution is centred around Kerry. Statistical analysis is ongoing on the survey data and will compare the communities across a range of scores and habitats using diversity indices and multivariate analysis. Preliminary analysis suggests complex relationships between beetle communities and the PMP scoring system. A novel aspect of the research will be to develop a wetland fidelity index for carabids related to the PMP scoring scheme. This work will feedback into reviews of the PMP peatland and grassland score cards and facilitate understanding of their ability to reward wider biodiversity.

Water-Energy-Nutritional Nexus: improving environmental assessment of the seafood sector in the Atlantic area

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Environmental impact categories applied in Life Cycle Assessment, such as the Cumulative Energy Demand or the Water use, offer very high-value information only taking the raw materials for energy generation and the water consumption for the calculations, respectively. Although this kind of indicators allow eventual further improvements in processes, products and services, they give a bounded knowledge and, consequently, the intervention in the real economy will be always incomplete. This gap, not minor, strongly demands an interconnection between variables to reach the most precise criteria for the decision-making process.

In a seafood scenario, the nutritional approach must be included in the equation because of its relevance in health and habits but also the interconnexión with the energy and water production and consumption. Therefore, a water-energy-food nexus appears as an opportunity to integrate the three variables to improve the environmental analysis. This nexus involves, among other phases, the building of a robust database for species and seafood supply chains, the promotion of continuous improvements of products and processes along the life cycle, and the development of Green Public criteria and guidelines to get a concrete definition in the society and markets.

Currently, Neptunus project is facing this challenge through several footprint guidelines and its application in numerous case studies of fleets and companies in the European Atlantic area.

Assessment of the potential of Brewer's spent grain as a valuable source of proteinsJiao zhang¹¹Envirocore, Institute of Technology Carlow

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Brewer's spent grain (BSG) is the residue left after the separation of wort during the beer-brewing process. Ireland has a strong brewing industry producing significant amounts of BSG. Although this by-product has reported having between 14 to 26% proteins it is normally treated as waste or animal feed. The aim of this work is to assess the potential of BSG as a source of valuable proteins to use in the pharma, food, or cosmetic industries. For that, a questionnaire was done to twelve breweries in Ireland. It was corroborated that the BSG is mostly used as animal feed, the grains used in higher amounts are wheat and barley, and that the amount of BSG produced differs between 2 to 2500 tonnes a year, depending on the scale of the brewery. BSG was then obtained from a partner industrial brewery (IBSG) and compared with BSG obtain from a homebrewing process (HBSG). The moisture content of both IBSG and HBSG was compared, and the proteins were extracted using the pH-shifting method. The isoelectric point of both IBSG and HBSG extracted proteins were calculated and the proteins were analyzed using Reversed-Phase High-Performance Liquid Chromatography (RP-HPLC). The IBSG showed a higher moisture content when compared with the HBSG (74.40±0.47 % and 71.62±1.71 % respectively). Moreover, it was possible to extract protein from the IBSG and the HBSG respectively when extracted at pH 12 and 11. It is possible to conclude that it is possible to extract good quality protein from BSG and that the heterogeneous nature of this by-product presents potential to be used for the extraction of a variety of proteins that might be of interest to the pharma, food, or cosmetic industries.

Public STEAM: Inventing Transdisciplinary tools and practices for 'Education for Sustainability' in Adult and Community Education ContextsGiselle Harvey¹¹ Limerick School of Art and Design, Limerick Institute of Technology, Clare St, Limerick. IrelandCorresponding Author Email Address: giselle.harvey@lit.ie

This poster will present a developing embodied environmental adult and community education practice conceptualised as a transdisciplinary feminist public pedagogy-research framework. The purpose of the framework is to provide processes, tools and spaces for community engagement and empowered climate justice actions underpinned by an intersectional feminist human earth-care ethic. This practice responds to the problem of climate change, argued to be a crisis of culture, by transforming culturally driven destructive human-earth relations towards creative collaborative relationships which can support healthy sustainable communities and multi-species flourishing and regeneration. Non-formal adult and community education orientated to social justice is identified as a site of learning which can accommodate these transdisciplinary practices necessary to empowering transformative community led climate justice actions. However, a serious gap has emerged in the field of adult and community education in Ireland due to significant funding cuts resulting in critical social justice practices being replaced with accredited programs orientated to market needs justified through a neoliberal discourse. Additionally, Irish government policy regarding 'Education for Sustainability' in adult education reinforces this gap by focusing on the 'green economy' without an inclusion of the critical transdisciplinary practices cited as necessary for empowering collaborative transformative community climate actions. The research will address these practice gaps by developing an embodied environmental adult and community education framework using an embodied-eco-praxis process mediated through making. The framework will be explored using an art-based Participatory Action Research (PAR) methodology in collaboration with non-academic actors. These non-academic co-researchers are invited to use the framework to collaboratively research, identify and execute community led climate justice actions, and subsequently evaluate the frameworks process and tools by reflecting on the question, 'was that empowering for you'? The project is currently commencing the public outreach program, [EM] PowerGeneration, to gather a community of curiosity to this research opportunity. This workshop centred on small-scale making will generate kinetic energy using a spinning wheel in the Burren Co. Clare as a praxis starting point. The intended research outcome is a practice-based case study of transdisciplinary feminist tools, processes, and spaces through which to evaluate the benefits and opportunities they afford for community engagement on social and ecological justice issues and empowered action which can support flourishing sustainable communities and regenerative ecologies. Further, the findings of the research will be used to inform future transdisciplinary feminist pedagogical practice for the field of adult and community education in Ireland.

A critical examination of the practice and sustainability potential of foraging in Ireland

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Unsustainable food systems globally cause substantial environmental and human health deterioration and severely reduce natural resources. Transitioning towards a more sustainable and alternative food system that explores foraging rules, tools, skills and understandings (using a social practice theoretical framework) may provide citizens globally with free, nutritious food an opportunity to protect natural resources connect with nature thus their community. Foraging, defined as the search for wild sources of food, is a ubiquitous behaviour among humans and the oldest form of food provisioning. In the Global North the ability to identify, access, process and consume wild edibles via foraging, except in periods of hardship and famine have diminished. Foraging may contribute towards a sustainable food system by means of connecting people to their landscape, enhancing biodiversity and conservation protection thus offering a complementary method of free, nutritious food supply. Despite this, scholarly analyses of contemporary human foraging in the Global North remain rare.

This research will examine if foraging can transition towards a sustainable food system in Ireland. A four phase methodology will be adopted in this research project such as data acquisition, data compilation, personal interactions with foraging stakeholders and a backcasting exercise. Objectives from this research are to: identify contemporary foraging practices across communities in Ireland, assess how contemporary foraging is practiced and governed, establish the sustainability implications of these foraging practices and develop recommendations for how foraging in Ireland should be governed in the future. More broadly this research will explore the governance of foraging across communities in Ireland. The contemporary landscape of foraging is increasingly mediated through the tools of information and communication technologies (ICT). How this ICT interface affects both communities and foragers, and foraged foods has though yet to be subject to critical examination. Indeed, there are concerns that the increased visibility of foraging via these technologies may lead to overexploitation of wild foods, causing damage to local ecosystems in communities and even illegal practices. A foraging database of 52 foraging instructors across the island of Ireland has been devised detailing information on whom, where, what and for what purpose wild edibles are foraged. An Environmental Sensitivity Map has been created to identify where foraging is taking place in areas of sensitivity which is illegal yet may be undertaken inadvertently. Therefore, this will lead to designing sustainable scenarios to educate foraging instructors who foraging in illegal areas.

**Impacts of Extreme Weather Events on Mental Health – Preliminary Results of
a Global 'Scoping' Literature Review**Carlos Chique¹, Paul Hynds², Marguerite Nyhan³, Jean O'Dwyer¹¹ School of Biological, Earth and Environmental Sciences, University College Cork² Technological University Dublin³ School of Engineering & Architecture, University College Cork, College Road, Cork, Ireland

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Available evidence indicates an indisputable link between anthropogenic activity and a rapid alteration of global climate. One key concern arising from a rapidly changing climate is the impact of increasingly frequent and/or intense Extreme Weather Events (EWEs) on public health. Current evidence suggests the frequency of EWEs has increased ten-fold since 1950 in conjunction with a 0.5°C global temperature rise. EWEs have substantial socio-economic and physical health impacts; however, due to a range of impediments, their impacts on mental health and well-being remain largely ambiguous. Within this framework, a literature review grounded on a meta-analytical approach was employed to provide a novel 'empirical' assessment of the psychological impacts on populations exposed to EWEs. To integrate the wide range of psychological metrics available in the literature, inclusive of both psychopathological and well-being measures, the 'holistic' concept of 'psychological impairment' was adopted. Impairment, or morbidity, data was collated at different levels, including 'composite' (any impairment) and main (DSM-based) 'domains' (e.g., PTSD, Anxiety, Depression). Where applicable, reported risk factors ($p < 0.05$) and (pooled) odds ratios (POR/OR) were extracted and calculated from relevant studies. A total of 59 investigations were included in the final dataset. Estimated POR (1.9) indicate a high likelihood (> 90%) of (any) negative psychological outcomes among exposed individuals. Additional insights include a prevalent lack of integration of 'control' criterion among investigations. As such, collated 'pooled' data best represents 'prevalence' rates rather than a finite metric linking EWE exposure and negative outcomes (i.e., incidence). Notwithstanding, presented data serve as key reference points with high applicability in future investigations. A prevalence rate of 24% was estimated at a 'composite' level, with 24% for Depression and □ 17% for PTSD and Anxiety. Globally, Asia was the region exhibiting the highest impairment (both 'pooled' and country-specific); a factor attributed to a combination of high EWE frequency and population density. Overall, both reported risk factors and 'pooled' data highlight the higher burden among traditionally 'disadvantaged' sub-populations, namely, females, racial/ethnic minorities, and respondents with lower education and socio-economic status. Additional risk factors include belonging to an "adult" age category (aged 31-50) and experiencing higher levels of (peri-) event stressors. The results of this investigation are expected to inform relevant stakeholders in designing and/or improving bespoke intervention measures aimed at mitigating EWEs impacts on public health.

An analysis of packaging waste generation and measurementJohn Gallagher¹¹Trinity College DublinCorresponding Author Email Address: j.gallagher@tcd.ie

In 2016, two-thirds (67%) of Irish packaging waste was recycled; however, the recycling rate is only 31%. Plastic packaging use equates as 57.9 kg per year per person (kg/p/yr) in Ireland (Fig.1), compared with an average figure for the EU-28 of 31.9 kg/p/yr. Re-Wrapped project has indicated that some of the difference can be attributed to different data collection methodologies applied in Ireland versus other EU Member States. This project aims to critically compare methodologies from across the EU for the compilation of packaging waste statistics, determining their reliability and comparability based on the point of collection, the accuracy of accounting and to examine the influence of the behaviour or producers add households. The results have identified a lack of transparency in what different member states include or exclude in their packaging waste declaration, due to exceptions in the application of Extended Producer Responsibility (EPR) schemes in some European states. Through efforts at EU level e.g. setting stricter recycling targets, plastic packaging management is improving and the level of recycling is increasing, although a large share goes to incineration (often waste-to-energy) continues to be exported to third countries. Improvements in recycling rates for different polymer type plastics is necessary, to support the transition from the linear (take-make-dispose) economy to a more regenerative circular economy. The harmonisation of reported statistics for plastic packaging across Europe will support the effort of improved management and recycling.

An Assessment of the Urban Water and Wastewater Supply Systems (UWSS) of Cork City in terms of Integrated Water Resources Management (IWRP) using the City Blueprint Approach'

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This paper identifies the serious environmental crisis we are facing on a global scale in terms of threats to natural resources from increasing urbanisation and resulting increases in pollution. It outlines the global response through the UN's 17 sustainable development goals (SDG) and in particular SDG No 6 - Water and Sanitation. It emphasises the need for an Integrated Water Resources Management IWRM which feed into SDG No 6 developed from the Dublin Principles of the International Conference on Water and the Environment (ICWE) held in 1992.

This paper discusses implications of IWRM on the Urban Water Cycle which has in many cases overtaken the natural hydrologic cycle. By 2050 it is predicated that over two thirds of the world's population will live in cities. This calls an immediate response for urban water supply systems which, if taken seriously, will require a fundamental change in perceptions and political positions moving away from the traditional fragmented (silo effect) approach to one that is more holistic and coordinated.

The concepts of sustainability and resilience in terms of Urban Water Supply are discussed along with the need to establish an overall conceptual framework along with the subsequent development of indicators which are both qualitative and quantitative in nature. The framework can be used as a standard to be achieved such as the BREEAM and LEED frameworks used in the construction industry to provide comprehensive coverage of environmental, economic, social and other issues relevant to sustainability and use a mix of objective and subjective data.

The setting up of such a framework is beyond the scope of this paper but other frameworks have been identified especially the City Blueprint Approach (CBA) which is comprehensive and detailed and provides a baseline assessment of the state of existing urban supply systems in terms of sustainability and resilience and IWRM. Consequently, the City Blueprint Approach will be used as a tool as a means of assessing the sustainability of the Water and Wastewater Supply System of Cork City in terms of sustainability and resilience.

The City Blueprint Approach is the first step in the process to advance a sustainable Urban Water Cycle and Services (UWCS) in a city (Van Leuween, and Koop, 2015). This methodology has been applied to more than 70 municipalities and regions in 40 countries worldwide.

**Investigating potential pyrethroid tolerance in *Rhopalosiphum padi*,
an important BYDV vector in arable crop production**Alison George¹, John Carroll¹, Louise McNamara², Michael Gaffney³, Helena Meally²¹ Envirocore, Institute of Technology Carlow² Crops Science Department, Teagasc CELUP, Oakpark, Carlow³ Horticultural Department, Teagasc Food Research Centre, Ashtown, Dublin

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Rhopalosiphum padi (*R.padi*) is an important insect vector of yellow dwarfing viruses in cereal crops in Europe and North America. It is associated with the more virulent form of BYDV (PAV), which highly impacts crop losses due to crop stunting. In the Irish context, it would be considered secondary in importance to *Sitobion avenae* aphid in terms of its ability to vector BYDV and presence within crops. However, this is largely based on research conducted more than 30 years ago, and given the recent re-emergence of BYDV as a disease causing persistent economic crop loss, it is extremely important to re-evaluate. Controlling aphid populations is currently the only way of reducing BYDV damage as the virus has no direct control and is vectored by migrating aphids feeding on crops. Pyrethroids are a class of insecticide that target the central nervous system and are one of the few current chemicals left on the market. Resistance has become an issue in recent years with *S.avenae* now showing *kdr* (partial resistance) with an LC50 value surviving half of field rate, being discovered in the UK in 2011 (Foster et al., 2014) and Ireland in 2013 (Walsh et al., 2019). Potential tolerance to pyrethroids has been suspected in *R.padi* species (Walsh et al., 2020). In this study, 6 *R.padi* individuals were collected and colonies were established from counties Carlow (Cw1 and Cw2), Laois (Ls), Kilkenny (Kk) and Cork (Ck1 and Ck2) and were subjected to full dose response assays of *-cyhalothrin* (a commonly used pyrethroid insecticide) of 5g ai/hectare which is full field rate. The LC50 values for 5 of 6 colonies observed indicated susceptibility. The Cw2 colony showed potential tolerance with an LC50 value of 36% field rate. If there is tolerance and potential resistance occurring in Irish *R.padi* species, crop production will be challenged in the future, due to climate change, which will allow more favorable conditions for this aphid species. Understanding the level of pyrethroid susceptibility and BYDV incidence will be important to reduce the impact of chemical control to the environment by enhancing integrated pest management (IPM) strategies, and creating effective and sustainable control over this pest.

The presence of disinfectants in the environment arising from agriculture and the concurrence of antimicrobial resistance: A systematic reviewMeabh Dowler¹, Jean O'Dwyer², Paul Hynds¹¹ Technological University Dublin² University College Cork

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Antimicrobial resistance (AMR) is recognised as a global public health emergency, with global deaths attributed to AMR (~10, million) predicted to surpass cancer by 2050. Biocides refer to agents containing antimicrobial compounds for preventing/controlling harmful or unwanted organisms, including disinfectants, preservatives, insect repellents, rodenticides, and insecticides. These are frequently used in agriculture and remain relatively unmonitored with little information available regarding quantities and types used, and how they are applied in the environment. Incorrect usage or over-use of biocides potentially lead to the development of resistant bacteria. This resistance may occur from the use of sub-lethal doses of disinfectant as the exposure leads to the selection of resistant strains. Accordingly, the presented study employed a systematic review approach to answer the following questions: A) What is the environmental prevalence of disinfectants deriving from livestock farming? B) Does the presence of agriculturally derived disinfectant products in the natural environment drive the occurrence of AMR bacteria in-situ? Inclusion criteria for the identification of relevant studies included peer-reviewed journal articles from high-income countries, published between 2000 and 2021. The search was refined in two stages: the first to eliminate irrelevant papers based on the title and the second stage included reviewing abstracts to excluding papers based on the inclusion criteria. This process identified 17 studies relevant to the research questions, with comprehensive data extraction subsequently undertaken. The 17 identified studies were from Belgium (n = 3), Denmark (n = 2), Spain (n = 1), Switzerland (n = 1), Turkey (n = 1), United Kingdom (n = 1), and the United States (n = 7). The most frequently occurring disinfectants were quaternary ammonium compounds (20%), phenolic compounds (12%), sodium hypochlorite (12%), and hydrogen peroxide (10%). A high range of disinfectant concentrations were detected (<0.4 to 147.8 ng/L). Bacterial samples from animal houses obtained after cleaning and disinfection protocols were tested for resistance to various disinfectants at differing concentrations and exposure durations. Large variation was observed with respect to the susceptibility of various bacterial species to disinfectant compounds. For example, sodium hypochlorite exposure resulted in a reduction of 92.5% to 99.99% of *Salmonella* spp isolates, while quaternary ammonium disinfectants were associated with a reduction rate of 57.8% to 93%. Where protocols for disinfection were followed, the majority of compounds exhibited high bactericidal activity.

Extending the range of forest yield models to better quality soilsMaarten Nieuwenhuis¹, Charles Harper¹, Luke Dowd¹¹ UCD School of Agriculture and Food Science,
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Forecasting future timber volumes and the production of forest products is a critical part of forest management. This is important in both operational and financial planning for all forest owners and the wood processing sector. The main tool that forest managers use for this forecasting is known collectively as the dynamic yield models. These have become the standard tool for forest management planning in Ireland. The first dynamic yield models were produced for Sitka spruce in 2001 and since then models have been added for all of the main forest tree species used in Irish forestry. The dynamic yield models have brought Irish forest growth and yield modelling to an advanced standard compared to that in many other countries. Dynamic yield models allow for the prediction of stand development and timber production based purely on the current status of the trees and the planned management regime, without the need for information on past stand development estimates and management activities. However, due to recent developments in the forest estate, with afforestation of better land by private landowners now dominating, the dynamic models, especially for conifers such as Sitka spruce, have been found to inadequately cover the full range of yield classes now experienced in forest management decision making. Therefore, it has become necessary to explore ways to improve the models, especially for high and very high yield class stands.

The DYNAMOD project is carrying out an exploration of suitable data, to assess the quantity and quality of available data that consist of pairs of plot measurements at two points in time, 3 years apart, in high yield class stands. In addition, new data are being collected on the current status of a series of sample stands and their characteristics 3 years ago, using tree and stand reconstruction methodologies based on detailed tree ring analysis. Based on the assessment of these existing and new data, it will then be decided if these new data should be incorporated in the existing yield models by re-parameterising them, or to develop stand-alone models for high yield class stands.

Influence of recycled dairy processing sludge amendment on soil phosphorus availability and dynamics.Olha Khomenko¹, J.J. Leahy², Owen Fenton¹, Karen Daly¹¹ Teagasc Crops, Environment and Land Use Programme, Johnstown Castle, Wexford² Department of Chemical Sciences, University of Limerick, Bernal Institute, Limerick

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Dairy processing sludge (DPS) and second generation STRUBIUS (struvite, biochar and ash) products are being land applied as fertilizers to grassland in Ireland. Their effects on soil phosphorus (P) availability and dynamics after application are understudied. In the present incubation experiment soil phosphorus (P) availability in DPS and STRUBIUS amended soils was investigated using novel isotope pool dilution method with a ³³P radioisotope being used as a tracer. Fertilizers were applied to P rich and P deficient soils at different P application rates and incubated for 7 days. The size of the exchangeable soil P pool (E-value), reflecting the soils capacity to maintain P supply to crops over a growing season, and soil P in Morgan's extract were examined in the incubated soils.

Results showed that readily available P (Morgan's P) increased from 2.3 mg P·L⁻¹ in a P deficient soil to 6.8, 4.5, 12.9, and 10.2 mg P·L⁻¹ when treated with 180 mg P·L⁻¹ ash, hydrochar, struvite, and raw DPS respectively. In a P-rich soil Morgan's P increased from 12.3 mg P·L⁻¹ to 14.5, 14.2, 18.6, and 22.9 mg P·L⁻¹ when treated with 180 mg P·L⁻¹ ash, hydrochar, struvite, and raw DPS respectively.

The Exchangeable P pool in the P-deficient soils increased 3-fold following treatments, increasing from 18.7 mg P·L⁻¹ soil to 57.1, 37.4, 64.4, and 55.6 mg P·L⁻¹ in soil treated with 180 mg P·L⁻¹ ash, hydrochar, struvite, and raw DPS respectively. In contrast, the P-rich soil showed no significant changes in E-value from the initial value of 102.1 mg P·L⁻¹ to final values of 110.0, 108.3, 90.4, and 103.9 mg P·L⁻¹ following treatment with ash, hydrochar, struvite, and raw DPW respectively.

These results suggest that while recycled DPS has a potential to supply crops with P as an attractive alternative to conventional P fertilizers, the initial P status of the soil needs to be considered and evaluation of its impact on soil P transport, dynamics, and losses needs to be conducted. An increase of Morgan's P (intensity factor) without increase of E-value (capacity factor) in some soils indicates possible risks of P losses due to leaching. The results of this work in conjunction with data on crop response to the amendments will inform guidelines for sustainable use of recycled DPW that minimises P losses into the environment.

Comparative Analysis of the Environmental Impacts of Varying Dietary Patterns across High-income Countries from a Farm-to-Fork Lifecycle PerspectiveDaniel Burke¹, Paul Hynds¹, Anushree Priyadarshini¹¹Technological University Dublin

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The global population is predicted to increase from 7.2 billion (current) to 9.6 billion by 2050, with dietary patterns also predicted to shift significantly; for example, by 2050, animal-sourced foods and milk consumption will increase by 73% and 58%, respectively (FAO). Lancet Report 2019 states that to avoid climate and social catastrophes, including increasingly frequent extreme weather events, rising sea levels, desertification, ecosystem loss, decreased net agricultural outputs, and increased human migration, high-income countries, including Ireland, need to reduce meat consumption by 90%. Emissions from Agriculture, Forestry, and Other Land Use require reductions through national/regional changes in diet and subsequent food production patterns as these equate to 24% of global anthropogenic greenhouse gas emissions (GHGEs), with livestock-related emissions contributing almost two-thirds of the total (FAO). In Ireland, seafood and pasture-based dairy sectors are economically and culturally crucial. However, Ireland's per capita GHGEs are the highest in the European Union, with the agri-food sector accounting for 35% nationally. The Health, Environmental and Economic Impact of Diet (HEED) study is investigating and comparing current dietary patterns (omnivorous, vegetarian, vegan, recommended, and high-protein) across high-income countries through a scoping review utilising systematic review methodology to analyse GHGEs. Approximately twenty peer-reviewed studies have been identified through two online bibliographic databases, Scopus and Web of Science, which predominantly highlight current dietary patterns and their subsequent environmental impacts from a farm-to-fork lifecycle analysis perspective. Dietary patterns are being examined based on fixed inclusion/exclusion criteria to answer the research question, "What are the current dietary and food consumption habits of high-income countries, and what are the environmental impacts of these dietary habits?" Emissions and other environmental impact data are being analysed to identify associations between dietary patterns, climate change, and regional environmental quality. To date, findings suggest that by switching from a high-meat diet to a more balanced flexitarian or vegetarian diet, adverse environmental impacts will be minimised, for example, reducing GHGEs and land use. Finally, comparisons between current dietary patterns in high-income countries and Ireland will be outlined.

Biochar as a plant growth substrate amendmentEric Hynes¹, Barbara Doyle Prestwich¹, Eoin Lettice¹¹School of Biological, Earth and Environmental Sciences, Distillery Fields, University College Cork

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Biochar is produced from the pyrolysis of biomass. This highly porous substance is used as an environmental and agronomic tool for soil amendment. It has been proven elsewhere to improve soil fertility and to increase crop productivity. After biochar is added to a soil it becomes carbon neutral, thus making it a viable climate change mitigation strategy for the carbon capture and sequestration of greenhouse gases. This project is observing the effects of two biochar types (made from oak and rush, respectively) on plant growth when grown on a peat-free compost. In succession, two separate experiments were established, each running over a six week period. Each week, the plant growth response of perennial ryegrass and oilseed rape to each biochar was recorded weekly. Fresh weights and dry weights were taken at the end of each experiment. Overall, heights between the test and control plants were relatively similar throughout the experiments. Germination inhibition was experienced in plant pots with oak biochar (particularly perennial ryegrass) compared to the control. The same was experienced with rush biochar, however reduced germination was also experienced in the controls of both plant test species. At the end of the rush biochar experiment perennial ryegrass experienced the greatest plant growth. Fresh weights and dry weights of oilseed rape in the control were 1.04% and 1.06% greater than those grown with oak biochar, respectively. With perennial ryegrass, the control was 1.23% and 1.16% greater than the oak biochar specimens, respectively. With these results in mind, a long term experiment began in March to run until September. Large containers with the same ratio of biochar to peatless compost have been set up outside in an effort to 'activate' the biochar before reusing these mixtures in similar experiments to the first two above.

Impact of soil compaction on plant growth and root architecture

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Rooting is a fundamental aspect of plant development and productivity. Roots serve a variety of essential functions including physical support systems for plants in soils, water and nutrient uptake, and secretion of root exudates attracting microorganisms to the rhizosphere. These functions can directly influence a plants reliance to stress as well as affecting yield and quality. Soil compaction is a major constraint to agricultural production worldwide and has been shown to cause inadequate rooting as well as limiting plant growth and development. While tremendous progress has been made in the field of crop improvement, most efforts have focused on the easily accessible above-ground traits. Although crucial plant organs, root system studies are often thwarted by limited direct observations, destructive techniques and expensive equipment. This study relies on the use of mini-rhizotrons as a non-destructive in situ method to quantify the effect of soil compaction stress on plant performance and to measure the effect of soil compaction on root architecture (root branching and root length) using opensource image analysis software (ImageJ). Utilising inexpensive and opensource technologies enables highly reproducible experiments and extends the methodologies to a wider range of potential users. The main objective of this study is to elucidate the relationship between soil compaction and root architecture in perennial grain and oilseed crops. Preliminary results show the addition of an element of compaction through an increase in wet bulk density has an effect on branching and root diameter (root swelling) as well as above-ground traits (height, fresh weight and dry weight) of perennial rye grass (*Lolium perenne*). Similar results are seen with oilseed rape (*Brassica napus*).

Ash dieback disease in the island of Ireland: Comparison of treatments to reduce the spread of the pathogen *Hymenoscyphus fraxineus* on ash tree

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The common ash tree (*Fraxinus excelsior*) and narrow-leaved ash (*Fraxinus angustifolia*) are currently under threat by the new invasive species *Hymenoscyphus fraxineus*, which has been decimating the ash tree population in Europe and Ireland over the past 20 years. Originally from Asia, this ascomycete fungus was firstly observed in Poland in 1992, and since then, it has spread all over Europe reaching Ireland in 2012. Eradication of *Hymenoscyphus fraxineus* is no longer feasible, and so current research focuses on developing practices and treatments to reduce the spread of the pathogen.

The Nexcelsior project is a multidisciplinary collaboration between Trinity College Dublin (TCD), University College Dublin (UCD) and Agri-Food and Biosciences Institute (AFBI) in Northern Ireland. The aim of the project is to identify novel methods to control *H. fraxineus* by testing the effect of three separate treatments on the spread of the pathogen in agroforestry and forestry ash plantations on the island of Ireland. The three treatments involve thinning of the tree crown and, sheep grazing and urea spraying in the understorey of the tree stand. The effect of these treatments on *H. fraxineus* population will be assessed by quantifying the formation of the pathogen ascocarps and spores. Moreover, microclimate measurements and assessment of the microflora on the forest floor will be carried out to evaluate other changes in the ecosystem which could further impact the proliferation of the pathogen. Results from this project will help to inform future management strategies against *H. fraxineus*.

LIFOR - Improving the forecast of forest productivity in Ireland using LiDAR data.

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One of the challenges for the forest industry in Ireland is to know what amount of timber will be produced by the private forest estate in the years ahead so that it can plan its products and services. A timber supply forecast is compiled for Ireland on a five-year basis, providing an indication of the potential roundwood production over the following 20 years. However, there are a number of weaknesses in the current forecasting method, these range from using a standard estimate of non-planted areas in forests, tree species coverage in the model, and assumptions of growth rates of forest tree species.

This study investigates the scope for using aerial LiDAR data to improve the forecasting of roundwood production in private forests in Ireland by integrating data derived from aerial LiDAR scanning into the existing methods. We used LiDAR data to estimate Top Height and, associated with this, the stand productivity, and to automatically delineate forest boundaries based on vegetation height differences. The LiDAR based estimates were compared to ground-truth data and to the results of the currently used methodologies. We set out to demonstrate that our new method is more accurate and more cost effective than the existing method.

The stand extent and productivity estimates obtained using the three methods were compared and then used as input in the harvest forecast software to determine the impact of their differences on the predicted roundwood volumes.

Results from this study have indicated that the stand productivity estimates obtained using the LiDAR methodology are much closer to the field-based estimates than those obtained using the current method that is based on bio-physical site factors that can be extracted from existing GIS-based data bases. The relationships between the LiDAR estimates and the field-based ones are strongly linear and allow for the easy adjustment of the Top Height estimates from LiDAR data to the field-based ground truth values. In terms of productive area estimates, the results indicate that the uniform adjustment factor of 15% is too high overall. The combined effects of these two new estimation methods for area and productivity on the harvest forecast is still being analysed at this moment. However, the study has produced new pathways to improve forecast accuracy in terms of productivity and productive area, leading to better informed business and policy decisions in terms of timber production, carbon accounting and non-timber goods and services.

MARLSITES Project: Forest growth and root development on calcareous soils

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Inhibited growth is observed in many forest stands that are planted on marl, a calcareous limnic deposit permeated by variable quantities of shells or freshwater molluscs that presents as a subsoil or discontinuous layer predominantly beneath Midland peats. Forest tree roots have varying tolerance to calcareous material in soil solution. Indications are that all tree species are limited by this material to varying degrees, with alder (*Alnus glutinosa* (L.) Gaertn.) the most tolerant. Grant support under the Department of Agriculture, Food & the Marine Afforestation Grant & Premium Scheme is denied, and a site is considered unsuitable for forestry under the Forest Service (2017) Land Types for Afforestation, when an "acid test" with dilute (10%) hydrochloric acid detects calcareous material within 70 cm of the soil surface. However, forest managers and previous studies have reported rejected sites where successful plantations have developed. This study investigates soil conditions that may limit or promote establishment and growth of various tree species where an "acid test" detects marl or other calcareous material. Investigation into the root-limiting zones where marl or other calcareous materials are observed is being carried out in order to better distinguish boundaries between rootable and root-restricting environments. A soil-coring survey aims to sample the lower rooting boundary where calcareous deposits are noted. Split-tube undisturbed root coring at 40 cm depth intervals and 7 cm diameter are collected and subjected to X-ray Computed Tomography (CT) scanning. This captures 3D images which can be analysed to characterise details of the root–mineral interface and identify whether roots can penetrate the marl material. Preliminary results from root scanning images show the ability of roots to penetrate the marl layer on a site where 32-year-old Sitka spruce (*Picea sitchensis* (Bong.) Carr.) is successfully established. Future work included in this study is the use of the core-break method, collection of soil samples, and carrying out various laboratory tests. Tree and stand growth will be measured as height, basal area, and annual increment from stem disks, to assess the impact of variables of the soil environment on forest development. Results from these tasks will have the potential to inform future forest policy for sites where marl or other calcareous materials are present, to increase forest ecosystem resilience by better matching species and management to site conditions.

Microbial endophytes as new potential active ingredients of new potential biostimulants and biopesticides tailored for barley production and protectionDiego Dylan Bianchi¹, Fiona Doohan², Trevor Roland Hodkinson¹, Brian Murphy¹¹School of Natural Sciences & Trinity Centre for Biodiversity Research, Trinity College Dublin,
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All plants harbor within their tissues heterogeneous microbial communities of bacterial, fungal, archaeal and protist taxa. These microorganisms are also known as endophytes and play crucial roles in plant development, fitness, growth and diversification. The interaction between host plant and its associated endophytes ranges from mutualism to pathogenicity, depending on a complexity of multiple factors including the genotypes of both plants and microbes, environmental conditions, inter-dynamics of endophytic members, biotic and abiotic stresses. Research is beginning to reveal the application of symbiotic endophytes associated with cultivated crops in agriculture, as these microorganisms have in some instances shown promising benefits both on yield and plant stress tolerance. There is evidence that crop landraces are more likely to have maintained a richer diversity of microbial associations respect to modern elite cultivars, which contrarily have gone through an intensive process of selection and domestication. Therefore, we consider the discovery and application of endophytes from wild relatives of cultivated crops an untapped source to restore this core beneficial microbiota. Barley (*Hordeum vulgare* L.) is the world's fourth most important cereal crop (\approx 48 million hectares/year) and requires significant inputs of chemical fertilisers and pesticides, which overuse is an undisputable threat to ecosystems as well as a huge economic cost. The inoculation of barley with beneficial endophytes may provide part of the solution for a more sustainable approach on a global scale. This project aims at developing a library of endophytes (fungi and bacteria) isolated from selected wild species that are phylogenetically related with barley. These microorganisms will be characterised by relying on a combination of microscope analysis and DNA barcoding of several genetic markers (Tef, α -tubulin, ITS, 16s). Some of these endophytes will be then tested as potential active ingredients of new biostimulants and biopesticides on modern varieties of spring/winter barley. Experimental trials will be previously performed in growth chambers and lately at the glasshouse and farm scale to assess growth development and yield of barley inoculated with endophytes under (a) deficient nitrogen/phosphorus regimes and (b) diseases such as net blotch, take-all, *Ramularia* leaf spot and BYDV. Additionally, as endophytes are known to persist within their host plant for long periods of time but not necessarily for the entire life cycle, the persistence of the endophytes inoculated in field trials will be tested by qPCR analysis.

Climate Change in the Irish Mind

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There is now a strong scientific consensus that global climate is changing, that these changes will continue and intensify into the future with a wide range of social, economic and environmental impacts. Responding to the challenges posed by climate change requires significant changes in individual and collective human behaviour and decision-making.

Over the past decade substantial efforts have been made to rectify this situation by engaging with the public through various means such as deliberative democracy and national dialogues. One of the key emerging findings is that audience segmentation is of paramount importance when communicating climate change issues to the public. Different cultures and communities require substantially different messages for effective climate change communication.

In light of this we conducted a study investigating how different sections of society understand and respond to the climate change issue, with a particular focus on the perception of climate change in Ireland. We did this primarily by conducting a systematic review of existing surveys and data such as the Eurobarometer series on climate change. We also examined past literature, government-led initiatives on climate change such as the Citizens' Assembly and we performed a longitudinal, cross-sectional and comparative analysis of the data.

We were able to build a comprehensive profile of climate change understanding and behavioural responses in the people of Ireland, stratified by age, occupation, socioeconomic factors, political affiliation and more. Our results indicate that some parts of society are aware of climate change but their own behavioural responses are lacking, others are well-intentioned but engage heavily in optimism bias. We found Irish people have much in common with their EU counterparts, but there are also many distinct facets to Irish society that must also be taken into account to promote effective dialogue on climate change.

Using Reconstructed Soil Microbiomes for Improving Soil BioremediationRobert Conlon¹, Kieran Germaine¹, David Dowling¹¹ Institute of Technology Carlow

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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. It is becoming increasingly clear that a strong understanding of plant-microbe interactions is key to optimising bioremediation technologies. The current goal of this project is to test a variety of different species of plants such as *Sinapis alba*, *Chichorium intybus* and *Lolium perenne* to discover which plants provide the greatest phytoremediation potential. The selected plants are being used in a pilot scale trials that test the plants ability to degrade total petroleum hydrocarbons (TPHs) in contaminated soil. Soil from two different contaminated sites was used in separate greenhouse trials. Initial results for the first trial showed statistically significant differences between controls and most plant treatments. Soil samples will be taken at regular intervals for microbiome analysis to evaluate how the microbiome changes as the plants grow and TPHs are reduced. Simultaneously, a degradation rate experiment is being run to test the degradative ability of several different bacterial consortia constructed to degrade TPHs. The consortia were introduced into flasks with minimal media and 2% v/v oil, along with controls, all analysed in triplicate. Each week a set of samples are removed for Optical density, colony count tests and solvent extraction. Extracts are dissolved in hexane 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.

**Method development for the determination of emerging pharmaceutical contaminants
in surface water environments.**

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The continually increasing consumption of small molecule pharmaceuticals has led to the contamination of global surface water ecosystems from $\mu\text{g/L}$ to ng/L concentrations. The concentrations, fate and toxicological implications of pharmaceuticals and their residues remain generally unknown. The continual release, stability and biological activity of these "micro-pollutants" can lead to chronic environmental exposure, with ensuing behavioural and health-related effects to wildlife and potentially on humans. The objective of this project is to determine the presence and concentrations of pharmaceuticals in surface water and relate it to potential environmental effects on aquatic ecosystems. 11 pharmaceuticals are investigated in this study including diclofenac, trimethoprim, ciprofloxacin, sulfamethoxazole, amoxicillin, gemfibrozil, venlafaxine, carbamazepine, Estrone, 17 β -ethylene estradiol, 17 β -estradiol. These pharmaceuticals were selected from the water framework directives "Watch List", or are recognised as contaminants of emerging concern. 1L Surface-water grab samples were collected from the Tolka river and further underwent pre-treatment and concentrated using solid-phase extraction (SPE) with OASIS HLB cartridges. Detection was performed by high-performance liquid chromatography coupled with a UV detector (HPLC-UV). Outcomes from this research will aim to provide a robust method to systematically monitor the occurrence of pharmaceuticals in surface waters at environmentally relevant concentrations.

A Citizen Science Approach to Microplastics Sampling

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The study of environmental contamination by microplastics has emerged as a major field of research within the last decade. Microplastics are plastic particles less than five millimetres in size and originate from various sources such as personal care products, textile fibres, and plastics waste that break down and disperse in the environment. Microplastics have been found in freshwater, oceans, sediment, soil and in biota. Some of the compounds in plastic are quite toxic and there are major concerns about what health effects they pose to living organisms. Current data on the prevalence and characteristics of microplastics in the Irish environment is scarce. This project aims to assess microplastics contamination in the River Barrow catchment utilising a citizen science approach. Citizen science has been utilised as a valuable tool for the collection of environmental data. Through utilising citizen scientist's collection of data can be performed on a scale difficult to achieve using traditional approaches. Citizen science can increase public engagement and increase their understanding of the importance of current environmental issues concerns. This project will help towards this by opening scientific communication and debate about microplastics and advance scientific knowledge on microplastics in one of Ireland's major rivers. A panel of citizen scientists has collaborated in the project design and methodology and a sampling toolkit has been developed for use by the public to sample water from the Barrow River catchment. A survey has been designed and disseminated via the project website (<https://barrowmicroplasticsproject.ie/>), in order to ascertain the public's view on plastic pollution and their general knowledge of microplastics which showed that 30% of people did not know what microplastics are. Current findings from the survey will be presented. Barrow River water samples will be analysed using methods developed in previous microplastics-focussed research projects at IT Carlow, to detect, quantify, and characterise the microplastics present in terms of their morphology, chemical identity, size, and colour. Datasets and reports generated during the course of the project will be made available via an online, open-access database.

Challenges in Characterising the Carbonate System in Coastal WatersDaniel Kerr^{1,2}, Brian Kelleher^{1,2}, Anthony Grey¹¹Organic Geochemical Research Laboratory, Dublin City University²Irish Centre for Research in Applied Geoscience, University College Dublin

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Increased release of anthropogenic CO₂ to the environment has led to mounting concerns of drastic changes to seawater carbonate chemistry such as ocean acidification. This has spurred on the development and refinement of analytical methods used to determine the carbonate system parameters over the last few decades. A fundamental concept of carbonate chemistry is that if two of these four parameters are known, upon supplying ancillary physical and chemical information one can calculate the remaining two parameters and obtain a complete description of the system. However, uncertainties in the accuracy of the input parameters can lead to the propagation of errors in calculated values and thus present gross misrepresentations of carbonate chemistry. Although the analytical methods for carbonate system studies are well documented for pelagic waters, for heterogeneous coastal zones certain challenges to conventional analytical methods are introduced. Terrestrial discharges of freshwater carrying nutrients, organic and inorganic carbon present potential analytical interference to the two conventionally used input parameters, dissolved inorganic carbon (DIC) and total alkalinity (TA). The latter of these parameters, TA, is a descriptor of a water body's buffering capacity or ability to resist substantial changes in pH upon acidification. TA is typically attributed to inorganic anions such as bicarbonate and carbonate, however growing evidence alludes to substantial contributions from non-carbonate organic molecules. This portion of TA is termed organic alkalinity (OrgAlk), and is routinely ignored or deemed negligible in open ocean carbonate system studies. Due to this, failure to account for or incorporate OrgAlk can lead to the propagation of errors in carbonate chemistry data for coastal water bodies. This is of consequence as many littoral zones are susceptible to acidification due to low alkalinity riverine discharge. The characterisation of OrgAlk as a fraction of TA presents a complex endeavour as OrgAlk components present a heterogeneous array of terrestrially derived and autochthonously arising organic molecules which may vary over seasonal, diurnal and tidal cycles. If TA is to continue as a widely used input parameter for carbonate studies, the inclusion of OrgAlk is critical in minimising propagated errors and ensuring accuracy in calculated carbonate system descriptors.

Water Quality, Climate Change and Thermal Stratification in Irish Lakes

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The European Union Water Framework Directive (WFD) is a piece of legislation which came into effect in 2000. The aim of the WFD is to regulate and protect water bodies such as lakes, rivers, coastal waters, groundwater and estuaries in Europe. A central component of the directive is that each member state establishes a national monitoring programme that provides a comprehensive assessment of the ecological and chemical status of surface waters and the quantitative and chemical status of groundwaters. The most recent WFD monitoring programme in Ireland is for the period 2019-2021 and consists of 3,169 surface and groundwater bodies. In Ireland, 224 lakes are included in the national monitoring programme and one part of this programme involves collecting vertical depth profiles of water temperature and dissolved oxygen (DO) from the lake surface to the lake floor. This data is crucial for understanding and predicting the evolution of lake water quality, especially in terms of suitability for aquatic wildlife.

In 2012, as part of a MSc in Environmental Science at UCD, a study was carried out on the stratification of Irish lakes using the depth profile data. This study identified lakes that do and do not stratify, the frequency of stratification and the extent of oxygen depletion in the stratified lakes.

Following on from this 2012 study and to bring the findings up to date, this master's thesis project will use data analysis and mathematical modelling to examine the depth profile data from 2001 to 2020. The project will look for trends indicative of climate change and analyse changes in stratification, temperature, dissolved oxygen and other chemical parameters. The dataset may be complemented by meteorological data, latitude, longitude and volume of lakes along with other variables.

Techniques that may be used to predict water quality, climate change and thermal stratification include:

- Multiple linear regression models
- Neural networks
- Random forests
- Support vector machines
- Principal component analysis
- Time series analysis

Evaluation metrics will then be used to quantify and visualise the performance of these machine learning models.

A spectroscopic sensor for accurate, real time monitoring of personal exposure to nitrogen dioxideEibhlin Halpin¹¹School of Chemistry, University College Cork

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Air pollution is one of the most serious public health problems caused by environmental factors. Research shows that air pollution is responsible for over 500,000 premature deaths each year in Europe. Nitrogen dioxide (NO₂) is a priority pollutant and strongly associated with traffic emissions. NO₂ produces serious health outcomes including an increased risk of cardiovascular mortality, an increased risk of lung cancer, and a 50% increased likelihood of children developing asthma. Many European cities, including Dublin, report high levels of NO₂ in breach of EU regulatory limits.

Measuring personal exposure to NO₂ is challenging. Sensors must be compact, selective, and sensitive. Large reference monitors are not portable and are too expensive for personal exposure measurements. On the other hand, emerging portable and low-cost sensors have poor accuracy. This project aims to overcome the disadvantages of existing methods by developing a sensitive, low-cost, and portable NO₂ sensor based on the structured absorption spectrum of NO₂.

We describe a prototype NO₂ sensor based on incoherent broad band cavity enhanced absorption spectroscopy (IBBCEAS) and demonstrate that it can detect NO₂ with excellent sensitivity and accuracy. Its sensitivity and accuracy are assessed against a reference-grade chemiluminescence monitor in atmospheric simulation chamber experiments. This sensor is intended for sensitive and accurate real-time remote sensing and for personal exposure measurements. Later project objectives to monitor NO₂ levels outside schools and at roadside locations are described.

**Current concentrations and long-term trends of tropospheric ozone in Ireland,
and the potential for damage to vegetation**Keelan McHugh¹, Julian Aherne², Thomas Cummins¹¹University College Dublin²Trent University Canada

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It is well established that ground-level ozone is a powerful oxidant that can damage vegetation and impact ecosystem health. Nonetheless, there have been relatively few studies carried out on the levels of tropospheric ozone in Ireland (de Kluizenaar et al., 2001; Tripathi et al., 2010; Derwent et al., 2018). Sorting airmasses by origin, as done by Derwent et al. (2018) for the Mace Head site on the west coast of Ireland, distinguishes an Atlantic baseline condition from continental influence, in addition to seasonal variation. The potential for impacts on vegetation is blind to airmass origin, with metrics of daytime accumulated exposure over a threshold concentration (AOTx), and phytotoxic ozone dose over a threshold (PODy), available for assessment, among others. Three-month AOT40, with unit ppb h, has shown strong linear association with impact to sensitive crops (Mills et al., 2007). In the current study, measurements of current tropospheric ozone concentrations based on 5 years of available data (2015–2019) from 12 stations in Ireland were investigated. Ozone concentrations vary spatially across Ireland with generally higher concentrations in coastal locations and lower concentrations in urban areas. In addition, long-term trends over 15 years (2005–2019) were evaluated using unsorted concentration data at a subset of 7 stations. Exceedances of critical levels for vegetation based on the AOT40 concentration metric were estimated over the growing season for crops, forests, and semi-natural vegetation types during the period 2015–2019. This study aims to provide a better understanding of the changing status and potential impact of tropospheric ozone on vegetation in Ireland, comparing to previous studies.

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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 CarlowMutian Wang¹¹Institute of Technology Carlow

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Soil is one of the most important non-renewable resources available to mankind. Chemical pollution, arising from industrial, agricultural, and domestic activities seriously compromises the health of ecosystems and humans worldwide. The extraction, processing, storage, and use of crude oil and its derivatives cause 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, which poses a grave threat to the health and well-being of human beings, animals and plants. In Europe, there are estimated to be around 2.5 million contaminated sites, of which about 14% are considered to be heavily contaminated, If current trends continue, the number of sites needing remediation is expected to increase by 50% by 2025. 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. Bioremediation is the use of microorganisms that have the ability to metabolize petroleum compounds, decreasing their concentration and associated health risks. 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 was carried out in order to identify the major bacterial groups present in the enrichment consortia. Individual strains within the consortia were isolated and characterized 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 the H2020 Greener project, which aims to the development of innovative, efficient, and low-cost hybrid solutions.

An investigation into the genomic and proteomic effects of heavy metal exposure to the hyperaccumulator plants *Eichhornia crassipes* and *Pistia stratiotes*Tapiwa Nyakauru¹, David O'Neill¹, Catherine O'Reilly¹, Orla O'Donovan¹¹Waterford Institute of TechnologyCorresponding Author Email Address: tapiwa.nyakauru@postgrad.wit.ie

Water quality is a measure of the chemical, physical, and biological state of water, and standards of quality will depend on the intended use of a given water supply. Water quality can be degraded by numerous contaminants, e.g., heavy metals, that can cause water to become toxic to living organisms. Heavy metals such as copper are natural components of the earth's crust and contribute to water pollution around the world. Entering water bodies due to anthropogenic activities such as mining and agriculture, or by natural processes such as weathering of rocks, heavy metals can persist in ecosystems as they cannot be degraded or destroyed. With long-term exposure, heavy metals exert their toxic effect on organisms by binding to biological molecules such as enzymes or transport proteins, altering their configuration and inhibiting their activities, resulting in diseases such as cancer.

Water hyacinth (*Eichhornia crassipes*) and water lettuce (*Pistia stratiotes*) are aquatic plants native to South America and have been used as paper material, compost material and as a livestock feed in Asian countries. *E. crassipes* and *P. stratiotes* are hyperaccumulator plants. They can accumulate heavy metals to levels that are thousands of times greater than other plants, thereby greatly reducing the heavy metal burden of water bodies. Metallothionein (MT) and phytochelatin synthase (PCS) genes in plants are known to be involved in heavy metal accumulation. However, MT and PCS genes have not been intensively characterized in *E. crassipes* and *P. stratiotes*.

The aim of this research is to improve our understanding of the molecular mechanisms that take place during heavy metal accumulation in *E. crassipes* and *P. stratiotes*. This information is vital to eco-engineers who use plants to alleviate heavy metal problems in water. The work presented here outlines the design and optimization of conventional PCR and real time PCR tests to target known and/or novel MT and PCS genes, and endogenous control genes (18S rRNA gene and Glyceraldehyde 3-phosphate dehydrogenase gene) in *E. crassipes* and *P. stratiotes*. Novel tests for these targets were also designed for the relative quantification of gene expression by real time PCR.

STREAM (Sensor Technologies for Remote Environmental Aquatic Monitoring)

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Climate Change has had a significant impact on the marine and estuarine environment over the last century and will continue to do so under future climate projections (IPCC). It is therefore crucial for governments to gather relevant data to better understand climate change and how it will impact coastal communities both now and in the future. The STREAM (Sensor Technologies for Remote Environmental Aquatic Monitoring) project is a collaboration between Waterford Institute of Technology, Swansea University and Munster Technological University. The project aims to increase the current understanding of the environment and climate change in both Ireland and Wales. STREAM will achieve this by deploying state of the art sensor systems along both coastlines in Ireland and Wales, this data will then be analysed and made available to government bodies responsible for monitoring the marine environment in both countries. STREAM will manufacture its own sensors that will be rigorously tested against the commercially available sensors under controlled environmental conditions to ensure their accuracy. In order to disseminate the data created by the project, STREAM will create an online portal where users can access live and archival data from these sensor systems. STREAM will create and publish factsheets, reports, climate change toolkits, and scientific literature detailing its discoveries as well as actively presenting them to the public through workshops, summer schools and seminars. By the end of the project, it is envisaged that STREAM will have increased cross-border collaboration between Ireland and Wales developing the capabilities of both countries to adapt and mitigate the impacts of climate change. The STREAM project is part-funded by the European Regional Development Fund (ERDF) through the Ireland-Wales Interreg programme 2014-2020.

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- Swansea University Bay Campus, Crymlyn Burrows, Swansea, United Kingdom.
- Munster Technological University, Rossa Ave, Bishopstown, Cork, Ireland.

**Estimation of Atmospheric Emissions from Irish wildfires and prescribed burns:
A laboratory and field-based study**

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Globally vegetation fires are estimated to emit 2.5×10^{12} g C/year to the atmosphere, however their emissions also have a major impact on local air quality and human health. Climate change is exacerbating the number and intensity of fires and each year catastrophic fires are reported in the media, with 2020 seeing dramatic fire seasons in Australia, California, and Indonesia and other parts of the world. In Ireland, prescribed burns have been used for many years as a land management practice however they can get out of control. Wildfires are also started maliciously and by accident. However the quantity and characteristics of the gaseous and particulate emissions from such fires have not been systematically studied up till now. The EPA-funded FLARES (Fire, Land and Atmospheric Remote sensing of EmissionS) project aims to improve the accuracy of emissions estimates from vegetation fires in Ireland. Emission Factors (EF) capture the amount of pollutant produced (g) per amount of fuel burnt (kg) and they depend strongly on fuel type and burning conditions. A broad body of field and laboratory studies of fires and fuels for various biomes exist internationally, but the vegetation specific to Ireland (gorse, heather, grasses) that is most prone to fires has received little attention. EFs of typical Irish fuels will be determined in burn chamber experiments at the Leibnitz Institute for Tropospheric Research in Germany. Although the prescribed burning season in Ireland is from September 1st to February 28th, many fires occur outside of this period. Field measurements of particle and gaseous emissions downwind of wildfires from a permanently stationed mobile sampling station will start in April 2021 and run through the summer months. The quantities and characteristics of the gaseous (CO₂, CO, NO₂, trace gases) and particulate (PM_{2.5}, PM₁₀; EC, OC; BC, BrC) emissions will be captured. These results will be compared with the estimates generated via the Copernicus Atmosphere Monitoring Service (CAMS) Air Quality products. CAMS provide hourly estimates of atmospheric constituents using a series of models which incorporate ground station data and satellite observations. The overall goal of the project is to make an estimate of emissions from all wildfires which have occurred in Ireland for the period 2015 to 2021. This study will help improve characterization of Ireland's greenhouse gas emissions and air pollution due to vegetation fires. Moreover it will provide insights on population exposure to harmful smoke.

Tracking dynamic time-dependent groundwater vulnerability using satellite scatterometer observations and land-use stochastic modelsArghadyuti Banerjee¹, Leo Creedon¹, Noelle Jones², Salem Gharbia¹¹ Institute of Technology Sligo²Galway-Mayo Institute of Technology

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Tracking time-dependent variables is an innovative approach to investigate the evaluation of contamination of groundwater (GW) by non-point sources and to forecast future trends. Therefore, it is important to recognise the cause-effect relationship between temporal changes in GW quality and both natural and anthropogenic factors. This effort will impose a breakthrough advancement in mapping hazardous areas as well as the efficiency in land use planning for groundwater protection. For this study, we choose nitrate concentration as the response variable. Nitrate, as an abundant contaminant of GW, is an effective indicator of groundwater contamination. The trend of GW contamination will be identified by the analysis of sufficient temporal monitoring of nitrate concentration in GW over a long period. The main aim of this study is to develop a framework/decision support tool that will generate different probabilistic groundwater contamination scenarios considering nitrate as an indicator. The study will integrate remote sensing, GIS and statistical methods to assess the efficacy of land use planning for groundwater protection. Both natural and anthropogenic factors will be used as evidential themes for the analysis. Nitrogen loading derived from urban areas cannot be easily and directly estimated quantitatively, so other variables like population density will be explored as a proxy for nitrate quantity. Population density will be calculated from census data. Radar satellite images will be used to identify and delineate urban areas. Soil Moisture Active Passive (SMAP) datasets will be analysed to trace the spatiotemporal changes in land cover and soil moisture as an important component for monitoring soil nutrient changes over time. Temporal multispectral images and very high-resolution optical datasets will be employed to get information on geology, hydrogeology and land use. Other spatial and non-spatial datasets to be studied describe surface conditions (e.g. lithology, soil characteristics), subsurface (e.g. unsaturated zones), underground (e.g. aquifer characteristics), topography, catchments, precipitation and GW recharge etc. After the completion of digital image processing of remotely sensed images and digitization of spatial layers (using ERDAS software), all thematic layers will be analysed in the GIS platform (ArcGIS) for the further validation of the model. Finally, a geostatistical modelling approach (using R) will be developed to analyse the groundwater volume and quality fluctuations under different scenarios of climate change and land use. The outcome of this study will provide policymakers with a tool to link groundwater pollution risk and time-dependent drivers.

Development of a real time SPE-CE method to ensure the API concentration in wastewater is below the EPA safe limit.

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The detection of pharmaceuticals in wastewater is becoming increasingly important for environmental monitoring. The release of pharmaceuticals from an ever-growing industry is causing devastating effects to the aqueous ecosystem and to the organisms that live in it. It is crucial that the concentration of the pharmaceuticals is at a safe limit before they are released back into the ecosystem for the health and wellbeing of the environment. Scientists have been developing methods to detect the pharmaceuticals in ground and wastewater. Liquid Chromatography/High Performance Liquid Chromatography (LC/HPLC) and Gas Chromatography (GC) are the commonly used analytical methods in their research. Capillary Electrophoresis (CE) is now gaining attention as an alternative analytical technique for environmental monitoring. It has many benefits over HPLC and is more environmentally friendly. Adding a pre-concentration step such as Solid-phase extraction (SPE) will boost the CE's sensitivity and potentially aid in the detection of pharmaceuticals in the lower concentration ranges. The aim of this project is to develop a real time SPE-CE method to determine Hovione's Active Pharmaceutical Ingredients (APIs) in their wastewater and compare the concentrations to the Environmental Protection Agency's (EPA) safe limit of 0.5 mg/L.

**Metagenomic and Physico-Chemical Characterisation of a Novel Microbial Biofilm
in a Deep Ground Water Well in Ireland**Rajesh Mali¹¹Institute of Technology Carlow

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Biofilms are comprised of a community of microbial consortia that adheres to a spatially structured surface. The term biofilm, defined by The International Union of Pure and Applied Chemistry (IUPAC) is "an aggregate of microorganisms in which cells that are frequently embedded within a self-produced matrix of extracellular polymeric substance (EPS) adhere to each other and/or to a surface". Microbial cells in this matrix can target individual interactions as well as multi-cellular processes. One key element responsible for developing biofilms among aqueous surroundings is Sulfur. This element inhabits the ecosystem and exists in bedrock, as either pyrite (FeS_2) and gypsum (CaSO_4) available on the surface of the Earth's crust. Sulfur is one example of an element whose transformation and fate in the environment are critically dependent upon microbial activities, in this case, biofilm formation. Sulfate (SO_4^{2-}) is the key terminal electron acceptor in the sulfur cycle producing an odorous compound known as Hydrogen Sulfide (H_2S). This project aims to focus on a biofilm located within a groundwater well on a farm in Loughavalley, County Westmeath. The key questions to address are the overview of the community structure, the major microbes responsible for its formation, and the matrix's chemical composition. These objectives are investigated through a series of metagenomic sequencing and isolation techniques for the dominant microbes circulating the biofilm as well as potential novel species. An isolate obtained from the complex was identified as a single gram-negative microbe, *Rhodanobacter spathiphylli*. Traditional chemical analysis of the well water showed that it had a pH 7, 1000mg/L carbonate, <100 ppm heavy metals, no nitrates, elevated arsenic, 40 ppm H_2S . DNA Extraction of the biofilm is conducted to ensure adequate levels of the key microbes have been harvested to identify the species responsible for the formation and maintenance of this substance. Representative samples have been sequenced to identify those species. Long-term storage of microbial isolates will be used to transcribe the data profiles such as resistance levels to heavy metals, disinfectants, etc. This project is funded by the Presidents Research Fellowship Scheme 2020 at IT Carlow, Ireland.

Microbial endophytes as new potential active ingredients of new potential biostimulants and biopesticides tailored for barley production and protectionDiego Dylan Bianchi¹, Fiona Doohan², Trevor Roland Hodkinson¹, Brian Murphy¹¹School of Natural Sciences & Trinity Centre for Biodiversity Research, Trinity College Dublin,
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All plants harbor within their tissues heterogeneous microbial communities of bacterial, fungal, archaeal and protist taxa. These microorganisms are also known as endophytes and play crucial roles in plant development, fitness, growth and diversification. The interaction between host plant and its associated endophytes ranges from mutualism to pathogenicity, depending on a complexity of multiple factors including the genotypes of both plants and microbes, environmental conditions, inter-dynamics of endophytic members, biotic and abiotic stresses. Research is beginning to reveal the application of symbiotic endophytes associated with cultivated crops in agriculture, as these microorganisms have in some instances shown promising benefits both on yield and ~plant stress tolerance. There is evidence that crop landraces are more likely to have maintained a richer diversity of microbial associations respect to modern elite cultivars, which contrarily have gone through an intensive process of selection and domestication. Therefore, we consider the discovery and application of endophytes from wild relatives of cultivated crops an untapped source to restore this core beneficial microbiota. Barley (*Hordeum vulgare* L.) is the world's fourth most important cereal crop (≈ 48 million hectares/year) and requires significant inputs of chemical fertilisers and pesticides, which overuse is an undisputable threat to ecosystems as well as a huge economic cost. The inoculation of barley with beneficial endophytes may provide part of the solution for a more sustainable approach on a global scale. This project aims at developing a library of endophytes (fungi and bacteria) isolated from selected wild species that are phylogenetically related with barley. These microorganisms will be characterised by relying on a combination of microscope analysis and DNA barcoding of several genetic markers (Tef, β -tubulin, ITS, 16s). Some of these endophytes will be then tested as potential active ingredients of new biostimulants and biopesticides on modern varieties of spring/winter barley. Experimental trials will be previously performed in growth chambers and lately at the glasshouse and farm scale to assess growth development and yield of barley inoculated with endophytes under (a) deficient nitrogen/phosphorus regimes and (b) diseases such as net blotch, take-all, *Ramularia* leaf spot and BYDV. Additionally, as endophytes are known to persist within their host plant for long periods of time but not necessarily for the entire life cycle, the persistence of the endophytes inoculated in field trials will be tested by qPCR analysis.



ESAI ANNUAL REVIEW 2020

Annual Review 2020



2020 was a busy year for the Environmental Sciences Association of Ireland (ESAI). This end of year report summarises some of the key events and activities throughout the year.

Environ 2020: The highlight of the year was our Environmental Researchers Colloquium (Environ). The 2020 Environ conference, hosted in collaboration between the ESAI and the Water Institute at DCU, was originally planned for April 27th-29th. Due to the COVID19 restrictions this was rescheduled to take place "virtually" in October 2020. The 2020 Environ was hosted online by the Water Institute at Dublin City University (DCU), (20th – 22nd October 2020). The 300 attendees had the opportunity to choose from 17 oral presentation sessions and six poster sessions over the three days of the colloquium, covering topics from Climate Change, to Ecotoxicology to Water Resources all contributing to the theme of the colloquium, Ireland's Water, Energy & Environment in a Climate and Biodiversity Emergency. In addition to the parallel sessions, delegates could attend a plenary session each day. The first plenary session on Tuesday included a welcome address from the Director of DCU's Water Institute, Professor Fiona Regan, the Chairperson of the ESAI, Dr. Liam McCarton, and from The President of Dublin City University, Professor Daire Keogh, who formally opened the colloquium. The keynote address was delivered by Mr. Gilles Gantelet of the EU's DG Environment who spoke about the EU's Green Deal and what this means for Irish researchers among other things.

Overall, 70 oral and 80 poster presentations were delivered, 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 DCU Water Institute Environ team of Prof Anne Morrissey, Dr James Carton, Dr Jenny Lawler, with special mention to Caoimhe O'Broin in DCU for all her assistance to the team. Congratulations to all the winners in the ESAI Environ Student Presentation competition which featured nine awards this year with a special mention to Merissa Cullen, NUI Maynooth and Tristan Nolan, UCD, winner of the best oral presentation and best poster presentation respectively at Environ 2020.

30 years of Environ: We also celebrated 30 years of Environ in 2020. As part of our 30 years celebrations we announced our first honours list. This is to acknowledge those who have contributed greatly to the success of ESAI and Environ and indeed have been at the forefront of environmental research, debate and policy in Ireland for over 30 years. These include; Dr Mary Brennan, Prof Mark Costello, Dr Debbie Chapman, Mr Michael Ewing, Emeritus Prof Brid Quilty, Dr Micheál O'Cinnéide, Dr Shirley Gallagher, Dr Billy Fitzgerald. All will be offered lifelong membership. An event was held on World Earth Day (22nd April 2021) to honour those awardees. The evening featured videos and discussion. Special thanks to Niamh Power for videos, Frances Lucy for compering and Sinead Macken for organising.

Annual Review 2020

ESAI Researcher Awards

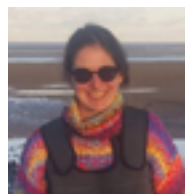
At the heart of great science lies a creative and moral instinct to explore and to question in order to create a better world. ESAI continue to recognise the excellence of young researchers in this regard at both undergraduate and postgraduate level.



Postgraduate Researcher of the Year Award: Sean O'Connor from the Institute of Technology Sligo is the 2020 winner of the prestigious ESAI Postgraduate Researcher of the Year Award. Sean's research is focused on developing small scale anaerobic digestion (SSAD) for the treatment of biomass and organic waste. This research was carried out under an EU INTERREG funded Renewable Engine project with collaboration from an industry partner (Organic Power). Sean's supervisor is Dr. John Bartlett.

This year the ESAI has decided to acknowledge the extremely high standard of competition by acknowledging two entries who were of exceptional standard but just missed out on the overall prize.

Postgraduate Researcher of the Year 2020 Runner Up: Kate Mahony is a researcher based in University College Cork. Her novel research is focused on working with an "ecosystem engineer", the common cockle *Cerastoderma edule*. Kate developed a holistic approach to study past and present conditions of cockles, in order to inform future sustainable management of this important resource. Kate's supervisors are Prof. Sarah Culloty and Dr Sharon Lynch.



Postgraduate Researcher of the Year 2020 Runner Up: Samuel Ross is a researcher based in Trinity College Dublin. His research is focused on developing novel methods to understand ecological resilience. By working with acoustic arrays, Samuel is researching how eco-acoustics can provide high resolution real time monitoring of ecosystems. Samuel's supervisor is Dr. Ian Donohue.

Annual Review 2020



ESAI HEI Undergraduate of the Year Award 2019/2020: ESAI and our sponsors continue to recognise the excellence of young researchers through our Undergraduate of the Year Awards. This is the 4th year of the competition with 15 nominations from 12 colleges. 2019-2020 Winners: Jessica Alvarado (GMIT), Alison Scott (University of Ulster), Hannah Farrelly (DCU), Thomas Robinson (TCD), Teagan Reinert (NUIG), Samantha O'Neill (Level 8, IT Carlow), Sean Brennan (Level 7, IT Carlow), Deirdre O'Donnell (UL), Karl Hoffman (Level 8, CIT), Maria Gulak (Level 7, CIT), Mairead

O'Donnell (LIT), Eva Naughton (UCD), Aoife McMullin (IT Sligo), Faolan Radford McGovern (Level 8, TU Dublin), and Sinead Aspell (Level 7, TU Dublin). Special thanks to Niamh Power for managing this on behalf of the ESAI.

Covid 19 restrictions unfortunately interrupted our **EPA funded Grassroots Award Scheme**. Public health restrictions meant that our 2019 grassroots awardee Aoife Long, UCC could not hold her workshop. The grassroots award has been relaunched as a virtual event in 2021. Special thanks to the EPA for their continued support.

Summer 2020 ESAI / TU Dublin Webinar Series: Summer of 2020 saw the ESAI move our events online through our summer webinar series managed by John Gallagher, TCD. Huge thanks to John and all the ESAI council for their work on this series. A total of 6 webinars were held sponsored by the EU Development Education and Awareness Raising Program, BUILD Solid Ground and the Development Technology in the Community Research Group at TU Dublin with 296 registered attendees. The full webinar series was as follows:

- 11th June - ESAI / EPA Grassroots Award Scheme #1(Aoife Lynch & Sean Long)
- 18th June – Environ 2020 Team Post Lockdown Path for Climate & Biodiversity (John Gibbons, Env. Writer & Columnist & Peter Stuart, IT Tralee)
- 25th June – ESAI / EPA Grassroots Award Scheme #2 (Jean O'Dwyer, UCC)
- 16th July – ESAI Postgraduate Researcher of the Year: What it takes to excel in research – (2017 Winner Philip Shine, CIT & 2019 Winner Molly Ann Williams, DCU)
- 16th July – ESAI Virtual Environmental Quiz
- 23rd July – Overcoming Adversity in your Research – Lessons for dealing with Covid-19 (Prof Enda

Annual Review 2020



photographer Jacque Pirez Nutan.

Hayes, Uni of Bristol) Carol O'Sullivan (EPA), Dr Kathryn Schoenrock (NUI Galway)

Nature is Art Competition: The ESAI in partnership with the Development Technology in the Community Research Group at TU Dublin, launched a "Nature is Art" competition in Summer 2020, attracting over 30 entries. Congratulations to the overall winner Aaron Foley 'Bluebells' and special thanks to judge, Galway based

Partnering with other groups to provide access to ESAI members to events

In 2020 the ESAI partnered with several organisations to support a number of environmental initiatives and provide access to our members.

- 22nd April CIEEM Conference – Conservation Approaches to Benefit Biodiversity: Big Challenges: Big Ideas – discount for ESAI members
- Partnering with EwB to promote their summer webinar series 'Resilient Cities – Resilient Communities' to ESAI members which ran from June – Aug hosted by Engineers Without Borders Ireland.
- June 24th-25th & 29th-30th – AquaTT & NUIG Webinar Workshop: Co-Creating Sustainable Change in Ireland with Dr Doug McKenzie-Mohr – Discounts for ESAI Members

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. On 12th Nov 2020 we held a meeting to discuss how we can best support liaison officers with representatives from 5 colleges in attendance. This is an ongoing discussion throughout 2021. We are also offering free membership to all undergraduates in relevant courses in each college.

ESAI Communications: ESAI members are the core of the organisation and during 2019/2020 we 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. At the end of 2020 the ESAI had 586 members, comprising of 216 full members and 270 student members.

ESAI Council Meetings and AGM October 2020: The ESAI held a total of 5 council meetings during 2020. The AGM was convened online to coincide with Environ in October 2020. Joe Harrington, CIT, Jenny Lawler, DCU and Declan Feeney, IT Sligo stepped down with nobody new joining. Postgrad of Year 2019 Molly-Ann Williams, DCU joined us to give a short presentation on her research.

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. As chair of the ESAI I would also like to acknowledge the passion, professionalism and commitment of the entire ESAI council during the past year.

The global and national impacts of Covid19 continue to challenge ESAI members, both professionally and personally. ESAI will continue to adapt to this global challenge and seek ways in which we can serve our members and the wider the environmental community in Ireland though this coming year

A handwritten signature in blue ink that reads "Liam McCarton". The signature is written in a cursive style and is positioned above a thin horizontal line.

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

Benefits of Membership

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

- Discounted rates at Environ, the annual Irish Environmental Researchers Colloquium, one of the major activities of the Association. It is now one of the largest national scientific meetings in Ireland attracting over 300 delegates each year.
- Discounted rates for selected workshops, seminars, further education courses and conferences.
- Access to ESAI listserv
- 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 opportunitie
- 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

2020 Events

Date	Event
February 28 th	ESAI Grassroots Workshop Support Scheme Sponsored by EPA – Rolling Call
April 22 nd	Discounts for ESAI Members CIEEM Online Conference 'Conservation Approaches to Benefit Biodiversity: Big Challenges, Big Ideas'
April 30 th	ESAI Grassroots Workshop Support Scheme Sponsored by EPA – Rolling Call
May 1 st	ESAI Environews Spring/Summer Edition available
June	ESAI Undergraduate of Year Awards 2019/2020 Review with HEI's commencesw
June 3 rd	ESAI Media Partners 'RESILIENCE – Rethinking Communities in a Post-Covid World' EwB & TU Dublin Lunch-time Summer Lunchtime Webinar Series
June 11 th	ESAI Summer Webinar Series ESAI/EPA Grassroots Award Scheme -Supporting Citizens Engagement in Ireland #1 'Developing a dance-based workshop in Science Communications' – Aoife Long 'OpenLitterMap: Open Data on Plastic Pollution with Blockchain Rewards (Littercoin)' – Sean Lynch
June 11 th	Launch ESAI Photography Competition Theme 'Nature is Art'
June 18 th	ESAI Summer Webinar Series – Environ 2020 Team & DCU Water Institute Post Lockdown Path for Climate & Biodiversity 'Irish Agriculture: Beyond Greenwashing and Towards A Green New Deal with Nature' – John Gibbons 'Why During this Health Crisis The Biodiversity Crisis Matters Even More' – Dr Peter Stuart
June 25 th & June 29 th -30 th	Discounts for ESAI Members AquaTT & NUIG Webinar Workshop Co-Creating Sustainable Change in Ireland with Dr Doug McKenzie-Mohr
June 25 th	ESAI Summer Webinar Series ESAI/EPA Grassroots Award Scheme -Supporting Citizens Engagement in Ireland #2 'Safeguarding private water supplies from contamination through public engagement' – Jean O'Dwyer
June 30 th	ESAI Grassroots Workshop Support Scheme Sponsored by EPA – Rolling Call
July 16 th	ESAI Summer Webinar Series ESAI Postgraduate Researcher of the Year Award – What it takes to excel in Research 'Novel Methods of monitoring Atlantic salmon using environmental DNA' – 2019 Winner Molly Williams 'Electricity use on Irish Dairy farms – A National Approach to Improving Efficiency using Artificial Intelligence' – 2017 Winner Philip Shine
July 16 th	ESAI Virtual Environmental Quiz Online social night for members

2020 Events

Date	Event
July 23 rd	<p>ESAI Summer Webinar Series Overcoming adversity in your Research: Lessons for dealing with COVID-19 'Looking back the effect of Foot & Mouth on my PhD' – Prof Enda Hayes, UWE Bristol 'Managing Productivity during COVID' – Carol O'Sullivan, EPA 'KepRes; Working with citizen scientists to better understand marine habitats, especially kelp forests in Ireland' – Dr Kathryn Schoenrock, NUI Galway</p>
August 31 st	<p>ESAI Grassroots Workshop Support Scheme Sponsored by EPA – Rolling Call</p>
September 17 th	<p>ESAI Photography Competition Winner Announcement Nature is Art – Winner Aaron Foley 'Bluebells'</p>
September 30 th	<p>Undergraduate Membership Offer Free Membership for all Undergraduate Members Scheme Rolled Out</p>
October 16 th	<p>ESAI Environews Autumn Edition available</p>
October 22 nd -24 th	<p>Environ 2020 – 30th Annual Irish Environmental Researchers Colloquium Co-hosted online with DCU Water Institute</p>
October 21 st	<p>ESAI AGM 2020 17:30-18:00, online (held in conjunction with Environ 2020) All members welcome</p>
October 24 th	<p>ESAI Student Competition Prize Giving Ceremony & 30th Anniversary Honours List Announcement</p>
October 31 st	<p>ESAI Grassroots Workshop Support Scheme Sponsored by EPA – Rolling Call</p>
October 31 st	<p>ESAI Postgraduate Researcher of Year Award Closing date for applications</p>
November 3 rd	<p>ESAI HEI nominated Undergraduate of Year 2019/2020 Announcements and presentation of certificates (by post!)</p>
November 12 th	<p>ESAI College Liaisons Meets with ESAI Council</p>
December 15 th	<p>ESAI Environews Winter Edition available</p>
December 31 st	<p>ESAI Grassroots Workshop Support Scheme Sponsored by EPA – Rolling Call</p>

ESAI INCOME AND EXPENDITURE ACCOUNT 2020

ESAI Income and Expenditure Account	€	€
For the year ended 31 December 2019		6,697
Opening balance as 01/01/20		
Income	€	€
Membership	3,579	
Environ 2020 – Delegate Fees	22,909	
Environ 2020 - Sponsorship	22,500	
Environ Prizes	1,500	
Sponsorship of Summer Webinar Series	850	
Rebate	18	
Total Income	51,356	
Expenditure	€	€
Environ 2020	14,300	
Environ 2020 – Refunds	5,161	
Prizes	2,450	
Website Maintenance	2,790	
Administration	9,196	
Travel	272	
Accountancy	0	
Bank Charge	320	
Merchant Banking	812	
Insurance	0	
Postage/Stationary	0	
Postgraduate of Year Prize	500	
Governance	1,338	
Other	75	
Website Revamp	2,153	
Total Expenditure	37,214	
Excess Income over Expenditure		14,143
Closing Balance per Bank @ 31/12/20		20,840

End of Year accounts are overseen and approved by external accountant

ESAI Council Members 2020

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	

ESAI Postgraduate Researcher of the Year 2021

Applications will be invited from Postgraduate students members doing either a PhD or a Masters degree by research in an environmental topic.

Winner receives €500.

**Award entry opens
June 16th – October 31st 2021.**

**Think
outside
the
box.**

