



ANNUAL REPORT 2021

Begin



Vision

To enable a transition to a zero carbon, resource efficient and sustainable society

Mission

To generate new research knowledge for the understanding and protection of our natural environment, and develop technologies, tools, services and policy knowledge to facilitate a transformation to a zero carbon, resource efficient, and sustainable society

THE ENVIRONMENTAL RESEARCH INSTITUTE IS COMMITTED TO THE FOLLOWING FIVE CORE PRINCIPLES

Research excellence

Interdisciplinary collaboration

Research with impact – Environmental, Societal & Economic

High quality postgraduate and postdoctoral education and training

Diversity and Equality

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Message from ERI Director

In November 2021, 196 countries from around the world met in Glasgow at COP26 to negotiate the next stage of an agreement to limit global warming to 1.5°C. The annual meeting represents the world's best chance to accelerate action on the climate emergency. The COP26 climate summit made important progress in a number of areas including curbing methane emissions, halting and reversing forest loss, aligning the finance sector with net-zero carbon, and accelerating the phase-out of coal. However, the world still remains significantly off track to limit global warming to 1.5 °C or 2 °C.

The ERI was delighted to work closely with the UCC President's Office to lead a range of initiatives on raising awareness around COP26 and contributing to a deeper understanding of its significance. UCC is the only Irish University to hold official observer status at COP and sent a delegation to Glasgow, led by Prof Brian Ó Gallachóir, consisting of students, researchers, and academics. The attendees, along with other researchers in ERI, were prominent on national and international media during COP26 discussing topics ranging from carbon budgets, transport, biodiversity, societal change, sustainable cities, law, and governance. At COP26, Prof Ó Gallachóir spoke

about Cork's experience of democratising the health agenda through the WHO Healthy Cities initiative. The British Ambassador to Ireland, H.E. Mr Paul Johnston, met with the UCC President's delegation upon their return from Glasgow where Professor John O'Halloran presented the Ambassador with UCC's COP26 Declaration. UCC also hosted a role-playing version of COP26 negotiations on campus to see if a global agreement could be reached by UCC students and staff; participants were tasked with negotiating a global pathway for climate action informed by climate modelling software. As a legacy to COP26, UCC commissioned the Sustainable Communities mural by Cork-based artist Kevin O'Brien representing a positive vision of a sustainable Cork City on UCC campus.

After a 10 year interlude, the ERI was very pleased to welcome the 31st Environmental Researchers Colloquium (ENVIRON 2021) back to UCC in June 2021. Convened by Dr Jean O'Dwyer, and attended by over 300 researchers, the colloquium focused on pathways for "*Healthy Planet, Healthy Communities*" reflecting the intrinsic links between the natural environment and human health in the midst of a global pandemic. The keynote talk from Prof Kate Raworth (University of Oxford and author of *Doughnut*

Economics) and Roisin Markham of IDEN (Irish Doughnut Economics Network) clearly underlined the urgent need to ensure our economic system addresses social, ecological and health challenges in Ireland.

The UCC Eco-Humanities Research Group was established in 2021 with support from the ERI and CACSSS. Convened by Prof Caitríona Ní Dhúill and Dr Crystal Addey, the group draws from across a wide range of disciplines to explore the crucial role that humanities and the arts can play in the sustainability transition, giving greater prominence to the human and cultural dimensions of the Anthropocene. 2021 also saw the establishment of the Centre for Sustainable Fermentation and Bioprocessing Systems for Food and the Bioeconomy (SUSFERM) in UCC, led by Dr John Morrissey, to provide a new interdisciplinary focus to address major challenges and opportunities in the bioeconomy.

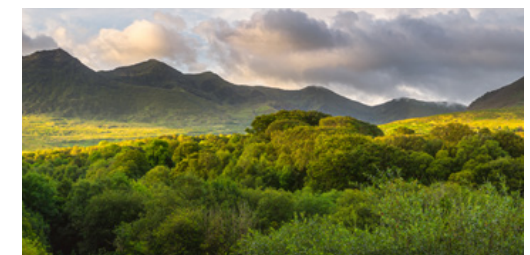
The Institute, its researchers and centres attracted €16.1M in research funding in 2021. It was awarded 83 new research projects bringing the current total to 291 active research projects worth over €86.6M. Institute researchers published a record 454 peer reviewed publications, and 40 postgraduates graduated under the supervision of ERI affiliated academics in 2021. The impact of ERI research was evident throughout the year across our three research challenges of Climate Action, Circular Economy, and Healthy Environment. On Climate Action, our research played a central role in underpinning the Government's Climate Action Plan and informing carbon budget policy deliberations at national level, along with developing toolkits for use by communities in engaging on climate action, and training of local authority staff on climate adaptation. It contributed to advancing a circular economy with a new pedestrian bridge built from wind turbines, a patent for recycling and upcycling plastic waste, and a recycling technology for composite materials. To protect human health a new air quality forecasting system was developed with Cork City Council to provide information about future air quality a few days ahead of time. Research at ERI also showed that almost two-thirds of Cork city can be considered green or blue with these spaces positively impacting bird diversity and highlighting how urban spaces can provide habitats for vulnerable species. The Institute was very pleased to contribute to a deeper understanding of knowledge co-production for sustainability in Ireland through the RIA Knowledge co-production for a sustainable society project.

The year saw many achievements by UCC, ERI and its academics and researchers. UCC was ranked 8th in the world by the Times Higher Education (THE) Impact Rankings placing it as Ireland's leading university for its impact in working towards creating a sustainable future. Dr Ger Mullally was awarded a "*Lifetime Achievement*" award by Cork Environmental Forum in recognition of his very significant leadership on sustainability over many years. Congratulations also to Dr Jean O'Dwyer who was appointed Deputy Director of iCRAG, and to Prof Colm O'Dwyer who has been elected 3rd Vice-President of The Electrochemical Society.

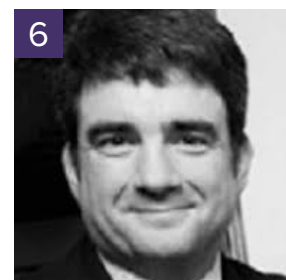
We were very pleased to welcome new affiliated Academics from across a host of UCC schools and departments in 2021 including Dr Richard O'Shea and Dr David Wall (School of Engineering), Dr Michelle McKeown (School of BEES), Professor Wim Naudé (CUBS), Dr Aoife Daly (School of Law), and Dr Janas Harrington (School of Public Health).

Through our inter- and trans-disciplinary projects across the natural and social sciences, engineering, business, and the arts and humanities, the ERI continues to span the complex boundaries that are encountered when addressing sustainability challenges. The significant capacity which the ERI has built in the area of sustainability will be leveraged within the ambitious programme of UCC Futures in 2022 which identifies sustainability as one of the ten strategic areas for the university. Through UCC Futures, the ERI will build on this success and continue to produce internationally leading environmental and sustainability research that has scientific and societal impact.

PROFESSOR SARAH CULLOTY
Director, Environmental Research Institute



ERI Management



1. **PROFESSOR SARAH CULLOTY**, ERI Director
2. **PROFESSOR JERRY MURPHY**, Director of the SFI MaREI Centre, Vice-Director of the ERI
3. **PROFESSOR BRIAN Ó GALLACHÓIR**, Director of the SFI MaREI Centre, Vice-Director of the ERI
4. **DR PAUL BOLGER**, ERI Manager
5. **DR GILLIAN BRUTON**, SFI MaREI Centre Manager
6. **DR JEREMY GAULT**, ERI Beaufort Building Operations Manager
7. **DR JIMMY MURPHY**, LIR NOTF Manager



ERI Academic Advisory Board 2021

PROF SARAH CULLOTY (CHAIR)
Director of ERI (Head of SEFS)

PROF JERRY MURPHY
Deputy Director of ERI
(School of Engineering and Architecture)

PROF BRIAN Ó GALLACHÓIR
Deputy Director of ERI
(School of Engineering and Architecture)

DR PAUL BOLGER
Manager of the ERI

PROF EDMOND BYRNE
School of Engineering and Architecture

DR FIONA CAWKWELL
School of the Human Environment

PROF ELEANOR DOYLE
Cork University Business School

DR NIALL DUNPHY
School of Engineering and Architecture

DR JEREMY GAULT
ERI Beaufort Building Operations Manager

DR CLODAGH HARRIS
School of Society, Politics and Ethics

PROF JUSTIN HOLMES
School of Chemistry

PROF MARCEL JANSEN
School of BEES

DR MARIA KIRrane
UCC Sustainability Officer

PROF MARY MCCARTHY
Cork University Business School

PROF OWEN MCINTYRE
School of Law

DR PAT MEERE
School of BEES

DR JOHN MORRISSEY
School of Microbiology

DR GER MULLALLY
School of Society, Politics and Ethics

DR STEPHEN ONAKUSE
Cork University Business School

DR ÉILIS O'REILLY
School of Public Health

DR TOM REED
School of BEES

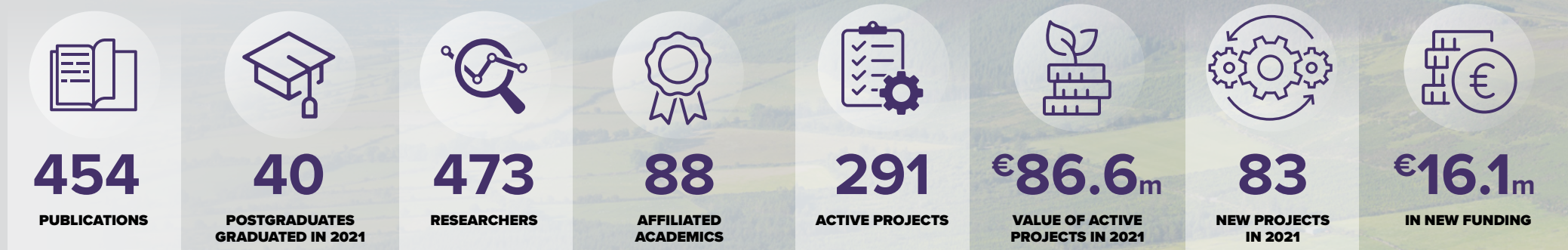
DR ÁINE RYALL
School of Law

DR MARIA DE SOUSA GALLAGHER
School of Engineering and Architecture

PROF JOHN WENGER
School of Chemistry

PROF ASTRID WINGLER
School of BEES

Snapshot of ERI in Numbers for 2021



Funding Source



1 | UCC at COP26

WHAT WAS COP26?

In November 2021, 196 countries of the world met in Glasgow at COP26 to negotiate the next stage of an agreement to limit global warming to 1.5 degrees (pre-industrial levels). The 26th 'Conference of the Parties' brought nations together to accelerate action towards the goals of the Paris Agreement (COP21, 2015) and the UN Framework Convention on Climate Change (UNFCCC), to limit the levels of global warming and climate change. The importance of COP26 in the global effort to reduce greenhouse gas emissions is underlined by the conference having been heralded as the 'last best chance' to limit catastrophic global climate change. **UCC is the only Irish University to hold official observer status at COP26 and is the only University in Ireland to have sent a delegation of students and academic researchers to the summit in Glasgow, led by Prof Brian Ó Gallachóir.**

WHO WAS IN THE UCC DELEGATION?

The UCC President's delegation to COP26 consisted of students, researchers, and academics with expertise in carbon emissions & budgets, transport, societal change, sustainable cities, air and water pollution, energy efficiency, law and governance and plant science. The delegation included Prof Brian Ó Gallachóir (MaREI, ERI, School of Engineering and Architecture), Dr Marguerite Nyhan (MaREI, ERI, School of Engineering and Architecture and Visiting Scientist at Harvard University), Dr Eoin Lettice (ERI, School of BEES), Dr Kian Mintz-Woo (ERI, Dept of Philosophy), postgraduate students Jason McGuire and Vera O'Riordan (both MaREI, ERI, School of Engineering and Architecture), Clara Felberbauer (ERI, CRAC, UN GEMS Water/CDC), and Rhoda Jennings (ERI, School of Law, Centre for Law and the Environment) and UCC SU Sustainability Officer Alicia O'Sullivan.



WHY WAS UCC IN ATTENDANCE?

UCC - as the only Irish university with official observer status at the United Nations COP26 conference - sent a delegation of researchers and students to the global summit in Glasgow. The UCC delegation was organised by a working group within the President's office in association with the ERI.

Prof Brian Ó Gallachóir who led the delegation, spoke to RTE News about the significance of UCC's involvement,



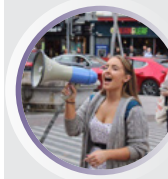
“ In UCC, we are doing research on the required solutions to deliver on this political ambition. As individual countries bring increased ambitions to COP26, I'm hoping to see stronger commitments to action from Governments to match their ambitions and to deliver the necessary solutions, including from Ireland.

Dr Kian Mintz-Woo commented,



“ The thing that COPs do is draw in expertise, whether scientific, policy, and practical, generating the space for discussion that is hard to replicate in any other context.

UCC SU Sustainability Officer Alicia O'Sullivan commented on her trip to COP26;



“ I got a train from Cork to Dublin, one from Dublin to Belfast, a ferry from Belfast to Scotland, a bus to Glasgow, and a train to Edinburgh.

THE ROAD TO COP26

The UCC President's delegation made the decision to travel to Glasgow by boat, train, and electric car rather than flying which has a much greater carbon footprint per passenger. PhD researcher Evan Boyle (MaREI, ERI, Dept of Sociology and Criminology) was part of an electric vehicle road trip to COP26 stopping at a farm in Offaly, at Queens University in Belfast and at a farm in Scotland on the 215km journey before arriving at the conference.



SUSTAINABLE COMMUNITIES MURAL

By 2050 nearly 70% of the world's population will live in cities. In Cork, the population in the metropolitan area is projected to reach 500,000 by 2050, a 60% increase. Commissioned by UCC to coincide with COP26, the Sustainable Communities mural created by Cork-based artist Kevin O'Brien, represents a positive vision of a sustainable city. The mural, located at the College Road entrance to the campus, depicts Cork against an imagined future version of itself. Signs beside the mural ask common questions around climate change and seek to encourage people to learn more about building sustainable communities at a dedicated website.



“*It is important that we point to solutions and work with communities in the urgent challenge that faces us all. This mural seeks to inspire thinking, encourage conversations and provoke action to create communities that work with our environment in securing a sustainable future.*”

President John O'Halloran



MODEL COP26 SEES UCC STUDENTS LIMIT WARMING TO 2°C

UCC also hosted a role-playing version of the negotiations in advance of the main conference, to understand the challenges and to see if a global agreement could be reached. Led by Dr Fionn Rogan, the event was jointly organised by the President's Working Group on COP26, UCC Green Campus, the ERI, the MaREI Centre for Energy Climate and the Marine, and a number of student societies including the Environmental, Law, International Development, International Relations, Engineers Without Borders, and Co-operative Societies. Participants adopted negotiating positions for different country groupings, and delegates were tasked with negotiating a global pathway for climate action while other students assumed the role of disruptive environmental and social justice activists. After negotiating their position, delegates returned their pledges for annual reductions of GHGs, rates of afforestation and

deforestation, and the proposed timeframes for such actions. Climate modelling software was then used to model the pledges of delegates and determine the global temperature trajectory under that scenario. Input from UCC President John O'Halloran, Prof Áine Ryall (Centre for Law and the Environment), Dr Fionn Rogan (ERI, MaREI, School of Engineering), and the British Ambassador to Ireland, H.E. Mr Paul Johnston guided the groups in the drafting of their resolution text.

Ultimately the negotiating result from the end of the night, after two rounds of negotiations saw the student pledges limiting warming to 2°C which is compliant with the Paris Agreement. A recent UN report noted that current country pledges only limit warming to 2.7°C so it is worth noting that UCC students managed to secure a better deal!



CLIMATE CHANGE AND HEALTH

As members of an Environment and Health Subgroup in WHO Healthy Cities, Cork Healthy Cities was invited to participate in a side event at COP26 on the co-benefits of health and climate mitigation. Prof Brian Ó Gallachóir represented Cork Healthy Cities at the event where he spoke about Cork’s experience of democratising the health agenda through the WHO Healthy Cities initiative, in which citizens and communities are consulted and represented and a focus is placed on health equity.

“ We now have a new action plan for Cork Healthy Cities from 2020-2030, and it is effectively centred around 6 themes with people being the first. People, places, peace, prosperity, participation and planet. ”
 Prof Brian Ó Gallachóir



BRITISH AMBASSADOR MEETS UCC PRESIDENT’S DELEGATION

The British Ambassador to Ireland, H.E. Mr Paul Johnston, met with the UCC President’s delegation upon their return from the United Nations COP26 conference. UCC President Prof John O’Halloran presented the Ambassador with UCC’s COP26 Declaration. This includes UCC’s commitment, while working collectively with peers along both north-south and east-west axes of the islands of Ireland and Britain, to develop knowledge-based solutions and innovations to address the challenges of climate change mitigation and associated environmental degradation, in tandem with research to inform future policies.

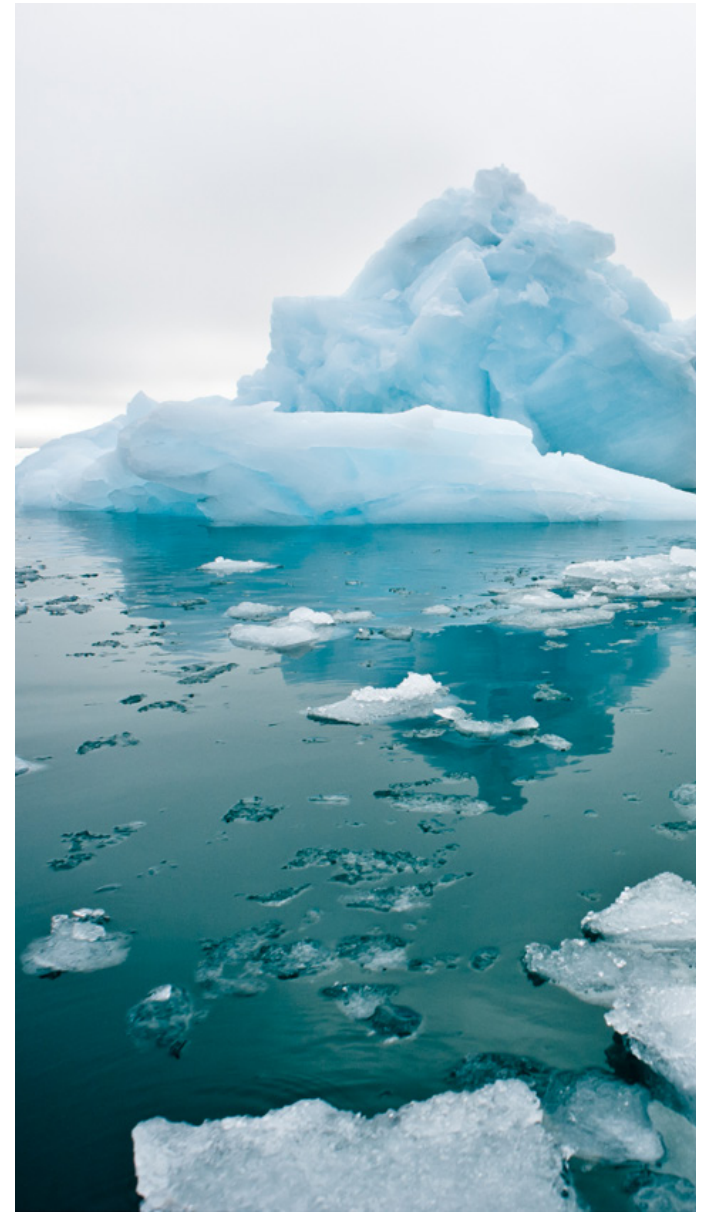
“ Through my discussions today with President John O’Halloran, staff and students from the President’s delegation, and through visiting the UCC’s sustainability mural, I can see first-hand the University’s strong climate action agenda and its commitment to tackling the climate crisis. I look forward to exploring further how UCC and the British Embassy can work together beyond COP26 to support the achievement of our climate targets. ”



British Ambassador, H.E. Mr Paul Johnston



Photo credit: Daragh McSweeney/Provision



2 | Training and Capacity Building

COLLABORATING FOR A MORE SUSTAINABLE SOCIETY

It has long been argued that solutions to inform better decisions on environmental challenges require collaborative research and teamwork. This collaboration is no longer limited to sharing ideas with the scientist in the lab next door. Interdisciplinary research between different disciplines, and transdisciplinary with non-academic partners, are necessary to address complex global environmental challenges and tackle wicked sustainability problems that require different types of knowledge. As part of ENVIRON 2021, ERI Manager Dr Paul Bolger with Connor McGookin and Evan Boyle (both ERI, MaREI) led a two-hour workshop on the theme *'Enabling team science and inter/transdisciplinary research for sustainability'*. The workshop provided an overview of the knowledge and skills that researchers need to be effective team scientists and inter/transdisciplinary researchers. The workshop particularly drew on the experience of the transdisciplinary research projects Dingle 2030 and Imagining 2050.

CAPACITY DEVELOPMENT FOR IMPROVED WATER QUALITY WORLDWIDE

2021 was a busy year for UNEP GEMS/Water Capacity Development Centre (CDC) team based in the ERI at UCC, with Phase II of the programme now fully operational. In September 2021, a total of 22 new students from around the globe joined the CDC to start their 2-year part-time online PGDip in Freshwater Monitoring and Assessment. A further 15 students continued with their MSc in freshwater monitoring and assessment, with the commencement of a range of projects from around the globe. In addition to these courses, the CDC launched a new range of free (open access) courses on water quality monitoring in 2021, hosted by the UNEP eLearning platform, and have continued to provide a range of targeted Continuous Professional Development courses. The CDC also developed and launched an inaugural virtual 'summer school' on water quality monitoring and assessment in 2021 and provided advice and input to a wide variety of other water quality monitoring initiatives and projects worldwide. The UNEP GEMS/Water CDC has now trained close to 340 persons in aspects of water quality monitoring and assessment from some 108 countries since inception.



SUSTAINABILITY IN ENTERPRISE

Growing public awareness and concerns over climate change and environmental sustainability are pushing enterprises to place sustainability at the heart of business strategy, operations and decision-making. 2021 saw the launch of the Certificate and Masters in Sustainability in Enterprise, as part of the Sustainable Futures project, led by Dr Marguerite Nyhan (School of Engineering and Architecture, MaREI, ERI, Visiting Scientist at Harvard University). Funded by the Higher Education Authority's Human Capital Initiative, Sustainable Futures is led by UCC in collaboration with Maynooth University, Atlantic Technological University and multiple industry partners. This programme leverages UCC's Sustainability Strategy and the interdisciplinary strengths and capacity within the ERI, to deliver a curriculum which delves into the key principles and theories associated with business, management and the circular economy, while also allowing graduates to develop transferable leadership skills and identify business opportunities through innovative frameworks. The current courses under Sustainable Futures include:

- A Higher Diploma in Sustainability in Enterprise (Level 8) postgraduate conversion course is focused on environmental sustainability and decarbonisation in industry and enterprise.
- An online Part-time PG Certificate in Sustainability in Enterprise (Level 9) to develop highly competitive graduates with expertise in environmental sustainability, sustainability in business and management, and in systems thinking.
- An Online Part-time MSc in Sustainability in Enterprise (Level 9) to support graduates to solve complex multi-faceted sustainability challenges both now and in the future.

NEW UCC SPACES DEDICATED TO TEACHING AND TRAINING FOR SUSTAINABILITY

2021 saw the completion of a Sustainable Futures teaching space in the Iris Ashley Cummins Building in the School of Engineering and Architecture, and an enterprise-academia collaboration space at the ERI Lee Road Building. The space within the School of Engineering is designed primarily for undergraduate and postgraduate teaching and training. It is envisaged that the space at ERI Lee Road Building will be used to catalyse and stimulate collaboration between academics and industry to generate new sustainability courses and research projects. UCC's Sustainable Futures project, led by Dr Marguerite Nyhan (School of Engineering and Architecture, MaREI, ERI, Visiting Scientist at Harvard University) aims to create a suite of training and academic programmes that directly address the skills gap within business in relation to sustainability. Particular emphasis is placed on enabling businesses to embed sustainability practices right across the business operations in order to move to a low carbon economy.



Photo credit: Nollaig Power

3 | Environ 2021 at UCC



“ I am so proud of what our team accomplished in the most challenging of times. It was a privilege to interact with so many enthusiastic scientists. ENVIRON 2021 convenor Dr Jean O'Dwyer

The Environmental Researchers Colloquium (Environ) is the longest running and largest forum for environmental researchers in Ireland with an average of 275 delegates attending the event annually. It provides a high-visibility platform for young and experienced researchers to present their findings to an audience drawn from academia, government bodies and agencies, as well as industry. Each year the ERI sponsors a postgraduate delegation from UCC to avail of what is for many students their first opportunity to communicate their research at a national level.

ENVIRON 2021, hosted in collaboration between the ESAI and the ERI took place from 16-18th June 2021. Convened by Dr Jean O'Dwyer (ERI, BEES, iCRAG), the theme of the conference was 'Healthy Planet, Healthy Communities', reflecting the intrinsic links between the natural environment and human health and wellbeing. Session themes included Water Quality and Resources, Environmental Geoscience, Environmental Communication, Waste Management, Energy, Climate Change, Environment and Human Health, Ecotoxicology, Air Quality and Urban Development, Marine and Coastal and Sustainable Land Use, Agriculture & Food Industry.

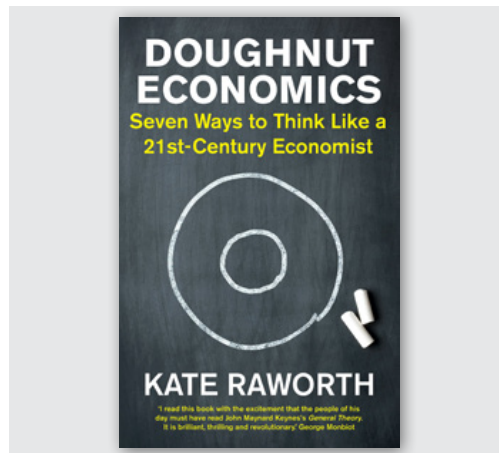
With over 30 different seminar sessions, 44 poster presentations, interactive workshops such as that hosted by ERI Manager Dr Paul Bolger on *Collaborating for a more sustainable society*, student prizegiving and social events, the 31st ENVIRON may have been virtual, but its impact was felt by all 300+ attendees locally and globally.

The ERI were pleased to be able to open the conference to a wider non-academic audience this year, coordinating two separate public-facing events on topics which are of particular public significance – economics and health.



CO-KEYNOTE: DOUGHNUT ECONOMICS

As part of our ongoing Greening Our City webinar series, the ERI welcomed the public to ENVIRON 2021 for a co-keynote talk from Kate Raworth (author of *Doughnut Economics*), an environmental economist focused on exploring the economic mindset needed to address the 21st century's social and ecological challenges, and Roisin Markham, founder and network steward of the Irish Doughnut Economics Network (IDEN). Chaired by ERI's Dr Ger Mullally, lecturer and Deputy Head in the Department of Sociology and Criminology in the School of Society, Politics and Ethics, Kate and Roisin provided an overview of the Doughnut Economics model and discussed how this could be applied in an Irish context.



PUBLIC Q&A: HEALTHY PLANET, HEALTHY COMMUNITIES

The public also took part in a panel discussion with special guests Prof Paul Ekins (Resources and Environment Policy at University College London), Dr Ina Kelly (Consultant in Public Health Medicine, and Chair of the HSE Public Health Medicine Environment and Health Group) and Denise Cahill (Healthy Cities Coordinator for Cork City and Adjunct Lecturer in the UCC School of Public Health).



4 | UCC Eco-Humanities Research Group

The rapidly destabilising ecological context demands a reflective space that allows us to come to terms with uncertainty and risk, and to rethink our priorities and values in the face of ecological crisis and climate breakdown.

Established in 2021 with support from the ERI and CACSSS, the **UCC Eco-Humanities Research Group** is a group of scholars from across and beyond the humanities disciplines whose work is concerned with the climate and biodiversity crises and with their far-reaching implications for human civilisation and culture. The Eco-Humanities Research Group sees itself as part of the wider global effort to bring the critical and creative energies of humanities research to bear on the pressing concerns of climate crisis, biodiversity loss and ecological degradation. The group aims to explore the extent to which environmental crisis is also a crisis of values, ideologies, and symbolic systems. The work of the group is motivated by the conviction that the capacities of empathy and imagination can be strengthened in response to ecological loss, and that these very capacities will help us to rise more effectively to the challenges that lie ahead.

The Eco-Humanities group is also working to develop critical ecological awareness within humanities education at undergraduate and postgraduate level in UCC, linking up with existing initiatives such as Green Campus, the UCC Community Garden, and the CIRTL Sustainable Development Goals Toolkit.

Co-convened by Prof Cairtriona Ní Dhúill (Dept of German, ERI) and Dr Crystal Addey (Dept of Classics) the Eco-Humanities group has had a busy schedule since its launch in 2021. Its inaugural *'Humanities for the Anthropocene'* research dialogue day, in conjunction with the Irish Humanities Alliance, led to the founding of a new *'Humanities for the Anthropocene'* all-island network. This work continued with a workshop on *'Agency, Onto-Epistemology and the More-Than-Human'* with Eva Meijer (Amsterdam). A major focus in 2022 is the Eco-Humanities Online Public Lecture Series, which features guest speakers Sharae Deckard (Dublin), Thomas Hylland Eriksen (Oslo), Alexander Hampton (Toronto), Freya Matthews (LaTrobe, Melbourne) and Andreas Malm (Lund). The group's Lunchtime Seminar Series convened by Dr Paolo Saporito (Dept of Film and Screen Media) enables researchers in the group to get to know each other's work, while outreach events have included a public discussion forum with Friends of the Earth Ireland.

Exciting opportunities for the Eco-Humanities group from 2022 onwards will arise in close collaboration and dialogue with UCC's new Radical Humanities Laboratory, which will work across disciplinary boundaries in UCC's four Colleges to explore the roots of global societal crises. One of the aims of the Radical Humanities Lab is to address key questions within Environmental Humanities such as climate histories and cultures, blue humanities, sustainability, eco-philosophies, eco-semiology, eco-cosmologies and new materialism. The Eco-Humanities Research Group forms part of the vibrant research ecology at UCC that will enable the Radical Humanities Lab to maximise its impact at pace.



Prof Cairtriona Ní Dhúill



Dr Crystal Adde



5 | Research Highlights 2021

5.1 CLIMATE ACTION

Climate change is one of the greatest threats facing humanity. The transition to a zero carbon and climate resilient society as committed to in the 2015 Paris Agreement is now underway. The ERI Climate Action challenge is focused on understanding, responding, adapting, and living with climate change.



CO-CREATING A CLIMATE RESILIENT SOCIETY

The 2020 Program for Government committed Ireland to a net zero and climate neutral economy by no later than 2050. The Climate Action and Low Carbon Development Act 2021 set this ambition in legislation and the Climate Action Plan 2021 defined a pathway to achieve it. For Ireland to make this transition, we need to make changes in our society and economy, and a collaborative effort is required by government, business, communities, and individuals. The National Dialogue on Climate Action (NDCA) will be the primary vehicle through which this will be realised, delivering a systematic means of actively engaging stakeholders and the public with climate action across Ireland, enabling and empowering people at a local and national level. **The outcomes of the EPA-funded Imagining 2050 project will directly inform the National Dialogue on Climate Action (NDCA) in terms of customising approaches and structures for engagement with society at different levels, and to build public support for this and future climate action plans.** Cumulating in 2021, with the launch of the Deliberative Futures Toolkit - a suite of tools drawing from deliberative democracy and participatory processes to help generate community-led alternative futures in a time of climate crisis, the project was led by Dr Gerard Mullally in UCC (ERI, School of Society, Politics and Ethics) and carried out in collaboration with colleagues in Queen's University Belfast.



SUPPORTING CLIMATE ADAPTATION CAPACITY WITHIN LOCAL AUTHORITIES

Climate Ireland is funded through the Department of Environment, Climate, and Communications (DECC) and the EPA and coordinated through MaREI, with a remit to support national adaptation on the impacts of climate change. To meet the requirements of Action No. 150 (to support the development of local authority climate action leadership and capacities) of the Climate Action Plan 2019, the Climate Ireland team worked closely with the Climate Action Regional Offices (CAROs) to support the development and delivery of bespoke climate action training programmes. The training was delivered through Climate Ireland's online learning platform and via three-day workshop-based events to almost 14,000 Local Authority Staff during 2021. Climate Ireland is also supporting Local Authorities better understand the climate risks they face by working with the CAROs to develop a semi-quantitative climate risk assessment methodology. This approach builds on previous risk assessments by providing information on the spatial distribution of climate risks. These types of risk assessments are needed as they support the planning and development of adaptation actions based on current and projected future risks. The semi-quantitative climate risk assessment methodology will be piloted further by Local Authorities during 2022.



USING THE CREATIVE ARTS TO WORK WITH COMMUNITIES ON CLIMATE ACTION

In a time of climate crisis, the creative arts provide a pathway to meaningfully connect people with the profound changes that are happening in our environment, society and economy, and can also transform that connection into behaviour change or climate action. 'Corca Dhuibhne Inbhuanaithe – A Creative Imagining' was awarded funding under the inaugural Creative Climate Action Fund, an initiative from the Creative Ireland Programme in collaboration with the Department of the Environment, Climate and Communications that supports creative, cultural, and artistic projects that build awareness around climate change and empower citizens to make meaningful behavioural transformations. 'Corca Dhuibhne Inbhuanaithe – A Creative Imagining' aims to work with local farmers, including the West Kerry Dairy Farmers' Sustainable Energy Community, to creatively look at ways in which farmers on the peninsula can diversify to address climate change. The project will see an embedded artist working alongside the Corca Dhuibhne Creativity and Innovation Hub, the Green Arts Initiative in Ireland and Dr Clare Watson of MaREI and the ERI. Meanwhile in Cork City, the Creative Climate Action Fund has sponsored the KinShip Project - a durational public artwork at Tramore Valley Park. KinShip will provide a programme of artistic residencies, the design and building of a sustainable Eco Lab and series of creative exchanges and knowledge exchanges which will put local community at the heart. Hosted by Cork City Council in partnership with artists Lennon Taylor the Kinship project partners include Cork Nature Network, Cork Healthy Cities, Cork's UNESCO Learning City, Green Spaces for Health, MTU Clean Technology Lab and the ERI.



THE IMPACT OF CLIMATE CHANGE ON MENTAL HEALTH

To date, the impacts of extreme weather events (EWEs) on mental health remain ambiguous, largely due to the inherent complexities in linking extreme weather phenomena with psychological status. However, an exploratory investigation led by Dr Jean O'Dwyer (ERI, BEES, iCRAG) and Dr Marguerite Nyhan (ERI, MaREI, School of Engineering and Architecture and Visiting Scientist at Harvard University) provides a new empirical and global perspective on the psychological toll of EWEs by exclusively focusing on psychological morbidity among individuals exposed to such events. The team collated morbidity data from a range of existing psychological and well-being measures and integrated the data to develop a single metric, namely, psychological impairment. **It was concluded that the odds of developing any psychological impairment were about 90% higher among individuals exposed to extreme weather events, with disproportionately high incidence in women.** This was due to cultural, socio-economic, and physiological factors, with women also likeliest to experience post-event violence.



UCC SUPPORTING SOLUTIONS TO AVERT BIODIVERSITY AND CLIMATE CRISES

In November 2021, Taoiseach Micheál Martin launched the All-Island Climate and Biodiversity Research Network (AICBRN) at a pivotal point, with the world recently having heard the true scale of the global crisis at COP26 and the UN Biodiversity Conference. The AICBRN is a researched-led initiative, bringing together experts from multiple disciplines across the island of Ireland to undertake the research necessary to address the climate and biodiversity emergencies. Members of the AICBRN are already working together on biodiversity rich renewable energy, low carbon biodiversity friendly agriculture, aspects of the blue economy, sustainable materials required for future infrastructure, nature-focused solutions for resilient cities and nature-based solutions for climate action, amongst other projects.

The SFI MaREI Centre was a founding member of the AICBRN, and MaREI Director Prof Brian Ó Gallachóir, has said:

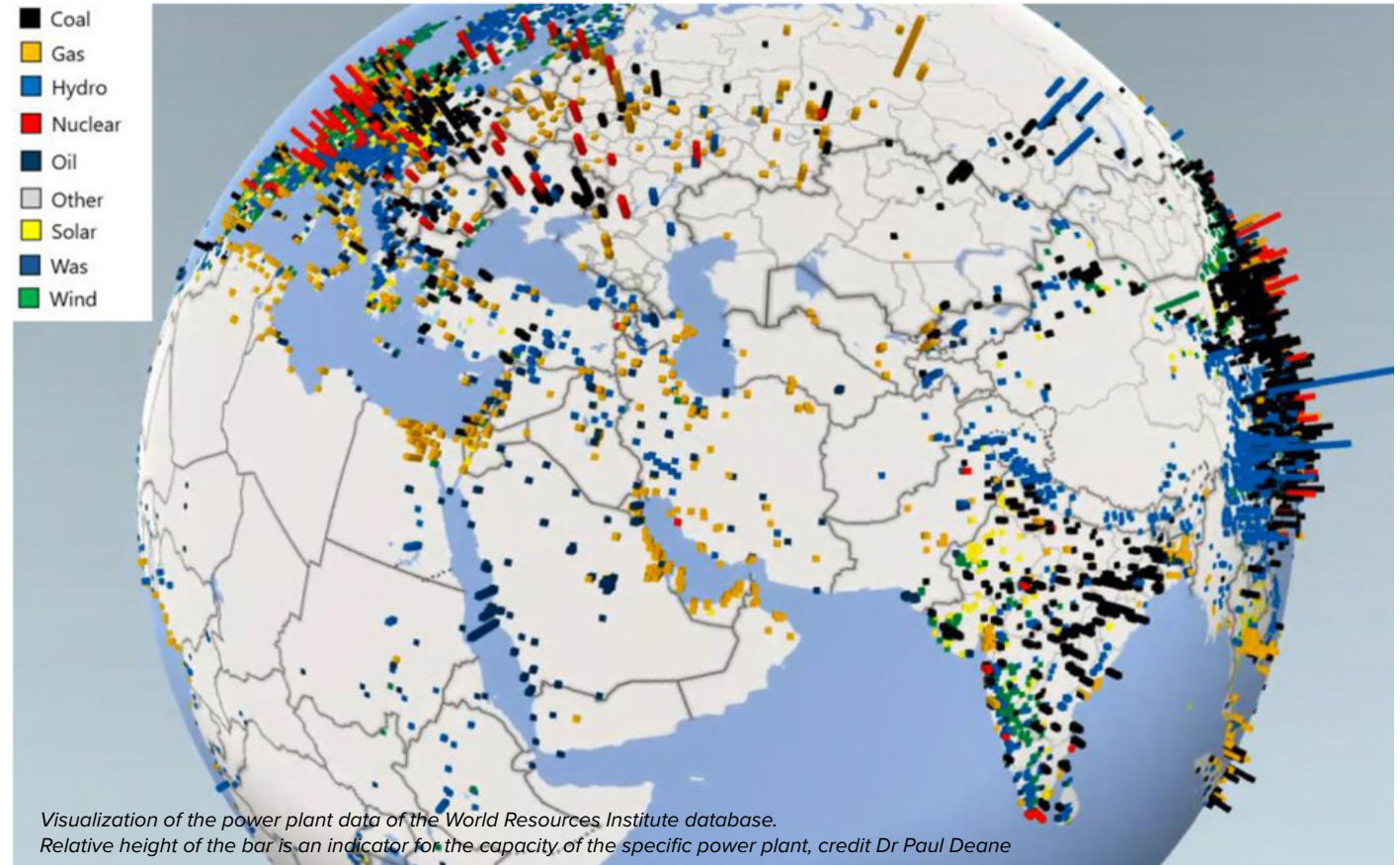
“The Oireachtas has legislated for one of the highest 10 year GHG emissions reduction ambitions in the world. The Northern Ireland Assembly is currently also enacting ambitious climate action legislation. Delivering on this political ambition requires a significant ramp up of research and science, as was the case in addressing the COVID-19 pandemic. We are launching this research network to support the Governments in delivering on the shared All-Island ambitions to address climate change and to restore biodiversity.

VISUALISING THE GLOBAL POWER SYSTEM

Deep decarbonisation of the global electricity sector is required to meet ambitious climate change targets. This underlines the need for improved models to facilitate an understanding of the future challenges for the electricity sector particularly on the concept of large-scale interconnection of power systems. Developments in recent years regarding availability of open data as well as improvements in hardware and software has stimulated the use of more advanced and detailed electricity system models. In a 2021 publication from Dr Maarten Brinkerink, Prof Brian Ó Gallachóir and Dr Paul Deane (all ERI, MaREI, School of Engineering) on global power systems entitled: *'Building and Calibrating a Country-Level Detailed Global Electricity Model Based on Public Data'*, the authors explain the process of developing a first-of-its-kind reference global electricity system model with over 30,000 individual power plants representing 164 countries spread out over 265 nodes. They describe the steps in the model development, assess the limitations and existing

data gaps and showcase the robustness of the model by benchmarking calibrated hourly simulation results with historical emission and generation data on a country level. The model can be used to evaluate the operation of today's power systems or can be applied for scenario studies assessing a range of global decarbonisation pathways.

This research is strategically important as it addresses an existing knowledge gap by using detailed computer simulations of future global power systems to quantify the impact of transnational grids to enable high levels of renewable generation. Government will benefit from better knowledge and information on the technical pathways, and ultimately society will benefit because of a better understanding of mitigation options for climate change.



WILL CARBON TAXES HELP ADDRESS CLIMATE CHANGE?

In the face of Ireland's daunting challenge to reach our 2030 emissions reduction targets, the government has committed to progressively raise the carbon tax rate to reach €100 per tonne of CO₂ by 2030, while recycling revenue to prevent fuel poverty, finance climate-related investment and ensure a just transition. However, carbon taxes have faced opposition and criticism from the public. In a 2021 publication in *The Ethics Forum*, Dr Kian Mintz-Woo (ERI, Dept of Philosophy), addressed several of the most common objections to carbon taxes: (1) that they do not change behaviour, (2) that they generate unfair burdens and increase inequality, and (3) that fundamental, systemic change is needed instead of carbon taxes. Dr Mintz-Woo's response outlined (1) that there is both theoretical and empirical reason to think that carbon taxes do change behaviour, with larger taxes changing it to a greater extent; (2) that undistributed carbon taxes are regressive but distributing the tax receipts can alleviate that regressivity (and, in many cases, make the overall effect progressive); and (3) that while small changes for increasing democratic decision-making may be helpful, (fundamental) change takes time and the climate crisis requires urgent action. Dr Mintz-Woo published widely on the topic of climate ethics in 2021, with additional publications exploring the moral dilemma of where the world should store its captured carbon, the ethics of carbon pricing and the unexpected connections between breastfeeding and climate justice.



ERI RESEARCH INFORMING NATIONAL POLICY ON CARBON BUDGETS

The Paris Agreement does not prescribe a single global carbon budget, nor does it indicate how countries should determine their national carbon budgets. As a result, countries are developing and setting their own carbon reduction strategies in different ways and increasingly, countries are implementing net zero targets for mid-century. The capabilities of the Energy Policy and Modelling Group at MaREI/ERI focus on increasing the evidence-base to allow informed policy choices by developing robust energy models and by building a range of future scenarios and energy models to inform these choices. Models that are used to inform policy decisions include the Irish TIMES energy systems model, which provides optimised least-cost future energy system pathways for the future. In 2021, the Times Irish Model (TIM) team led by Dr Hannah Daly with colleagues Dr Olexandr Balyk, Dr Andrew Smith, Ankita Gaur, Jason McGuire, Vahid Aryanpur (all ERI, MaREI, School of Engineering and Architecture) released the TIMES-Ireland Model, consulting extensively with policymakers, national stakeholders and the Climate Change Advisory Council (CCAC). The study heavily informed the CCAC's deliberations on carbon budgets, with results released on an interactive web-app, and the model has been made freely available.



COMMUNICATION AND ACTION THROUGH TREE PLANTING FOR CLIMATE-HEALTH

Communication and Action through Tree-planting for Climate-Health (CATCH) was a project led by Dr Christie Godsmark (School of Public Health and ERI) that concluded in December 2021. The CATCH project aimed to communicate climate change and its impact on human health and wellbeing. A large focus of the project was on local climate action and particularly the benefits of green spaces and trees. Planting trees can provide a dual mitigation and adaptation response to the climate crisis and high-quality green spaces can deliver benefits for the environment, health and society. Whilst not neglecting the need for rapid and long-lasting phase-out of polluting emissions, tree-planting is a climate action where anyone can get involved, empowering us all to take personal climate action and become part of the solution. The project kicked off with an online event opened by the President of the Tree Council of Ireland, Éanna Ní Lamhna, with contributions from various environment and health advocates (Dr Christie Godsmark, Dr Eoin Lettice, Dr Annalisa Setti, Dr Ríona Walsh, Dr Darren Reidy and Maria Young). Ted Cook, a local environmental advocate, produced a video for the project on trees for the Cork region and demonstrated a tree-planting technique. Next, an animation was produced on communicating climate change, health and some actions that elicit health and climate co-benefits. Finally, 16 participants were given a native Irish tree for planting and one native Crab Apple tree was planted outside the ERI Lee Road Building. The CATCH project will also be discussed in a short communication authored by Dr Godsmark to be published in *The Journal of Climate Change and Health* in April 2022.



MITIGATING THE IMPACT OF CLIMATE CHANGE ON MARINE BIODIVERSITY

The main target of the 2015 Paris Agreement under the United Nations Framework Convention on Climate Change (UNFCCC) is to limit temperature increase to less than 2°C above preindustrial levels at the global scale. Recent studies have demonstrated the potential benefits of this target for marine ecosystems. Seabirds are among the most threatened of all bird groups, with demonstrated sensitivity to climate change impacts such as extreme weather event exposure. Knowledge of climate effects on seabird health and wintering distributions is therefore essential for global marine spatial planning and conservation schemes.

Each winter, the North Atlantic Ocean is the stage for numerous cyclones, the most severe leading to seabird mass-mortality events called "winter wrecks", but the precise cause of these deaths was unclear. Newly published research from Dr Mark Jessop and Dr Manon Clairbaux (BEES, ERI, MaREI) found that these birds die because of the unavailability of their prey and/or their inability to feed during cyclones - providing essential information on seabird cyclone exposure in a context of marked cyclone regime changes due to global warming.

Additionally, the authors explored the implications of succeeding or failing to reach the Paris Agreement Objective of limiting global warming to <2°C on the North Atlantic Ocean seabird community distribution. Using Global Location Sensors to track the inter-breeding movements of five species across the North Atlantic Ocean and adjacent seas, and then modelling seabird energy requirement and seabird prey fields for each location, the team was able to confirm that meeting Paris Agreement Objectives will limit habitat range shifts of the North Atlantic Ocean seabird community in 21st century in comparison with shifts induced by a "no-mitigation" scenarios.

This analysis is key to defining and managing dynamic marine-protected areas (MPAs), which have emerged as powerful means to protect entire ecosystems.



5.2 CIRCULAR ECONOMY

A shift from a “take-make-consume” to a closed-loop economy where resources are kept in use for as long as possible is now an imperative for society and economy. The ERI Circular Economy challenge is focused on producing food and goods in a closed-loop approach with minimal or no waste.



NEW PATHWAYS TOWARDS SUSTAINABLE AQUACULTURE THROUGH CIRCULARITY

The generation of large quantities of waste from the aquaculture industry is a key sustainability issue for the sector and has prompted the need to increase circularity in feed production and valorise aquaculture wastes. Funded by Bord Iascaigh Mhara, Prof Marcel Jansen (ERI, School of BEES) is working to support an Integrated Multitrophic Aquaculture (IMTA) fish farm in Ireland using a Lemna (duckweed)-based system of water remediation. The AquaMona farm is a newly designed and constructed fish farm located on cutaway peatland at Mount Lucas, Co. Offaly. The IMTA principle underlying the farm means that the by-products, including waste, from fish are utilised as the input (i.e. fertilizer) for duckweed which, in the form of biomass, becomes a foodstuff for the fish. Duckweed biomass is considered an important source of nutrients including essential amino acids, fatty acids, vitamins and some minerals. The concept comprises a circular economy whereby there is a balance between the nutrient extraction capability of the duckweed, and nutrient production by the fish. In partnership with Keywater Fisheries and Goatsbridge Rainbow Trout Farm, the UCC team (also including Dr Simona Paolacci, Dr Vlastimil Stejskal, Mr John Hyland and Mr Wayne Malone), has established the first Irish recirculating system with duckweed-based phytoremediation. The research by Prof Jansen's group has also demonstrated that large amounts of duckweed can be cultured in Ireland, and this is facilitating development of novel industries that use duckweed as a sustainable protein source. In turn, this will help rural redevelopment and generation of rural jobs.



NEW UCC RESEARCH CENTRE ESTABLISHED TO SUPPORT CIRCULAR BIOECONOMY

The Centre for Sustainable Fermentation and Bioprocessing Systems for Food and the Bioeconomy (SUSFERM) was established in October 2021 to provide a new interdisciplinary focus to address major challenges and opportunities in the allied areas of sustainable food production and the circular bioeconomy. SUSFERM is a multidisciplinary centre that integrates the expertise of research teams from Microbiology, Food and Nutritional Sciences and Process & Chemical Engineering to create new research synergies to tackle complex scientific and technological challenges associated with development of new products and processes related to microbial fermentation. Microbial fermentation science is at the heart of SUSFERM research programmes, many of which focus on enhancing capacity to use microbes in the Food, Drink and Bioeconomy sectors. New training programmes to deliver MSc and PhD graduates equipped with the skills and expertise required to address current and future industry requirements sector are also being developed.

SUSFERM Director Dr John Morrissey (ERI, School of Microbiology) commented:



“

Whether it is taking advantage of microbial diversity to identify novel functionality for food systems, or using engineered synthetic cell factories in biorefineries, microbial fermentation is at the heart of contemporary developments in these sectors

MORE YIELD WITH LESS FIELD: CULTIVATING THE ‘WHEAT OF THE SEA’

Over the past decade, there has been a growing interest in the development of coastal shores as a source of alternative, sustainable food production, and other valuable products. A newly launched COST Action *Ulva: tomorrow's wheat of the sea* of which Dr Linda O'Higgins of the ERI is a key coordinating partner, looks to develop the ubiquitous green seaweed, commonly referred to as sea lettuce, as a model for innovative mariculture and an alternative sustainable food source. Much of the knowledge on *Ulva*, generated in diverse scientific disciplines and different communities, is not easily comparable nor is it shared among scientists, stakeholders, end users and the public. This COST Action proposes an innovative conceptual pathway to address these issues, significantly improving knowledge in the biology of the most promising *Ulva* species, capitalising on their economic potential, and exploring commercial applications in the human food, animal feed, pharmaceutical industries and ecosystem service. The Action builds on Dr O'Higgins' expertise in the ecology, physiology and metabolomics of aquatic microalgae with a focus on improving cultivation technology, carbon capture and bio-product yield from photosynthetic species within zero-waste, circular agronomic systems.



FROM BLADES TO BRIDGES: REUSING END-OF-LIFE WIND TURBINES

Exposed to sunlight, rain, wind and occasionally lightning, wind turbine blades have a life expectancy of about 25 years. There are thousands of blades to be decommissioned in Ireland in the next few years. The amounts of blade material have been estimated at 12,000 tonnes between 2026-2030 and 14,000 tonnes between 2031-2035 as the country scales up its wind energy infrastructure. It is difficult to recycle this material because it is made of many components which are challenging to separate. The blades, made of extremely durable glass fibre reinforced plastic, often find their way to landfills or are ground down for use in cement. In 2021, the Re-Wind project (ERI, MaREI) in partnership with Munster Technological University and Cork County Council successfully installed a pedestrian bridge in Cork made from decommissioned wind turbine blades. On a former train track bed connecting Midleton and Youghal, workers excavated the rusted remains of an old railway bridge and installed the 'upcycled' pedestrian one in its place. The 14m long blades came from a decommissioned Nordex 250kW turbine which was first used in 1994 and replaced the steel girders usually placed either side of a typical small bridge. The Cork Blade Bridge is the second one of its kind in the world. At 4m wide and 5.5m long, this circular economy solution can be used by maintenance and emergency vehicles as well as pedestrians and cyclists.



Photo credit: Kieran Ruane

DISRUPTIVE TECHNOLOGY WITH THE POTENTIAL TO TRANSFORM THE PLASTICS INDUSTRY

Ireland is producing the highest volume of plastic waste per person in the EU, while having the fourth worst recycling rate for the material. Data released by Eurostat in 2021 showed Ireland has the highest plastic waste generation at 54 kilos per capita, substantially more than the EU average of 33 kilos per capita. Now ERI researchers are part of an ambitious project to tackle this problem of plastic pollution in Ireland, funded through the Irish Government's 'Disruptive Technologies Innovation Fund'. The €2.9 Million PerPETual project will develop processes for recycling all grades of polyethylene terephthalate (PET) - the most commonly used food packaging material. The ERI team, led by Prof Justin Holmes (School of Chemistry and SFI AMBER Centre) have joined forces with the Technological University of the Shannon (TUS) and experienced industrial partners NovelPlast, producers of high-quality PET resin and Avoncourt, a leading Irish supplier of thermoformed packaging, to develop a continuous recycling process for all grades of PET. PerPETual will make a significant contribution towards halting resource depletion, landfilling and incineration of waste plastics, by converting them into valuable resources and demonstrating the implementation of an Irish circular plastics model. In December 2021, the team also filed a patent on a new chemical process for recycling and upcycling PET waste, based on microwave technology.



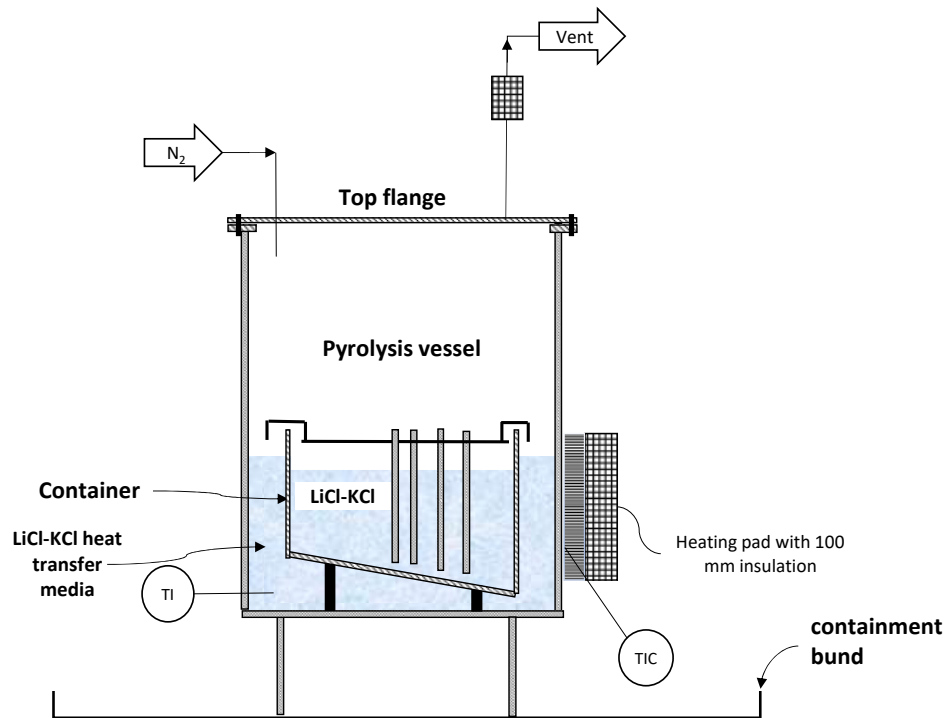
REDUCING THE ENVIRONMENTAL IMPACT OF TEQUILA PRODUCTION

According to the Mexican Tequila Regulatory Council, the production of tequila was 374 million litres in 2020 making it one of the most widely consumed traditional beverages in the world. However, the demand for the product is having damaging repercussions on the Mexican ecosystem. For every litre of tequila produced, an average of ten litres of vinasse (the liquid residue obtained after distillation) is generated. Vinasse is considered a pollutant due to its high temperature, low pH, and high organic contaminants. If all the vinasse produced in 2020 was released it would have been equivalent to the annual pollution from a population of 2.46 million people, representing a major environmental problem. Technologies for processing vinasse waste can be expensive and when adequate treatment methods are not available the vinasse may be discharged into water bodies. Therefore, there is a great incentive to meet the environmental requirements and exploit the potential valorisation of vinasses' high organic matter content via anaerobic digestion for the production of renewable energy. Over the last year the Circular Economy, Energy, and Environmental Systems group led by Prof Jerry Murphy (ERI, MaREI, School of Engineering and Architecture) have initiated a new research project exploring continuous anaerobic digestion trials of tequila by-products such as vinasse, expanding on the groups previous work in investigating novel anaerobic digestion systems for valorisation of other waste streams. Led by Dr Richard O'Shea, the research project will also determine potential for reductions in greenhouse gas emissions associated with the process and will produce a techno-economic analysis which can be disseminated directly to the industry.



NOVEL MULTIPURPOSE RECYCLING TECHNOLOGY FOR COMPOSITE MATERIALS

An unanticipated impact of the COVID-19 pandemic has been the generation of more electronic-waste (e-waste) due to an increasingly digital lifestyle. Crucially, much of what is labelled as e-waste is actually not waste at all, but whole electronic equipment or parts that are readily marketable for reuse or can be recycled for material recovery, and about 23% of e-waste consists of plastics. New recycling technologies must address problems that have prevented the realisation of e-waste recycling opportunities, including sorting efficiency, sorting individual elements, delivering high productivity, recycling difficult materials (e.g., non-recyclable plastics), and need to be more cost and environmentally effective. This has prompted the need for a novel multipurpose recycle capability which is the focus of the REEOL project led by Prof Maria Sousa Gallagher (ERI, School of Engineering). With 8 European partners and co-funded by the Geological Survey Ireland and EPA under EU ERA-MIN2 funding programme, the novel multipurpose recycling RecEol technology involves a single unit that can be scaled-up depending on the waste stream, and is complementary to, rather than competing with, existing metal recycling. The RecEOL technology, developed by Composite Recycling Ltd. in Cork, can recycle Printed Circuit boards (PCB), tantalum capacitors from PCB, indium from glass LCD screens, lithium-ion batteries, Automobile Shredded Residues (ASR), glass and carbon composite fibre materials, and a wider range of other composite materials such as aluminium-laminated plastics, mixed plastics, single plastic streams and plastic film packaging. Going forward, design of all products, not only electronic devices, should be established from a closed-loop perspective, ideally coming from circular economy waste streams with established cost-effective recycling pathways, and regulations should ensure that recyclability is as important a factor as price or usability in the development of electronic and plastic products.



Schematic illustrating the novel multipurpose recycling technology for composite materials.



5.3 HEALTHY ENVIRONMENT

Our economic prosperity and well-being are underpinned by the quality of our environment and natural capital. The ERI Healthy Environment challenge is focused on protecting our natural ecosystems and providing a healthy environment for humans to live in.



FORECASTING AIR QUALITY IN CORK CITY

Contrary to what you might expect, air quality is usually good in Cork and across Ireland in general, but there are recurring episodes when air pollution reaches levels deleterious to human health particularly in winter. To monitor air quality, Cork City Council in collaboration with the Centre for Research into Atmospheric Chemistry (CRAC), have set up a unique network of low-cost PM sensors across the city and an internet-based air quality information service (Cork Air Quality Dashboard) displaying corrected sensor readings. Now, a new interdisciplinary project funded by Cork City Council is building on this sensor network to explore forecasting of local air quality based on historical data and weather forecasts. **Information about future air quality, whether hours or a few days ahead of time, would allow Cork City Council to take active steps to forewarn the public.** Air quality forecasting will be led by Dr Stig Hellebust and Dr Dean Venables (both CRAC, ERI). A second part of the study, led by Dr Marica Cassarino (ERI, Applied Psychology) will investigate the extent to which city residents would engage with air quality forecasts. This critical element of the work will survey public opinions about how they would respond to air quality forecasts and explore what people know about air quality and its impact on health. Information from the survey will inform effective public messaging and the narrative needed to engage the public about air quality.



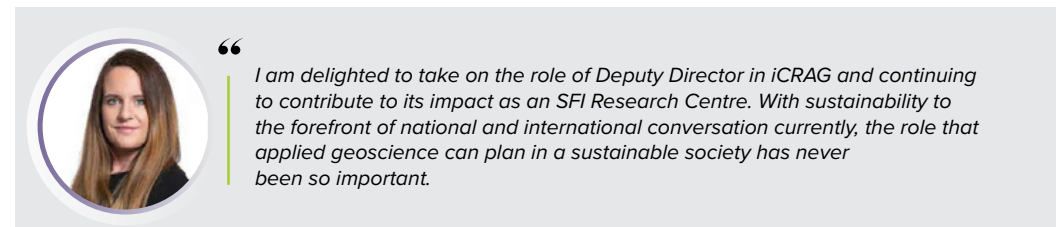
UCC RESEARCH LEADS TO INCREASED PROTECTION FOR SEABIRDS

Whilst many seabird nesting sites are protected, there is a gap when it comes to the feeding and foraging grounds at sea. In 2021, a new high seas Marine Protected Area (MPA) was designated for seabirds which is larger than the land mass of the UK and Germany combined. The designation of the high seas North Atlantic Current and Evlanov Sea basin MPA will cover nearly 600,000 km² and protect a vitally important area for seabirds, particularly protecting vulnerable species that are known to be in global decline. Tracking data provided by Dr Mark Jessop (MaREI, BEES, ERI) formed a crucial part of the large-scale analysis which found that the Site is an important feeding and foraging area and is used both by seabirds breeding on the coasts of the North-East Atlantic, and by those migrating across the globe or nesting in other parts of the world. This analysis went on to inform the MPA designation by OSPAR (the Oslo/Paris convention for the Protection of the Marine Environment of the North-East Atlantic), thus achieving the United Nations Convention for Biodiversity 2020 Aichi target of designating 10% of marine waters as MPAs.



ERI/BEES ACADEMIC APPOINTED DEPUTY DIRECTOR OF SFI ICRA G CENTRE

Dr Jean O'Dwyer, lecturer and researcher in the ERI and the School of BEES was appointed the new Deputy Director of SFI-funded Irish Centre for Research in Applied Geoscience (iCRAG) in 2021. Dr O'Dwyer is Deputy Head of Environmental Science in the UCC School of BEES, and Principal Investigator and Head of the Environmental Health Lab at the ERI as well as being Head of Environmental Geoscience at iCRAG where she oversees the iCRAG-GSI Environmental Geosciences PhD Programme. This latest appointment recognises the significant leadership which Dr O'Dwyer has shown in driving research in sustainable geoscience, groundwater quality, contaminant mapping (most recently COVID-19 mapping via water) and the mental health impacts of climate change. Speaking of her new appointment, Dr O'Dwyer said,



PESTICIDE MANAGEMENT FOR BETTER WATER QUALITY

Pesticide use can have significant adverse impacts on water quality and human health. However, there is a lack of knowledge regarding the interaction between pesticides and different types of soil which can determine the rate of degradation of the pesticide and its persistence. Researchers in UCC, with partners in NUIG and Teagasc are identifying new efficient, low-cost methods to mitigate pesticide loss in agriculture and urban environments. Led in UCC by Dr Paraic Ryan (Civil Engineering, MaREI, ERI), the EPA and DAFM-funded PESTMAN research project will improve our knowledge on effective pesticide management, develop and test methods to reduce pesticide loss in surface and groundwater, and quantify these interventions on human health. The project uses a multidisciplinary approach merging soil processes, molecular biology, engineering, and quantitative risk assessment methodologies to understand the drivers and pressures for the use of pesticides in the environment, examine their fate and persistence, evaluate any potential impact and risks to the environment and human health, and develop a low-cost, passive, *in situ* method to remediate pesticides in the environment. The team will engage with end users such as farmers and land managers to ensure that new methods are rapidly translated into safer pesticide practices.

A TRIP TO THE DENTIST MAY INVOLVE MORE THAN YOU THINK...

Mercury-free dental filling alternatives, some of which contain nanomaterials, have seen an upswing in use in recent years. However, the efficacy of current dental wastewater filtration systems as well as the potential environmental implications of any release of these materials to the wider environment are not currently fully understood. A multidisciplinary research collaboration spanning both the College of Medicine and Health, and the College of Science, Engineering and Food Science (SEFS) at UCC aimed to address these knowledge gaps. The Less Hg project, led by Prof. Mairéad Harding (Director of the Oral Health Services Research Centre at the University Dental School) and Dr Timothy Sullivan, (Director of the UNEP GEMS/Water Capacity Development Centre, ERI, BEES) combined expertise to examine dental wastewater streams from three dental facilities in Ireland with differing amalgam separators in place. The conclusions of the study, published in the *Science of the Total Environment* in 2021, highlighted the highly variable physicochemical characteristics of dental wastewater - reaching extremes of pH, containing many dissolved substances at the micro and nano-scale, and with a relatively potent toxicological profile when tested against the freshwater organism *Daphnia magna*. The findings have prompted the authors to call for continued scrutiny of the ongoing suitability of amalgam separation technologies to effectively separate a broader range of newly introduced nanomaterials.



THE CONTRIBUTION OF HUMANS TO THE OCEAN SOUNDSCAPE

The underwater soundscape is characterized by natural sound and anthropogenic noise. The latter is known to have impacts on marine life because vision is limited underwater, whereas sound can be heard for thousands of kilometers and is crucial for marine communication. The MaREI – coordinated JONAS project (Joint Framework for Ocean Noise in the Atlantic Seas) is an INTERREG Atlantic Area-funded research project addressing threats to biodiversity from underwater noise pollution through better risk management and monitoring. The project has made significant progress in noise modelling and mapping activities, the creation of new Ocean Soundscapes (pictured here), and launch of a new open source tool for Passive Acoustic Monitoring.

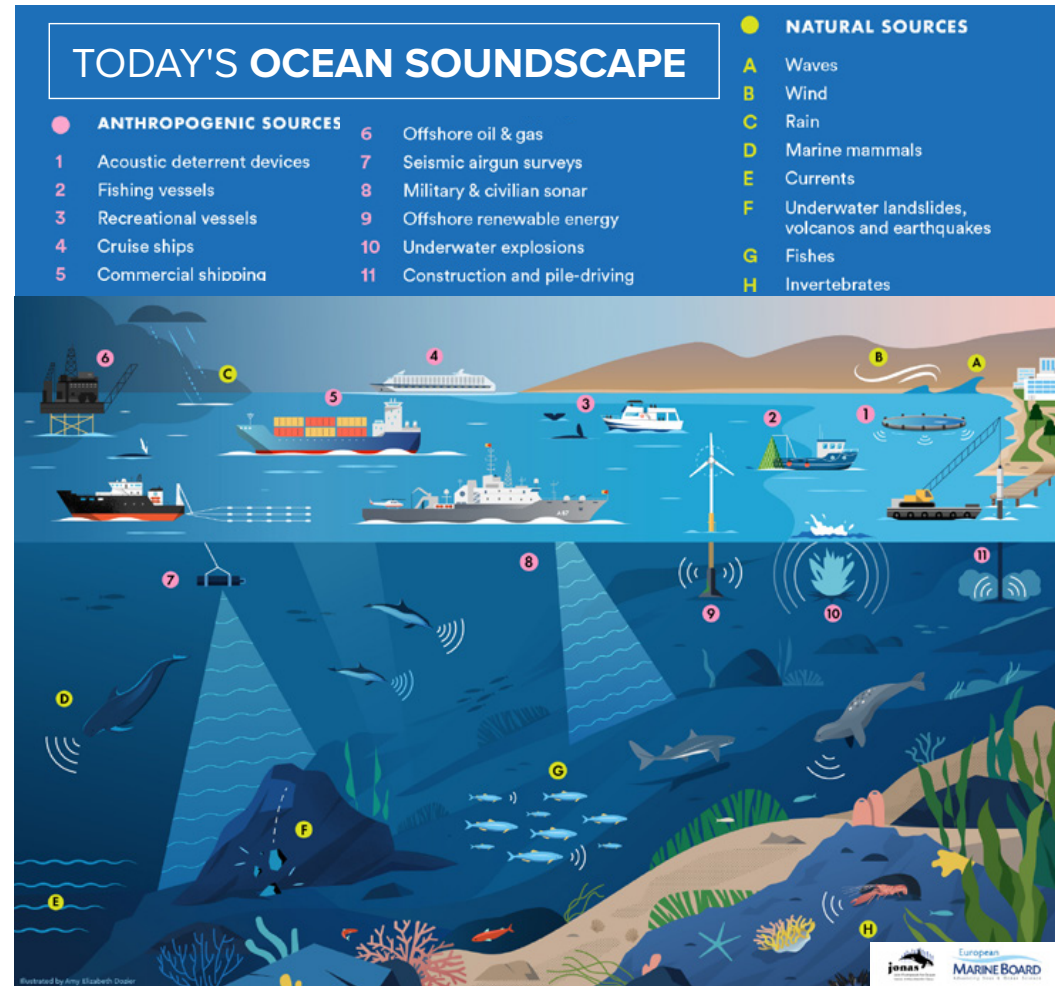


Illustration by Amy Dozier from Thomsen et al., (2021) Addressing underwater noise in Europe: Current state of knowledge and future priorities.

UCC RESEARCH PROTECTS VITAL MARINE ECOSYSTEM

Our natural marine environment and its renewable energy resources can help us to meet our climate goals, but our ocean area is home to an array of marine life which we are also committed to protecting. Understanding our marine biodiversity is crucial when developing plans for the offshore renewable energy generation. In June 2021, the ObSERVE 2 Aerial survey project began extensive aerial surveys of almost 500,000km² of Ireland’s maritime area to build a greater understanding of Ireland’s marine species and the habitats they need to survive and to thrive. Led by UCC’s Prof Emer Rogan and Dr Mark Jessop (ERI, BEES, MaREI) the data collected as part of the first phase of the programme has already filled major data gaps and has assisted in more informed and sustainable management of offshore activities, and in the development of suitable conservation strategies that will sustain our marine environment into the future. It is anticipated that ObSERVE 2 will provide us with a unique timeseries to look at trends in seabird and cetacean abundance and distribution. The second phase involves active partnership and coordination between the Department of the Environment, Climate and Communications, the Department of Housing, Local Government and Heritage, and the SEAI, who together have provided funding of €1.6 million for the aerial survey project. This brings the total investment of the ObSERVE Programme so far to €4.5 million.

“ We are determined to protect our marine environment and the wonderful biodiversity it contains while developing our offshore wind resources. The scientific knowledge from the observe project will play a critical role in developing our resources in a sustainable way.



BETTER TOGETHER: KNOWLEDGE CO-PRODUCTION FOR A SUSTAINABLE SOCIETY

There is a growing international momentum for transformative action at multiple levels to address key sustainability crises such as climate change, biodiversity loss and creating a circular and resource efficient society. With lead author Dr Paul Bolger of the ERI, the recently published Royal Irish Academy (RIA) white paper, ‘Better together: Knowledge co-production for a sustainable society’, provides an overview of knowledge co-production for sustainability and environmental research in Ireland; highlights the benefits and challenges of co-production approaches, and identifies key levers for building capacity and capability for knowledge co-production. The paper draws on almost 50 case studies of co-production research for sustainability, along with the outputs from the online RIA symposium and workshop which took place in June 2021. Hosted by the ERI in partnership with the RIA Climate Change and Environmental Sciences Committee and Future Earth Ireland, the symposium explored how the Irish research system can respond to the demand for increased levels of collaboration and interaction amongst scientists.



MALARIA VECTOR CONTROL ACROSS AFRICA

Despite considerable progress since the turn of the century, the fight against malaria has stalled in the last few years. There are two main obstacles to eradication of the disease: resistance of mosquitoes to insecticides and their ability to avoid core vector control measures. Recognising that both of these phenomena are heavily influenced by environmental variations in the abundance of natural resources that mosquitoes need to survive, AXA-funded research led by Prof Ger Killeen (ERI, BEES) aims to characterize the malaria control opportunities and obstacles that arise from biodiversity conservation efforts across Africa, with the overall goal of bringing malaria one step closer to elimination while also fostering improved management of wildlife conservation areas. Assisted by Dr Fidelma Butler and a team of postgraduate students from the School of BEES and the ERI, Prof Killeen has spent 2021 working in collaboration with the Ifakara Health Institute and Sokoine University of Agriculture in Tanzania to establish a field insectary for rearing and experimenting on wild-caught malaria vector mosquitoes, as well as a centre of operations for the Village Game Scouts who implement the conservation functions of the ILUMA (Eastern Tanzania) Wildlife Management Area.



Deo Kavisha, Research Scientist at the Ifakara Health Institute in Tanzania and PhD student in the School of BEES, successfully field tests his new invention: A ventilated backpack with passive evaporative cooling, for long distance transportation of live mosquitoes.

UCC STUDY SHEDDING LIGHT ON INVISIBLE GREEN SPACES

Birds can be a key indicator for gauging the health of green and blue spaces as natural habitats, and in a city setting, connected green and blue spaces (such as urban gardens and brownfield sites) can play a particularly crucial role in the sustainable management of biodiversity. In 2021 Dr Paul Holloway, Dr Fiona Cawkwell and Luke Lambert (ERI, BEES, MaREI, School of Geography), undertook a bird diversity survey in Cork city, and then analysed the configuration of the urban landscape and its impact on the recorded biodiversity. The team can now estimate that almost two-thirds of Cork city can be considered green or blue, with these spaces positively impacting bird diversity and abundance, and 38% of the species recorded also listed as being of conservation concern in Ireland, highlighting how urban spaces can provide habitats for vulnerable species. Of note were the 'invisible' green spaces, such as gardens, hedgerows, and ponds; when these spaces are considered at a city-scale, it suggests that Cork has a well-connected green and blue network, that is central to supporting biodiversity.



UNVEILING THE SECRETS OF THE SEABED

The Marine Geosciences Research Group are a multidisciplinary team led by Prof Andy Wheeler (BEES, ERI, iCRAG) devoted to understanding ocean processes across the seabed and through geological time. Over the course of 2021, the group continued to explore the deep ocean and Irish shelf seas to better understand ocean environmental change, map the ocean floor and assist offshore windfarm development. Ship-based surveys recommenced after a COVID-induced hiatus, and in January the group undertook a deep penetration geotechnical appraisal of the Braymore windfarm licence offshore of Dundalk as part of an academic-industry programme funded by the SEAI. The IMORE project - Informing and Mapping the Offshore Renewable Environment - was carried out in conjunction with industry partners GDG and SSE. Work on cold-water coral habitats has also continued in strength with the Little MonSta benthic lander array recovered from the Moira Mounds (700m below sea level) for environmental monitoring and microplastics studies (as part of the Plast-Chem-Cora project) and publications and PhDs coming out of the Porcupine Bank Canyon cold-water coral sites on litter, coral health, coral microbiome, late glacial ice sheet, iceberg dynamics and coral refugia (MMMonKey_Pro and iAtlantic projects). Work on using machine learning to identify seabed geomorphological features (NoMans_Tiff and MarPAMM projects) and to characterise objects from submarine video (ASMaT and MMonKey_Pro projects) has continued apace with the first "draft" Irish shelf geomorphology map now successfully computed. The group is planning further surveys for summer 2022 involving deep ocean bedrock drilling as part of the BeTar-Drill project and additional Little MonSta deployments in Whittard Canyon, off the SW Approaches as part of iCRAG2.

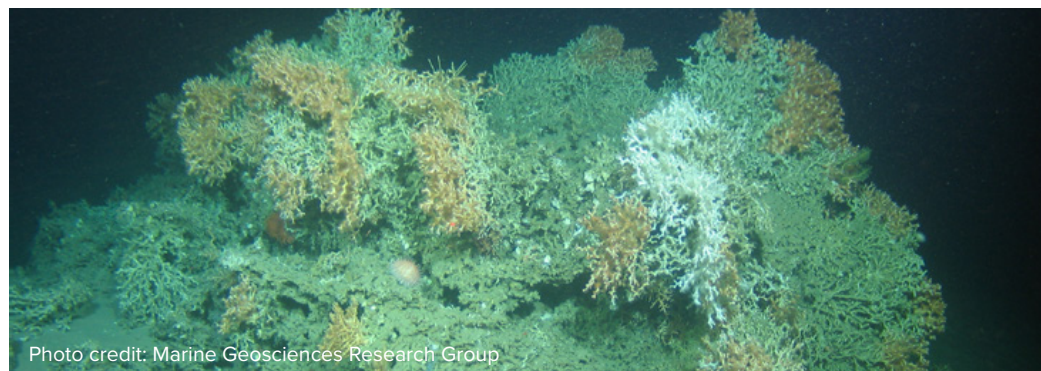
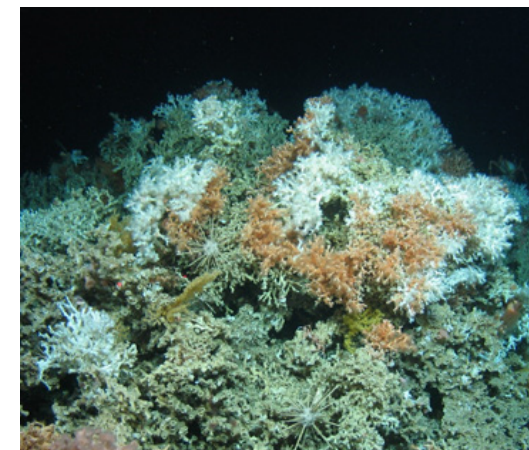
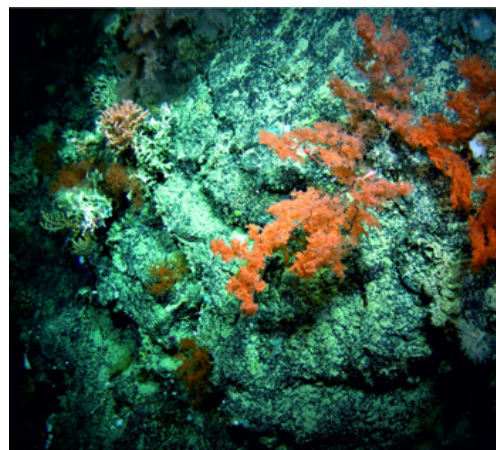


Photo credit: Marine Geosciences Research Group

6 | ERI Research Centres' Reports

6.1 MAREI, THE SFI RESEARCH CENTRE FOR ENERGY, CLIMATE AND THE MARINE

MaREI is coordinated by the ERI and is Ireland's SFI Centre for energy, climate and marine research, development and innovation working across 12 Irish academic institutions and collaborating with over 50 industry partners. The Centre is led by Co-Directors Professor Brian Ó Gallachóir and Professor Jerry Murphy. The Centre Manager is Dr Gillian Bruton.



MAREI AND THE EUROPEAN GREEN DEAL

The European Green Deal is an EU-wide commitment to tackling climate and environmental-related challenges and is designed to set Europe on a path to becoming a climate resilient, zero carbon society that improves the well-being of all citizens. The objectives of the Green Deal will be met through a number of instruments, with research and innovation programmes being one element. In 2020, the H2020 Work Programme was launched with specific topics focused on the Green Deal and MaREI was a key partner in three successful applications:

- **REACHOUT** (Resilience in Europe Through Activating City Hubs – Reaching Out to Users with Triple-A Climate Adaptation Tools) is a €5 million project which sees MaREI collaborating with 18 other organisations to advance Climate Services for urban environments in seven City Hubs across Europe.
- **FORWARD 2030** (Fast-tracking Offshore Renewable energy With Advanced Research to Deploy 2030MW of tidal energy before 2030) is a €28 million project in which MaREI will provide expertise on aspects that include marine planning, and environmental and societal acceptance.
- **ILIAD** (Integrated Digital Framework for Comprehensive Maritime Data and Information Services) a €17 million project to develop and launch a Digital Twin of the Ocean that will provide highly accurate predictions of future developments at global seas. ILIAD project comprises 56 partners from 18 different countries in Europe, the Middle East and North Africa with the UCC team being led by MaREI PI Prof Gregorio Iglesias.



SUPPORTING THE ENERGY INDUSTRY THROUGH COLLABORATION AND CO-CREATION

As a Centre, MaREI have grown their cumulative industry partner portfolio to 103, comprising €9.4m in contracts and 69 repeat engagements. These repeat engagements represent an upscaling and deepening of key relationships.

- **The Entrepreneurship@MaREI programme** provides support to new and early-stage companies, providing a unique interface for the exchange of ideas, insights, expertise, and human capital. To date, MaREI have engaged with over 120 start-up companies across Ireland through the Entrepreneurship@MaREI programme, with eight clients at HPSU or equivalent level. This has been achieved in collaboration with Enterprise Ireland, who directly fund this position within MaREI. Furthermore, over 100 pipeline development activities have taken place, together with 11 sector-building events with over 1,000 attendees. Notable initiatives have included participation in the ProtoAtlantic Accelerator Programme, which aims to develop and validate models for the prototyping and exploitation of innovative ideas in the maritime sector, and the 'European Space Agency Business Incubation Centres' partnership, developed to create viable businesses and new jobs.
- **The MARINERG-I project** was included as one of 11 research infrastructures announced by the European Strategy Forum on Research Infrastructures (ESFRI) on its Roadmap 2021, which stimulates the development and implementation of such facilities. Coordinated by MaREI, MARINERG-I builds on approximately ten years of planning through the MARINET and MARINET2 H2020 projects. MARINERG-I provides a long-term strategy for integration and collaboration amongst offshore renewable energy testing facilities across Europe, thereby providing a hugely important function to industries in this sector.
- **Supporting Local Offshore Renewable Energy (ORE) Industry:** MaREI have supported local ORE companies through the transfer of personnel into key technical roles, including: Simply Blue Energy (Dr. Val Cummins, Zoe O'Hanlon); Green Rebel Marine (Dr. Jared Peters, Dr. Sarah Kandrot, Dr. Gavin Arneill, Georgina Foley); DP Energy (Dr. Sarah Armstrong, Dr. Joe Kelly, Yvonne Cronin); Gavin & Doherty Geosolutions (Dr. Cian Desmond, Christopher Wright); and Offshore Wind Consultants (Dr. Nguyen Dinh).

MAREI LEADING THE WAY ON UNDERWATER NOISE RESEARCH

The SATURN (Solutions @ Underwater Radiated Noise) H2020 project brings together expertise from multiple disciplines to engage stakeholders in developing solutions to the problem of underwater radiated noise (URN). SATURN will develop and progress standards for terminology and methodology across all disciplines working on URN, producing recommendations for effective underwater sound management and addressing policy needs.

MAREI SUPPORTING RESEARCH AND INNOVATION IN THE BLACK SEA

The DOORS (Developing Optimal and Open Research Support for the Black Sea) H2020 project utilises European and regional expertise to implement the four pillars of the Strategic Research and Innovation Agenda (SRIA) for the Black Sea – looking to unlock the significant potential of this marine environment, while also taking the necessary steps to restore and maintain the valuable ecosystem services that underpin this potential. Within the DOORS project, MaREI will lead a work package on capacity building focusing on how to address the human and climate change impacts on fragile and damaged ecosystems, and to overcome the barriers to the advancement of the Blue Growth agenda in the Black Sea region.



ENGAGED RESEARCH – DINGLE PENINSULA 2030

Dingle, Co. Kerry was identified by ESB Networks in 2017 as a demonstration location for the smart electricity network of the future. The Dingle Peninsula 2030 initiative was established in early 2018 as a broader collaborative initiative, involving the Dingle Creativity and Innovation Hub, ESB Networks, North East and West Kerry Development (NEWKD) and MaREI, working with local communities on the transition to a low-carbon society and to plan for an environmentally and economically sustainable future. The initiative follows the Quadruple Helix Model, involving science, policy, industry and society, and partners actively collaborate with the local community, schools, business, transport, and farming sectors to support this transition. Through an engaged research approach, the MaREI team is supporting initiatives in the region and building an understanding of underlying technical, social, and economic considerations, including the role of multi-stakeholder collaborations. Objectives include an exploration of interactions between top-down and bottom-up stakeholder groups, and the forming of collaborative visions for the future energy system.



GOVERNMENT WELCOMES MAREI REPORT HERALDING A NET-ZERO ENERGY SYSTEM


Powering the country without creating greenhouse gases is possible by 2050 and will create 50,000 jobs along the way, a study by Dr Paul Deane of the MaREI Centre and the ERI has found. A 'net zero' energy system will mean an almost complete switchover from oil and gas to electricity as the main energy source, with the electricity coming entirely from renewable sources, chiefly wind and solar, according to the report conducted on behalf of Wind Energy Ireland.


Minister for Environment, Climate Action and Communications Eamon Ryan TD welcomed the report, saying:




“ We have set a national climate objective to reach net-zero emissions by 2050. In the coming months we will develop a new Climate Action Plan to set out how we will achieve this. Today’s report from the MaREI Centre and Wind Energy Ireland is an important and valuable contribution to the debate. It shows not only how we can decarbonise but how we can do so in a way that builds our economy and delivers a cleaner, more sustainable and secure future for us all.

The report identifies three key ‘no-regrets’ options which must be aggressively pursued by the Government:

- 

ENERGY EFFICIENCY FIRST:
Making our society energy efficient must be our first principle. The barriers – policy and financial – to retrofitting homes and using more energy efficient technology must be eliminated. Investment is required to rapidly train the skilled workers we will need.
- 

ELECTRIFICATION:
Electricity, not oil, must become the backbone of our energy system. Every form of transport or heating that can be electrified, must be, as quickly as possible.
- 

MORE RENEWABLES FASTER:
Renewable energy projects like wind farms – on and offshore – and solar farms must be developed far more quickly, and sustainable bioenergy will also be needed to fully decarbonise our energy system.

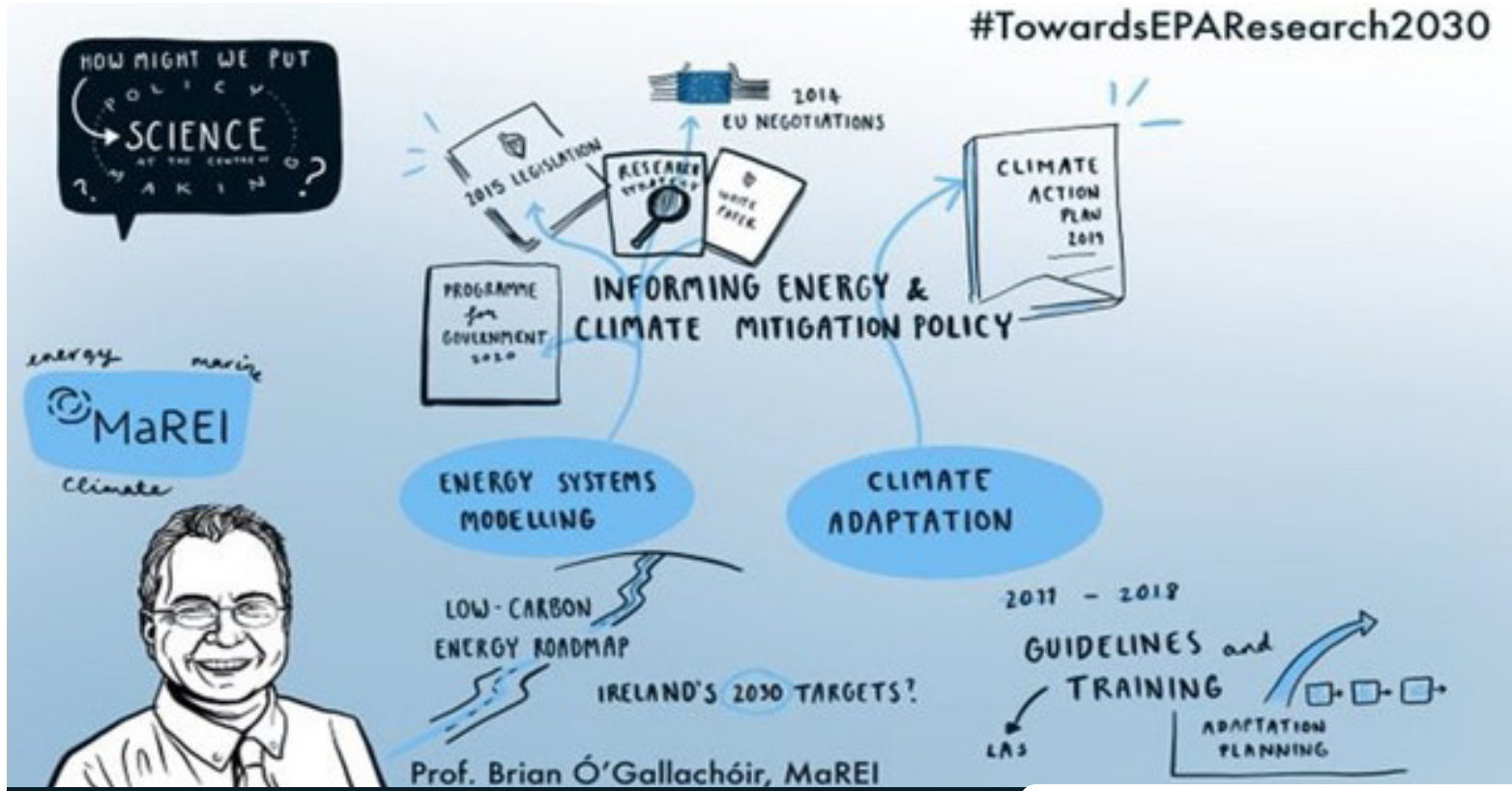


POLICY ENGAGEMENT

MaREI aims to facilitate informed decision-making through the provision of research, data, and tools in formats appropriate to policy-makers, government, state agencies, local authorities, civil servants, and advocacy organisations across the areas of energy, climate, and marine, and to subsequently inform all stakeholders on policy and practice in these areas. In 2021, MaREI placed significant focus on structured engagement with policy makers and have employed innovative approaches to the translation of research results into policy insights.

MaREI researchers drafted Ireland’s planning guidelines for climate adaptation, while their climate mitigation analysis informed the increased Government ambition that has been embedded in new climate legislation. Internationally, MaREI research with the International Renewable Energy Agency (IRENA) has fed into the 2030 renewable energy targets.

Ireland’s Minister for Housing, Planning and Local Government, convened an Expert Group on Marine Protected Areas (MPAs) during 2021. MaREI’s research leadership in this area was recognised through the appointment of Dr Anne Marie O’Hagan to lead the sub-group on legal, governance and political aspects of MPAs. In this role, Dr O’Hagan has contributed to a significant report on the expansion of Ireland’s marine protected area (MPA) network, which sets out the various legal bases under which MPAs can be designated and presents options in terms of multiple use of sites.



EPA research 2030: Thematic Hubs Virtual Workshop
28 October 2020



“
MaREI’s research plays a central role in underpinning the Government’s Climate Action Plan and provides world-leading research support. This energy expertise is critical to our ability to meet our climate targets.
Minister of Public Expenditure and Reform,
Michael McGrath



“
Long term climate monitoring programmes are needed to provide the evidence required to support national climate policy and action. It is through sustainable long term monitoring networks that we can measure the current state of our climate, and how much it has changed by, which in turn gives us an indication of how much more it is likely to change by into the future.
Jeremy Gault,
Research Co-ordinator for Coastal and Marine Systems, MaREI.

6.2 UN ENVIRONMENT PROGRAMME GEMS/ WATER CAPACITY DEVELOPMENT CENTRE

The UN Environment Programme GEMS/Water Capacity Development Centre (CDC) provides global capacity development in water quality monitoring and assessment working on a programme of activities to support the Water Sustainable Development Goals (SDG), specifically SDG 6 – Clean Water and Sanitation. The Centre is based at the School of Biological, Earth, and Environmental Sciences and ERI and is led by its Director, Dr Tim Sullivan.



DR TIM SULLIVAN APPOINTED AS NEW UN GEMS WATER/CDC CENTRE DIRECTOR

GEMS Water/CDC experienced a significant change in 2021 as Dr Debbie Chapman, who has now retired as Centre Director, handed the baton over to Dr Tim Sullivan. Tim is Principal Investigator of the Materials & Environmental Science Applications (MESA) Research Group (ERI, BEES) and has previously worked with the GEMS/Water CDC as a tutor on their online courses and has instructed PGDip and MSc students during field sampling trips. The hard work, dedication, and selfless effort that Dr Chapman has put into the Centre since its inception in 2015 will be continued in her new role as Advisor and Ambassador for the UNEP GEMS/Water CDC.



Dr Debbie Chapman



Dr Tim Sullivan

MSC STUDENTS IN FRESHWATER QUALITY MONITORING AND ASSESSMENT PROJECT FEATURE:

Cordelia Samuel's characterization of Wastewater Stabilization Ponds effluent discharge and its impact on the South Negril River in Jamaica.

Cordelia Samuel carried out her research in Westmoreland, Jamaica. Her project involved characterising the discharge from the Negril Wastewater Stabilization Ponds (WSP) and carrying out a short-term Impact Assessment on the water quality of the South Negril River. The National Water Commission (NWC) in Jamaica is the statutory body responsible for treating wastewater and delivering potable water to Jamaicans. Cordelia collated approximately twenty years of water quality information from NWC for the effluent discharge and different sampling points along the river, and the resulting database allowed for the comparison of various water quality parameters between different periods of time. In addition, Cordelia tested various physicochemical and microbiological parameters over a six-week period during the dry season of 2020 in both the effluent and at different sampling points along the South Negril River. Cordelia found that the South Negril River's water quality was impacted by the effluent and her research also suggested other sources of pollution to the South Negril River such as the peat-laden riverbed, nearby agricultural land and illegal fishing. Monitoring of point sources of pollution in the South Negril River, like the effluent discharge of these WSPs, will guide management practices to improve the water quality of the river and the coastal sea of Negril and its touristic coral reefs.



COUNTRY STORY: SIERRA LEONE AND CAPACITY DEVELOPMENT

In 2021, Sierra Leone reported their SDG indicator 6.3.2 result to the UN for the first time, due in no small part to the UN GEMS Water/CDC in UCC. In 2017, during the baseline data drive for this indicator, the national focal point Mr Mohamed Sahr E. Juanah, Director of Hydrological Services of National Water Resources Management Agency (NWMRA), highlighted data gaps and identified the need to build capacity in the country to ensure that water quality data could be collected reliably. As a first step, the national focal point undertook the UN GEMS Water/CDC Postgraduate Diploma in Freshwater Quality Monitoring and Assessment, which provided him with the knowledge and skills to design a full monitoring programme for the Rokel River basin for the first time. After the implementation of this monitoring programme, and

the collection and analysis of water quality data, a SDG indicator score of 41.7% of designated water bodies with good water quality was reported. The data obtained also allowed the characterisation of the Rokel basin as having naturally very high phosphate and very low electrical conductivity values. The country now plans to expand monitoring to neighbouring basins and eventually to a national level, supported by the training of additional staff through UNEP GEMS/Water CDC CPD courses. The ambitions to develop laboratory-based analytical capacity, establish a data management framework and implement management actions to identify and mitigate against pollution will ensure longevity for the initiative, sustaining a continued improvement in water quality well into the future.

INTERNATIONAL COLLABORATION BRINGS EXCHANGE OF IDEAS FOR SUSTAINABLE WATER MANAGEMENT

The UNEP GEMS/Water CDC is a partner in the Erasmus+ WATER - Work based Learning Paths in Water Management Project, the objective of which has been the exchange of good practices for efficient and sustainable water resources management approaches and tools. The aim of training visits within the project are to exchange and innovate around educational water programmes of the countries involved by bringing together enterprise and research institutes. The UNEP GEMS/Water CDC contributes by providing experience on third level education and training with their post-graduate courses. This project is even more important given that almost all of the students are full time working professionals in the water sector, closing the gap between the research and the professional arena, updating knowledge and skills in the water sector, and more specifically in monitoring and assessment of the quality of freshwaters worldwide. In November 2021, the new director of the Centre Dr Tim Sullivan and the Programme Coordinator Dr Lucía Hermida visited Valencia, Spain, the second stop of the project and visited the various organisations involved in water management at different levels.

THE ROLE OF WATER QUALITY MONITORING IN THE SUSTAINABLE USE OF AMBIENT WATERS

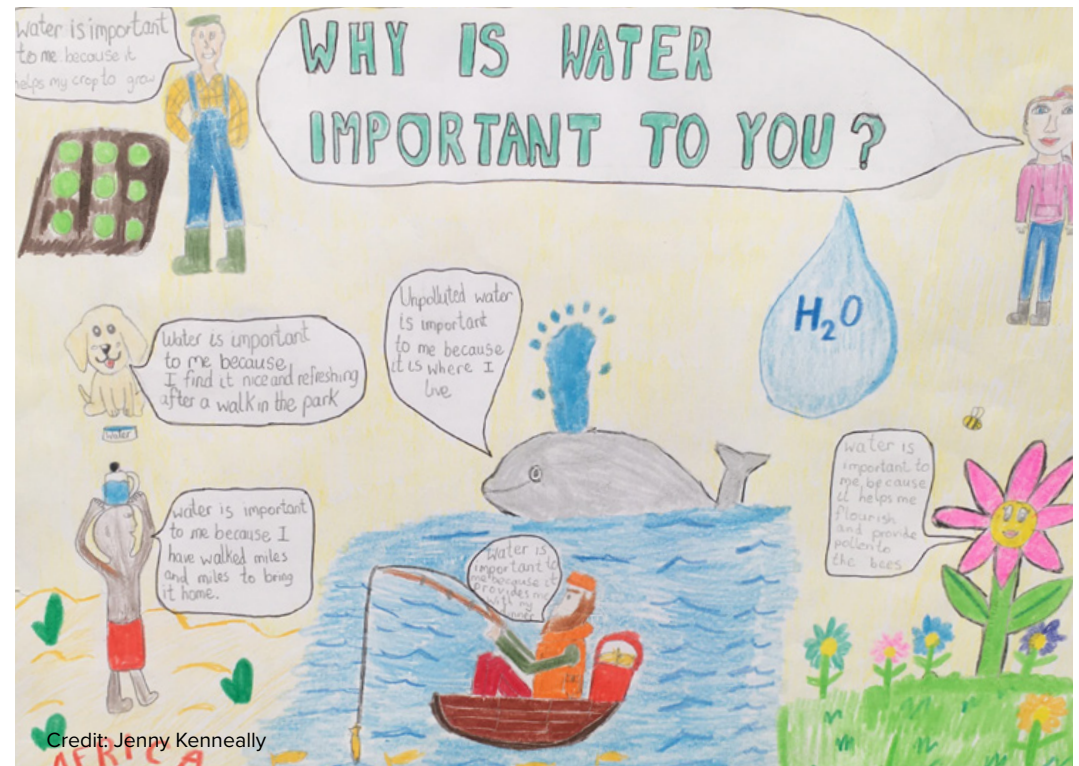
It is now evident to domain experts that human activities are profoundly shifting the health and functioning of freshwater ecosystems away from their natural states. Aquatic ecosystems are suffering biodiversity loss and increasingly act as a sink and conduit for anthropogenic pollution. The detailed extent and impact of this remain unclear due to major deficits in our capability, capacity, and willingness to adequately monitor ambient water quality at scale. To reverse this trend, and to understand our ability to restore and return ambient water bodies to a more sustainable baseline, we need to make a societal commitment to increase our monitoring of freshwaters globally. To highlight the rationale for, and the challenges to monitoring ambient freshwaters, Dr Debbie Chapman and Dr Tim Sullivan have outlined their views and provided a primer on monitoring of freshwaters at the global scale. In a primer, to be published in *OneEarth* in 2022, Debbie and Tim discuss the current status, gaps, and future needs for coordinated water monitoring programs, concluding that in the absence of sustained periodic monitoring, intervention, and management, the health of aquatic ecosystems and environments, and consequently our own health, prosperity, and well-being, will be permanently and irreversibly damaged.

WORLD WATER DAY 2021

The 22nd March, 2021 was World Water Day, an international celebration officially established in 1993 to help raise awareness of our freshwater resources throughout the world, and championed by the UNEP GEMS Water/CDC annually with local events and awareness campaigns. In 2021, several students from primary and secondary schools in Cork took part in a poster competition to raise awareness for World Water Day. The 2021 theme was 'Valuing Water' and 'What Does Water Mean to You?.'



Credit: Beth Coveney



Credit: Jenny Kenneally

6.3 CLEANER PRODUCTION PROMOTION UNIT (CPPU)

CPPU conducts engaged research focused on the theme of society, sustainability and energy, with a particular emphasis on people's relationship with energy and the energy system. The unit is led by Dr Niall Dunphy (School of Engineering & Architecture, and ERI).



RE-DEFINING ENERGY CITIZENSHIP FOR EUROPE

A common theme of much of the unit's work in recent years has been understanding the evolving roles people play in the energy system. Building on this scholarship, the unit are partners in a new Horizon 2020 project on energy citizenship which commenced in June 2021. ENCLUDE is a transdisciplinary project led by ETH Zurich, which is working to develop knowledge of and operationalise the energy citizenship concept at multiple scales of policy and decision making. Although the term 'energy citizenship' has increasing currency in discourse around the energy transition, the concept remains under-theorised, and what it actually involves in practice is open to interpretation. Within the project, CPPU is leading a package of work to (re)conceptualise individual and collective expressions of citizenship within the energy domain. The researchers are working to explore meanings and attributes attached to the concept in different contexts, capturing and characterising the diverse forms of energy citizenship emerging within the European energy domain as well as in other regions of strategic importance to Europe.



NEW RESEARCH ON ENERGY PERFORMANCE CERTIFICATION

The EUB SuperHub project launched in mid-2021 seeks to support the creation of a harmonised certification process in the EU by developing a scalable methodology to view, assess and monitor the buildings throughout their life cycle. The project led by Geonardo Environmental Technologies, Hungary is currently devising the next generation of energy performance assessments and certificates to better account for the growing levels of data concerning the operational use of buildings. CPPU's contribution is focused on characterising the value chains involved in building construction and renovation, and on better understanding the needs and expectations of stakeholders including end-users on energy performance certificates. In realising this, CPPU expect to develop a deeper understanding of public perceptions and acceptance around current market-based and official certificates, and discern how to integrate lessons learned into the new generation of energy performance certificates.



ADDRESSING ENERGY POVERTY WITH TARGETED SMALL MEASURES AND BEHAVIOUR CHANGE SUPPORT

The EnergyMeasures Horizon 2020 project, led by CPPU, is continuing its work offering tailored measures to support energy vulnerable households in seven European countries: Belgium, Bulgaria, Ireland, Netherlands, North Macedonia, Poland, and the UK. The project involves identifying energy poor households, selecting and deploying appropriate low-cost energy conservation measures, and leveraging this deployment for a more wide-ranging engagement to support residents to understand and change their energy-related behaviours. Work to date has focused on developing a deeper understanding of the institutional contexts pertinent to energy poverty, and on developing tailored strategies for energy poor household engagement, in each of the participating countries. Although engagement of households was initially delayed by the COVID-19 pandemic, since last Autumn project partners have engaged more than 1070 households and work continues apace.



6.4 CENTRE FOR RESEARCH ON ATMOSPHERIC CHEMISTRY (CRAC)

CRAC is a leading national centre for atmospheric chemistry research carrying out laboratory, field and modelling studies to support clean air quality. The Centre is based in the School of Chemistry and Environmental Research Institute. The CRAC Centre Director is Professor John Wenger.



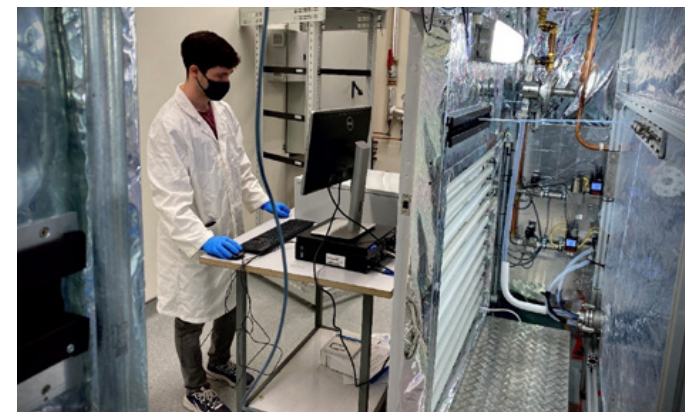
PROMOTING ACCESS TO RESEARCH PLATFORMS IN ATMOSPHERIC SCIENCES

In 2021, the European research community of atmospheric sciences received €15M from the H2020 programme to develop solutions for sustainable access to atmospheric research facility services. The ATMO-ACCESS consortium gathers 38 scientific institutions from 19 European countries of the atmospheric research infrastructures ACTRIS, ICOS et IAGOS, and is coordinated by the French National Research Centre (CNRS). Through consortium members in CRAC, UCC and the ERI will play a leading role in developing new ways of providing access to atmospheric research infrastructures for a wide range of users in research, technology and innovation. In this project, the entire scientific community as well as private sector actors will have the opportunity to access the main European research platforms, to participate in scientific experiments, to train new measurement techniques, to test new sensors or to develop new applications based on data from research infrastructures. For UCC, a key part of this will be to provide international researchers the opportunity

to access its new state-of-the-art Irish Atmospheric Simulation Chamber facility. The €1.1M facility, funded through an SFI research infrastructure grant, is used to investigate atmospheric processes that affect air quality and climate. The chamber is also used to develop new instruments and sensors for measuring gases and particles in the atmosphere. Prof John Wenger said;

“

I am delighted to be leading UCC's involvement in this ambitious project. It strengthens our position as a key part of the atmospheric research infrastructure in Europe and allows us to increase our contribution to international efforts towards an improved understanding of the atmospheric processes that affect air quality and climate.



STRENGTHENING AIR QUALITY MANAGEMENT IN IRELAND

The EPA's recent improvements to monitoring and assessment has highlighted more individual exceedances in air pollution levels than anticipated in both urban and rural areas. This emphasises the need to further investigate the extent of the air pollution, improve governance and take appropriate action. Amongst the number of issues and barriers relating to the assessment of air quality are the fact that Ireland does not have an air quality forecasting system. There is also the need for greater resolution to identify pollution hotspots, allowing for more accurate health exposure calculations, and to provide sufficiently high quality, spatial, residential and traffic emission intensity data to build urban scale air quality models. Another contributing challenge is the upsurge in the use of wood to heat homes, alongside a misunderstanding of what may constitute green fuel for home heating. In response to this, the key goal of the newly funded LIFE EMERALD project, led by Prof John Wenger and Dr Stig Hellebust, is to strengthen air quality management in Ireland, to ensure effective implementation of the two complementary EU Ambient

Air Quality Directives (AAQD) and to help implement the European Green Deal. The project will address the recommendations of the Clean Air Dialogue with Ireland (a supportive and collaborative programme of information exchange set up by the EU in 2015), ensuring that sufficient detailed information on air quality can be made available to citizens and stakeholders to accelerate decisions aimed at tackling air quality issues.



PROF JOHN WENGER APPOINTED CHAIR OF GOVERNMENT EXPERT GROUP

From the beginning of the COVID-19 pandemic, Prof John Wenger (CRAC, School of Chemistry, ERI) has been a strong advocate of the role adequate ventilation has to play in curbing the spread of the virus. This work has been recognised in the appointment of Prof Wenger as chair of the Government's Expert Group on the Role of Ventilation in Reducing Transmission of COVID-19, which brings his experience as a specialist in atmospheric chemistry and air quality to bear in informing public policy. The Expert Group is working with the Senior Government Officials Group to further inform sectoral guidance and public information regarding ventilation. Initial reports and recommendations included the widespread use of carbon dioxide monitors to assess ventilation and the supplementary use of air filtration and ultraviolet disinfection. Separately in 2021, Prof Wenger was also appointed to the EPA Advisory Committee. The Advisory Committee has a wide range of advisory functions under the EPA Act, including making recommendations to the EPA, or the Minister, relating to the functions of the Agency.



AIR POLLUTION IN THE DUBLIN PORT AREA

Ship emissions contain sulfur oxides, nitrogen oxides and particulate matter (PM) that impact on human health and the environment. In addition, transport and other logistical activities in shipping ports can also contribute to emissions that affect air quality. The newly launched EPA-funded PortAIR project, coordinated by Prof John Wenger and Dr Stig Hellebust aims to determine the impact of shipping emissions and other port activities on air quality in Dublin and provide policy recommendations and mitigation options for reducing pollution. This goal will be achieved through a combined measurement-analysis approach involving continuous year-long monitoring of the chemical composition of PM in real-time; a multi-instrument intensive field campaign conducted during the height of shipping activity; and detailed source apportionment models providing robust quantitative estimates of the impact of shipping emissions and other major pollution sources on Dublin's air quality. The results will deliver new and valuable information on the influence of the various port-based activities on air quality in Dublin city. They will also provide Dublin Port Company, Dublin City Council and the EPA with a sound scientific basis for developing an air quality action plan for the Dublin Port area involving strategies to reduce pollution from every source which would provide valuable support for implementation of the MARPOL convention (International Convention for the Prevention of Pollution from ships) and the proposed National Clean Air Strategy.



CRAC RECEIVES SFI FRONTIER AWARD 2021

Free radicals are not only harmful for humans, but they are also the driving forces behind the chemistry of the natural and anthropogenically polluted atmosphere. Owing to their high reactivity, even minute concentrations can significantly affect air quality and the evolution of atmospheric processes. Hence there is a need to further improve technologies, such as cavity-enhanced absorption spectroscopy, to enable the detection of trace species at the lowest possible level. In 2021, Prof Andy Ruth (ERI, CRAC, Department of Physics) and Prof John Wenger (CRAC, ERI, School of Chemistry) were successful in attracting a €1M SFI Frontier for the AtmoTrace project on ultra-sensitive cavity-enhanced trace gas detection for new atmospheric science and socio-economic impacts. A highly collaborative project with 6 academic and industrial partners in Ireland, Germany and the USA, AtmoTrace will provide several cutting-edge instruments and new experimental approaches for trace gas detection based on ultra-sensitive cavity-enhanced absorption spectroscopy. Through this development, the new Irish Atmospheric Simulation Chamber (IASC) at UCC will gain world-unique capabilities for research into atmospheric chemistry. Moreover, studies related to transport and balance of nitrogen oxides in the upper atmosphere (tropopause) will deliver unique new datasets with high relevance for climate research. Ultimately the project will enable better predictions of atmospheric and climate scenarios.



6.5 CENTRE FOR LAW AND THE ENVIRONMENT

The Centre for Law and the Environment is a centre of excellence for research, teaching and policy work relating to environmental law, policy, regulation and governance. Based in the School of Law, the Centre supports and promotes a wide range of research activity in Environmental, Marine, Climate, Energy and Natural Resources Law. Although the Centre is rooted firmly in the discipline of Law, it is engaged in significant interdisciplinary research collaborations and extensive advocacy and outreach activity. The Centre is led by its Co-Directors Professor Owen McIntyre and Professor Áine Ryall.



RESEARCH HIGHLIGHTS 2021

The Centre delivers a wide range of high-impact, frontier research activity. In 2021, Dr Ruby Moynihan Magsig, Irish Research Council Postdoctoral Fellow, published her monograph *Transboundary Freshwater Ecosystems in International Law: The Role and Impact of the UNECE Environmental Regime* with Cambridge University Press. Centre PIs continued to publish their work in important edited collections with leading international publishers and in prestigious national and international peer reviewed journals. We were delighted to see Dr Sean Whittaker (PhD, 2018) publish his doctoral research as a monograph, *The Right of Access to Environmental Information*, with Cambridge University Press.

In June 2021, PhD candidate Alison Hardiman presented her research on public participation in the EIA project authorisation process from the perspective of renewable energy infrastructure projects at the **31st Irish Environmental Researchers Colloquium (ENVIRON 2021) and won the Best Social Engagement Presentation prize**. In September 2021, PhD candidate Rhoda Jennings presented her research on the use of science in the precautionary principle at the *4th International Conference on Science Advice to Government (INGSA2021)*. Her digital poster was among those selected for an award and features in the *INGSA Horizon Series*, a collection of videos examining how the complex systems of our society need to adapt to face future “wicked” challenges.

COLLABORATION AND PEER ESTEEM ACTIVITY

Centre PIs are called on regularly to provide expert input to law and policy developments at the highest level. During 2021, Professor Owen McIntyre was appointed: Expert Reviewer for the National Science Centre, Poland (*Narodowe Centrum Nauki*); UN ECE Invited Expert Reviewer of the *Practical Guide for the Development of Agreements or Other Arrangements for Transboundary Water Cooperation (2021)*; and UN ECE / UNESCO: Invited Expert Reviewer of the *Second Progress Report on Sustainable Development Goal (SDG) Indicator 6.5.2, measuring transboundary water cooperation (2021)*. Professor Áine Ryall was appointed to the Environmental Protection Agency Audit and Risk Committee. Dr Ruby Moynihan Magsig took up a new position as Senior International Advisor at the New Zealand Government Department of Conservation, where she will lead a portfolio on International Environmental and Oceans Law and Policy. Alison Hardiman was appointed to the Major Projects Advisory Group by the Minister for Public Expenditure and Reform, Michael McGrath TD. Professor Owen McIntyre was appointed to the Editorial Board of *Environmental Policy and Law* and Professor Áine Ryall was appointed to the Editorial Board of the *Journal of Environmental Law*.

ENFORCING EUROPEAN UNION ENVIRONMENTAL LAW

In 2021, the Centre was again successful in securing funding from the Department of Foreign Affairs *Communicating Europe Initiative*. This funding supported a webinar on *Enforcing European Union Environmental Law* held on 13 October 2021. Convened by Professor Áine Ryall, this event attracted over 150 participants. It explored a range of themes including: implementation challenges from the perspective of the EU Commission; developments in nature protection law; and the influence of EU law on the right to participate in environmental decision-making. Ms Justice Marie Baker of the Supreme Court chaired the event. As part of the *Communicating Europe Initiative* project, the Centre also produced a series of podcasts exploring different dimensions of EU environmental law enforcement.



AVOSETTA 2021

The Centre was honoured to be selected to host the annual meeting of the Avosetta Group of Experts in EU Environmental Law in May 2021. Professor Áine Ryall hosted a group of over thirty leading scholars from across the continent for this annual meeting, the first Avosetta meeting to be held virtually. The theme of this year's meeting was Strategic Environmental Assessment.



INTEGRATION OF RESEARCH AND TEACHING

Research-informed teaching, at both undergraduate and postgraduate levels, is a fundamental element of the Centre's activity. The Centre offers its flagship LLM Environmental and Natural Resources Law programme, as well as specialist undergraduate modules in environmental law. On 30 March 2021, the Centre collaborated with students from UCC Law Society and EnviroSoc to host an online event on the theme How to use the Law to support climate action. The Centre's Co-Directors contribute annually to the University Wide Module on Sustainability. They were members of the teaching team for this module recognised with the UCC President's Award for Excellence in Teaching 2021.

ENVIRONMENTAL LAW ENFORCEMENT: EMERGING CHALLENGES 2021

Centre members participated in the annual *Environmental Law Enforcement: Emerging Challenges* conference organised by the Environmental Protection Agency (EPA) and the Irish Centre for European Law (ICEL). The conference, which took place on 17 and 18 November 2021, was convened by Professor Áine Ryall and Dr Tom Ryan (EPA). The Opening Address was delivered by the Chief Justice, Mr Justice Donal O'Donnell. Following a competitive selection process, PhD candidate, Amy O'Halloran was selected to present her research on **the role of law in efforts to address Global Problems such as Marine Plastic Pollution**.



PROFESSOR ÁINE RYALL ELECTED CHAIR OF THE UN ECE AARHUS CONVENTION COMPLIANCE COMMITTEE

In December 2021, Professor Áine Ryall was elected Chair of the Aarhus Convention Compliance Committee. The Aarhus Convention is a multilateral agreement linking the environment and human rights. The three core rights guaranteed under the Convention – information, participation and access to justice in environmental matters – underpin the right of every person of present and future generations to live in an environment adequate to their health and well-being. The Compliance Committee is tasked with overseeing implementation of the Convention across 47 State Parties. It comprises nine members with recognised expertise in international environmental law and human rights. The Committee sits at the Palais de Nations in Geneva. The main element of its workload involves dealing with communications from the public, including non-governmental organisations, alleging breach of Convention obligations by State Parties. Áine was first appointed to the Compliance Committee in 2015 and elected Vice-Chair in 2017. Following her nomination by Ireland, she was re-elected at the Meeting of the Parties held in October 2021 to serve a second term on the Committee.



6.6 AQUACULTURE AND FISHERIES DEVELOPMENT CENTRE (AFDC)

The AFDC is a centre of excellence for aquaculture and fisheries research focusing on fisheries and fish population genetics, health of aquaculture species, and marine mammal research based in the School of Biological, Earth and Environmental Sciences and affiliated to the ERI. The Centre is led by its Director, Professor Sarah Culloty.



NEW GENETIC STUDY SHEDS LIGHT ON MARINE MIGRATORY BEHAVIOUR OF SALMON

Marine survival of salmon in the eastern North Atlantic has substantially declined in recent decades, yet little was known about the migratory behaviour and distribution of populations. A 2021 genetic tagging study, published in the international journal *Fish & Fisheries*, shows where young salmon gather and begin to migrate during their first summer at sea; migrating along the continental shelves off Ireland, Scotland and Norway and subsequently aggregating to feed in the Norwegian Sea west of the Vøring Plateau in international waters. Here they are exposed to potential mortality from major commercial fisheries for other pelagic species. The genetic analysis of fish caught at sea demonstrates that the salmon stocks that make up this feeding aggregation are unexpectedly not from neighbouring Norwegian rivers but are predominantly from southern rivers such as those in Britain, Ireland, France and Spain. This points to fundamental differences in migration behaviours (routes) and likely explains variation in how

stocks from Northern and Southern European rivers have been responding to environmental change and critically to recent climate change, and may account for the differences that have been observed among stock groups in marine survival. Joint senior author of the paper, Prof. Philip McGinnity (BEES, AFDC, ERI and the Marine Institute) said,



“
This report is the culmination of a major logistical and technical effort to synthesise the data from 385 marine cruises, 10,202 individual trawls, 9,269 captured post smolts, spanning three decades and approximately 4.75 million Km² of ocean and 3,423 individuals assigned to their region of origin. The findings of this study are very important for the management and conservation of salmon in the pelagic marine ecosystem.



UCC ACADEMIC IN INTERNATIONAL TEAM EFFORT TO CONFIRM IDENTITY OF NEW WHALE SPECIES

Whales are often named after Western, male scientists but that tradition is about to change, as a newly discovered species of True's beaked whale (*Mesoplodon eueu*) will carry the name of the Indigenous woman and renowned whale expert who introduced it to the world. Initially discovered beached in New Zealand in 2011 by the local tribe of Ngāti Māhaki, the whale's skeleton was preserved at the Te Papa Tongarewa Museum with the help of Ramari Stewart, a Mātauranga Māori whale expert. Many Māori tribes have deep cultural connections to whales and often view them as sacred, so in New Zealand, responses to stranded marine mammals

are coordinated in consultation with local tribes to develop and follow cultural protocols. Ramari Stewart worked with scientific practitioners in New Zealand and globally, including Prof Emer Rogan of UCC School of BEES and the ERI, who helped to confirm the unique genetic identity of the specimen. The team compared other samples of True's beaked whales from both the Northern and Southern hemisphere, and realised that the True's beaked whales in the Southern Hemisphere had very different genetics and skull shapes – two key indicators that they were a different species.



Photo credit: Irish Whale and Dolphin Group



DOMESTICATED SALMON HAVE SMALLER EYES IN THE FARM BUT NOT IN THE WILD

The domestication of Atlantic salmon over some 15 generations of selective breeding in captivity has resulted in farmed Atlantic salmon having smaller eyes than their wild counterparts according to a new piece of UCC research published in the journal *Evolutionary Applications*. Unlikely to be a problem in the farm, in the wild, smaller eyes could make the offspring of farmed parents less able to identify and capture food, as well as increasing their chances of being eaten by predators. Researchers compared eye size at freshwater, transitional and saltwater life stages of the offspring of farmed and wild Atlantic salmon, including their hybrid offspring under both farm conditions (i.e., tanks) and in a natural river in Ireland. In all the tank-based experiments, farmed fish had smaller eyes relative to body size when compared to their wild counterparts, with hybrids having an intermediate eyes size, even though they had been reared in the same conditions. Yet, intriguingly, when

reared in the river, no differences in eye size could be seen between the progeny of wild and farmed salmon. Dr Joshka Kaufmann (ERI, AFDC, BEES) co-lead of the research adds,

“ Showing what allows eye size to vary in tanks but not in the river gives us a clue as to why farmed fish and their descendants are ill-equipped to deal with life in the wild. Escapes from farms pose a threat to the genetic integrity of wild Atlantic Salmon populations and impact population abundance in the long-term.

Dr Kaufmann will next be focusing his attention on the biology and genomics of the Burrishoole salmon pedigree as part of his 2021 prestigious SFI/IRC Foundation Award.

SUPPORTING IRELAND'S SHELLFISH INDUSTRY

Mussel and oyster farmers were significantly impacted in the first half of 2020 by the market access and price difficulties caused by the COVID-19 pandemic. While these issues eased as the first wave of the pandemic passed, the impacts of lost sales and production left a lasting financial burden on these aquaculture enterprises. In addition to the introduction of direct financial support schemes for bivalve farmers, the Government has also invested substantially in R&D with a view to boosting the sustainability of the sector. The newly-launched DAFM-funded BIVALVE Project (Bridging Research & Practice to Improve the Future Sustainability & Growth of the Irish Bivalve Sector),

led by Prof Sarah Culloty, Dr Sharon Lynch and the Shellfish Health Group (ERI, AFDC, BEES), focuses on how shellfish will provide a key component of a sustainable aquaculture and fisheries economy for Ireland. In collaboration with the Marine Institute, the team will investigate the present status of bivalve stocks and identify the key drivers of growth, health, reproduction, and diseases in this sector currently and into the future. With industry partners, the project will then recommend, implement and monitor best practices for smart sustainable production of shellfish on an all-island basis.



7 | Meet Our New Academics



DR RICHARD O'SHEA

(UCC School of Engineering and Architecture, ERI & the SFI MaREI Centre for Energy, Climate and the Marine)

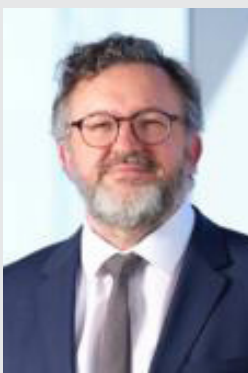
Dr Richard O'Shea is a Lecturer in Sustainability in Enterprise in the UCC School of Engineering and Architecture. Dr O'Shea worked as a Senior Postdoctoral Researcher, and a Postdoctoral Researcher with the Circular Economy and Environmental Systems Research Group in MaREI with an industrial partner company. His prime area of work was assessing methods to decarbonise a large facility in the food and beverage sector in Ireland. Dr O'Shea's research has focused on biomethane production via anaerobic digestion, resource assessments, technoeconomic analysis, optimisation, GIS, and multi criteria decision analysis. This has led to over 30 peer-reviewed journal publications in journals including *Applied Energy*, *Bioresource Technology*, and *Renewable Energy*.



DR DAVID WALL

(UCC School of Engineering and Architecture, ERI & the SFI MaREI Centre for Energy, Climate and the Marine)

Dr David Wall was appointed Lecturer in Transportation in the UCC Department of Civil, Structural and Environmental Engineering in 2021, and is a PI in the Circular Economy and Environmental Systems Research Group in the SFI-funded MaREI Centre for Energy, Climate and Marine. Dr Wall's research focuses on closing the loop on the energy-food-materials nexus and exploring the relationships between food production, biomaterials, and energy. Dr Wall co-represents Ireland at the International Energy Agency Bioenergy: Task 37 Biogas, and has three ongoing research projects: EPA funded NEWTRIENTS project, SEAI RD&D funded project Developing Economic solutions for on-farm Anaerobic Digestion technologies under Irish conditions (EcoAD) and the SFI Zero Emissions Challenge funded project ElectroFuels in A Circular Economy (EFACE).



PROFESSOR WIM NAUDÉ

(Cork University Business School, ERI)

Professor Wim Naudé is Full Professor of Economics at CUBS and an ERI Academic. His research and teaching are concerned with the economics of technological innovation, trade and entrepreneurship, and their implications for the global grand challenges, including pro-poor growth, equitable globalization, conflict resolution and climate change action. Examples of his recent international collaborative work include contributing to the OECD's Artificial Intelligence Observatory; co-directing a project funded by the Volkswagen Foundation on the diffusion of artificial intelligence, working with the United Nations Framework Convention on Climate Change (UNFCCC), contributing to the World Trade Organization's 2018 World Trade Report and writing a chapter for the United Nations' World Youth Report 2020.



DR AOIFE DALY

(ERI, School of Law)

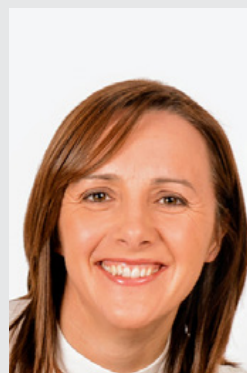
Dr Aoife Daly is a lecturer at the School of Law and an ERI-affiliated academic. She has taught widely on human rights, most recently at the University of Liverpool and the Human Rights Centre of the University of Essex. Dr Daly studies children's civil and political rights, particularly the protest rights element of youth climate activism, and how this is changing the arena of human rights, and she is currently writing a book entitled *Youth Climate Activism and International Human Rights Law*. Dr Daly's research interests cover a broad range of interconnected legal areas. Human rights law is a key area of Dr Daly's research expertise and informs her research in rights to a healthy environment, and the European Court of Human Rights.



DR MICHELLE MCKEOWN

(ERI, School of BEES)

Dr Michelle McKeown is a newly appointed Lecturer in Environmental Science in the School of BEES and an ERI academic. Dr McKeown's research goals are directed towards understanding long-term environmental change in mid-latitude and tropical regions. She is particularly interested in applying biological indicators (namely testate amoebae and chironomids) as tools for monitoring and assessing lake and peatland ecological integrity, reconstructing past climate conditions, along with establishing environmental baselines against which present day conditions can be assessed. Dr McKeown joins UCC after moving from her role as Eco-Hydrologist with Wallbridge Gilbert Aztec in New Zealand.



DR JANAS HARRINGTON

(School of Public Health, ERI)

A recent affiliate of the ERI, Dr Janas Harrington is Senior Lecturer and Director for the BSc Public Health Sciences, in the UCC School of Public Health. A research-active public health nutritionist with expertise in dietary pattern analysis, Dr Harrington's specific area of interest is in studying the determinants of healthy dietary patterns and the association between diet patterns and chronic disease, including cardiovascular risk and obesity. She has been involved in some of the largest epidemiological studies in Ireland and is member of the Healthy Eating Sub-group and the Food Re-formulation subgroup of the Obesity Policy Implementation Oversight Group, convened by the Department of Health. Dr Harrington is also Chair of both the GAA National Health and Wellbeing Committee and the Cork Food Policy Council.

8 | ERI in the Media 2021



MEDIA FOCUS: UCC AT COP26

“

By 2050, almost 70% of the world’s population will live in urban areas.. this will bring many challenges in relation to urban sustainability, with more people creating emissions which is relevant to both our climate and our health.. The elements that make up a sustainable city are those that consider the environmental, the social and the economic impact... At COP26 I’m really interested in hearing about how cities can lead the transition to a low carbon and sustainable future and be part of these ambitious goals.

COP26 delegate Dr Marguerite Nyhan, Senior lecturer in Future Sustainability in UCC (ERI, MaREI, School of Engineering and Architecture and Visiting Scientist at Harvard University) and expert in the area of urban sustainability spoke to RTE Radio 1 about how her research is becoming increasingly urgent.

Prof Caitríona Ní Dhúill who leads the Eco-Humanities research group at the ERI and CACCSS participated in the Radio na Gaeltachta panel programme which discussed the conference:

“

Séard a thaispeáineann an géarchéim aeráide dúinn ná go bhfuil bearna mór idir eolas agus tuiscint - agus gníomh. Agus chun an bearna sin a líonadh, is gá dúinn a bheith ag pléigh na rudaí seo agus ag dul i ngleic lenár mothúcháin. Nuair a smaoiním faoin ngéarchéim aeráide, bíim in ísle brí. Bíonn inní orm, bíonn eagla orm, bíonn fearg orm. Féach ar na daoine óga a bhí amuigh ar na sráideanna i nGlaschú le linn CoP26. Caithfimid dul i ngleic leis na mothúcháin sin; cabhróidh siad linn.

The climate crisis shows us that there is a huge gap between knowledge and understanding - and action. And to fill that gap, we need to discuss these things and address our emotions. When I think about the climate crisis, I feel down. I get anxious, I get scared, I get angry. Look at the young people who took to the streets in Glasgow during CoP26. We need to address those feelings; they will help us.

COP26 AND THE HISTORY OF CLIMATE CHANGE

“

While COP26 and what we can do to stop global warming is the story of the moment, the history of climate change started long before world leaders gathered in Glasgow.

UCC delegate Rhoda Jennings (Centre for Law and the Environment, ERI) on the role of COP in the long history of Climate Change.





CLIMATE CHANGE CONVERSATIONS WITH KIDS

With COP26 being such a widespread topic in the media, it was inevitable that our children would ask what it is all about. COP26 delegate Dr Kian Mintz-Woo (ERI, Dept of Philosophy) provided a helpful primer in *The Examiner*- *How to talk to your children about Climate Change*. Kian also spoke to Ryan Tubridy on the topic of climate ethics and who should pay for the costs of climate action.

“The key is that habits are formed early, and if children or young people have a sense of connection to the environment, and ways that they can contribute to sustaining it, that can help combat anxiety or powerlessness. Adults can help support children through activities, whether individually or in communities. If our grandchildren look back and ask what we did, raising a generation that understands the challenge—and has the confidence to do something about it—has to be part of the answer.

CLIMATE SOLUTIONS

Back in Cork, ERI experts provided analysis of the various climate solutions which were being discussed at COP26

Decarbonise Shipping

In writing for *The Conversation*, Prof Wim Naudé (CUBS, ERI) emphasised that the new deal to decarbonise shipping isn't enough and proposed how global trade can truly reach net-zero.

“The International Maritime Organization does have a target for cutting carbon intensity from ships by 40% by 2030, but COP26 was a missed opportunity to push the industry for more rigorous commitments, which were not included in the Paris agreement in the first place. One other glaring omission from the conference was any legally binding obligations for countries to include explicit targets for the decarbonisation of shipping (or air freight) in their nationally determined contributions, which are individual national commitments for reducing emissions.

Electric Cars

“They are a big win, win – electric cars. They remove air pollution. They can be powered by indigenous Irish produced energy – which is wind and solar energy,” said Dr Hannah Daly (ERI, MaREI, School of Engineering and Architecture) to RTE news, “Ireland imports about €5 billion worth of fossil fuels every year. If we can reach our climate goals by reducing those and using indigenous renewable energy instead, it is a big win/win.

Sustainable Forestry and Nature-Based Solutions

A deforestation pledge was one of the earliest agreements by more than 100 world leaders, including Taoiseach Micheál Martin, to not only end but also to reverse the highly damaging process. However there is a danger that the deforestation pledge will fail unless consumers switch to more sustainable food sources.

“Once again the issue comes back to the food that we eat. Vast areas of forests are being removed globally to facilitate livestock, soy and palm oil production.

Dr Eoin Lettice in the Irish Examiner.



THE STUDENT PERSPECTIVE

Two ERI students who were part of the UCC President's delegation, Vera O'Riordan and Clara Felberbauer wrote about the personal impact of the conference for them:

“Climate Change is personal. Hearing about climate change on the news or talking about it in general terms is one thing but meeting another person whose life has been affected by it is different. Speaking to an indigenous activist from the Amazon who is facing threats fighting for her community really does put things into perspective.

Vera O'Riordan also wrote in *The Echo*,

“A highlight of COP26 for me was meeting delegates from the Africa region. I heard about biofuel projects in Liberia, which used coconut waste for clean cooking, and sustainable agriculture initiatives in Ghana which involved people working on the ground with farmers to switch to more sustainable farming. We would do well to learn from our international friends in this respect.

WHY 2021 WILL BE A PIVOTAL YEAR FOR CLIMATE ACTION IN IRELAND,

Dr Paul Deane, RTE Brainstorm, Jan 2021

CHANCE FOR IRELAND TO PERMANENTLY BUILD ON PANDEMIC-RELATED EMISSIONS DROPS,

Dr Hannah Daly, Irish Examiner, Jan 2021

7 WOMEN CROSSING BORDERS WITH THEIR RESEARCH,

Prof Maria McNamara, Silicon Republic, March 2021

ROBOT TREES DIVIDE CORK COMMENTARIAT,

Dr Dean Venables, Irish Examiner, May 2021

DOMESTICATED SALMON HAVE SMALLER EYES IN THE FARM BUT NOT IN THE WILD,

Dr Joshka Kaufmann, Phys.org, May 2021

MICROPLASTICS IN IRISH WATERS "PASS UP THE FOOD CHAIN" INTO SYSTEMS OF HUMANS AND LARGER ANIMALS,

Prof Marcel Jansen, Irish Times, July 2021

LICE, INFECTIOUS DISEASE AND TAKING REEF FISH: THE IMPACT OF SALMON FARMS ON MARINE BIODIVERSITY,

Prof Phil McGinnity, The Journal.ie, July 2021

CLIMATE CRISIS: HOW STATES MAY BE HELD RESPONSIBLE FOR IMPACT ON CHILDREN,

Dr Aoife Daly, The Conversation, Sept 2021

RESEARCHERS FIND WILDFIRES TO BE UNDER-REPORTED AS CLIMATE IMPACT IS MEASURED,

Dr Fiona Cawkwell, Independent, Sept 2021

NEW UCC RESEARCH FINDS DRONES CAN BATTLE POLLUTION AND COMBAT ILLEGAL FISHING,

Dr Paul Holloway, Irish Examiner, Nov 2021

IRELAND MUST BREAK BOND WITH 'COSY FIRE' AS 50 PLACES BREAK AIR POLLUTION GUIDELINES,

Prof John Wenger, Irish Examiner, Nov 2021

JANUARY

MARCH

MAY

JULY

SEPTEMBER

NOVEMBER

FEBRUARY

€3.9M @UCC PROJECT WILL EMPOWER BUSINESSES TO MEET SUSTAINABILITY CHALLENGES,

Dr Marguerite Nyhan, Irish Examiner, Feb 2021

WHAT IS HAPPENING WITH POWER OUTAGES IN TEXAS?

Prof Brian Ó Gallachóir, The Green Scene, Newstalk, Feb 2021

APRIL

IRELAND HAS A CHOICE TO MAKE IN HOW WE RESPOND TO THE INDIAN VARIANT OF COVID-19,

Prof Gerry Killeen, Irish Examiner, April 2021

CALL FOR FLOOD RELIEF SCHEME TO MOVE FORWARD IN CORK IN RESPONSE TO STARK FINDINGS OF CLIMATE CHANGE REPORT,

Ronan O'Sullivan, Echo, April 2021

JUNE

UCC'S ORNITHOLOGIST JOHN QUINN COMMENTS ON THE DECLINE OF FARMLAND BIRDS,

Prof John Quinn, Ear to the Ground, June 2021

UCC'S DR FIDELMA BUTLER DISCUSSES THE RISKS POSED BY ASIAN HORNETS,

Dr Fidelma Butler, Drivetime RTE, June 2021

AUGUST

PEOPLE URGED NOT TO APPROACH WALRUS SPOTTED OFF CO CORK COAST,

Prof Emer Rogan, Irish Examiner, August 2021

ANIMALS WITH CAMERAS,

Dr Mark Jessop, BBC2, August 2021

OCTOBER

SHOULD SECTORS THAT 'WIN' FROM CLIMATE CHANGE BE TAXED?

Dr Kian Mintz-Woo, The Irish Times, Oct 2021

GDP IGNORES THE ENVIRONMENT: WHY IT'S TIME FOR A MORE SUSTAINABLE GROWTH METRIC,

Dr Stephen Onakuse, The Conversation, Oct 2021

DECEMBER

IRELAND HAS THE WIND AND SEAS TO BECOME AN OFFSHORE SUPERPOWER,

Dr Aldert Otter, The Conversation, Dec 2021

FRANKINCENSE AND MYRRH HAVE BEEN REVERED SINCE ANCIENT TIMES – BUT NOW THEY'RE UNDER THREAT,

Dr Eoin Lettice, The Conversation, Dec 2021

9 | Outreach and Public Engagement

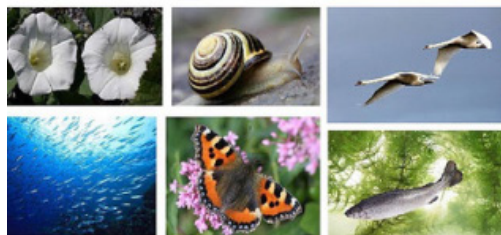
PUTTING PUBLIC CONVERSATIONS FIRST - SCIENCE WEEK 2021

While dissemination of research findings is crucial to the legacy and lasting impact of projects, in the ERI we are also interested in establishing two-way communication with stakeholders, particularly the public and local communities, so that we can hear the questions that need to be answered and co-design future research activities that are expert-fed not expert-led.

In this regard, the theme of 2021's Science Week - *Creating Our Future, a national conversation between the general public, the research community and policy makers* – was perfectly in line with our outreach ambitions. While 2021 marked the second

virtual Science Week, with most events taking place online to facilitate COVID-19 restrictions, the MaREI Centre embraced the theme of conversation to create a vibrant, multi-media experience of activities and events for all ages in November, with short films, training programmes, presentations, panel discussions and talks. Meanwhile, CRAC produced a video introducing their new Irish Atmospheric Simulation Chamber Facility (IASC) a custom-built atmospheric simulation chamber specially designed for asking questions about atmospheric processes, as well as testing and developing new atmospheric measurement techniques.

NATURE AND BIODIVERSITY TALK
WEDNESDAY NOVEMBER 10
AT 7:00 PM



ERI COLLABORATES WITH FUTURE EARTH IRELAND TO EXPLORE HOW HIGHER EDUCATION CAN 'BUILD FORWARD BETTER'

The pandemic has posed unprecedented challenges across our societies and economies, upending conventional wisdom in myriad ways. But the challenge of transitioning to a sustainable future remains an urgent priority at national, European and global levels. The need to “build back better” or, perhaps more appropriately, “build forward better”, has become a slogan of those seeking to integrate sustainability priorities into COVID-19 recovery plans and higher education is well-placed to lead this process. In 2021, the ERI collaborated with Future Earth Ireland at the Royal Irish Academy in two webinars to further explore this crucial role. These were organised and chaired by Senior Lecturer in Environmental Engineering & Future Sustainability Dr Marguerite Nyhan who is a member of the Future Earth Ireland committee. The webinars included key insights from ERI Director Prof Sarah Culloty and MaREI Director Prof Brian Ó Gallachóir and concluded that higher education campuses and staff can lead by example, by piloting best practice in sustainability initiatives, support policymaking and industry with evidence-based solutions and engaging generations of learners towards more sustainable ways of living.



SOME OF THE QUESTIONS FROM THE PUBLIC WHICH WE ANSWERED IN 2021:**HOW CAN WE MAKE CORK 'GREEN'?**

In this time of the creation of a new Cork City Development Plan 2022-2028 and influenced by our experiences as a city during the recent lockdowns, now is an opportune time to consider just what kind of a city we want to live in for the future. In partnership with SHEP Earth Aware, Green Spaces for Health, Cork Chamber, Cork Nature Network and Cork Healthy Cities, the Greening Our City webinar series has concentrated on opening up a discussion on how we might make Cork 'green'. Looking at what this means from many different perspectives, we invited expert practitioners in this field from both Ireland and abroad to share their thoughts, ideas and experiences and provided ample opportunity for the public to engage and discuss their reactions in the sessions. In 2021, we heard from Valerie Beirne of the Bankside Urban Forest in London, Dr. Eoin Lettice and Dr. Paul Holloway (ERI, BEES, School of Geography) on the biodiversity of Cork City, Dr Declan Jordan (CUBS) on the Doughnut Economics approach to sustainable and equitable city growth, Dr. Tamara Soma on food system planning for urban health, Fearghal Reidy, Director of Strategic & Economic Planning Cork City Council on the Cork City Draft Development Plan 2022 – 2028, and Prof Pekka Puska on the 'Public Health Interventions Lessons from the Finnish North Karelia Project'.

WHY IS CLEAN AIR IMPORTANT?

For Clean Air Day on June 17th, the ERI teamed up with the RADICAL project to find out why clean air matters on an individual level. We heard from ERI Academics Dr Kian Mintz- Woo and Dr Marica Cassarino, as well as RADICAL PhD researcher Vaishali Vardhan and RADICAL project manager Dr Tamela Maciel. RADICAL also took the opportunity to highlight Cork's Air Quality Dashboard as well as a variety of other projects based in CRAC. Director of CRAC Prof John Wenger also contributed a blog piece on how atmospheric radicals transform the air. The RADICAL group also produced a short animation during the year explaining their development of an 'electronic nose' which will further enhance the ability of scientists to detect airborne radicals. ERI and RADICAL hosted a UCC Community Week webinar on the topic of *Air Quality in Cork* which featured speakers from Cork City Council, the CRAC lab and researchers in the area of environmental psychology, as well as providing the opportunity for the public audience to ask the questions which most concerned them about Cork's Air Quality.

HOW SUSTAINABLE IS OUR FOOD SYSTEM?

As part of UCC's Community Week 2021, the ERI was also involved in producing a webinar with the UCC School of Public Health and the Cork Food Policy Council, which explored the dual concerns of sustainability and healthy eating, by featuring initiatives and research projects representing each stage of the food provision system (from farm to fork and beyond to food waste) and all of which are working to ensure that community involvement is integral. As part of the Greening Our City webinar series in 2021, we also heard from Prof Colin Sage (UCC Emeritus) and horticultural training coordinator Ms. Finola McCarthy who addressed the question of '*Can Cork Feed Itself?*', highlighting the importance of a self-sufficient food system and providing examples of where urban agriculture in Cork is supporting people to make more conscious, healthier eating choices which will also benefit the planet.

WHAT KIND OF SOCIAL MODEL WILL LEAD US TO A LOW-CARBON FUTURE?

As a recent reports from top scientists in the IPCC and beyond alerts us to the 'ghastly future of mass extinction' and climate disruption that faces us, it is clear that the public discourse is beginning to move beyond a fixation with techno-fixes and to focus on the central challenges of mapping a radically alternative social future. In March 2021, the ERI partnered with SHEP Earth Aware to host a webinar exploring the need for a move away from capitalism in order to achieve a truly low carbon society. Guest speaker Prof Peadar Kirby (Professor Emeritus of International Politics and Public Policy, University of Limerick and education coordinator of Cloughjordan Ecovillage) argued that our societies are shaped by the interrelationship of state, market and society which constitutes our social model, and that we urgently need to address what kind of social model can get us to a low-carbon future. He mapped out key elements of what should constitute such a social model and heard from the audience as to whether this model would be publicly accepted and what aspects should be further developed.

WHAT DO WE KNOW ABOUT IRISH FOSSILS?

Ireland's natural landscape is made up of a diverse and unique geology which contains clues about the ancient Earth. We can connect to this mysterious past by discovering and exploring the rocks beneath our feet. Hidden within some of these rocks are the remains of plants and animals that lived in Ireland millions of years ago. These fossils can teach us about exciting prehistoric worlds. Launched in 2021, Ireland's Fossil Heritage is a SFI science engagement project led by Prof Maria McNamara (ERI, BEES) with the aim of increasing awareness of, and interest in, Irish fossils by offering a diverse range of free resources to the public, including school workshops, a travelling exhibit, science and art collaborations and interactive web content for all ages and backgrounds. Developed by Prof McNamara and the project's Science Engagement Officer Dr Jess Franklin, Ireland's Fossil Heritage also invites fossil artwork submissions, runs frequent STEM career Q&As with paleontologists and features guided fossil walking trails on its newly launched website.

WHERE IS IRELAND WITH RENEWABLE ENERGY?

In September, MaREI Director Prof Brian Ó Gallachóir took part in a conversation about Ireland's renewable energy capacity, both now and into the future, with Rory Monaghan of NUI Galway at the Galway International Arts Festival as part of the *First Thought* talks series. The talk was preceded by interactive polls with the live audience gauging the perception of the public about Ireland's current renewable energy usage. Prof Ó Gallachóir reflected on a century of Ireland's energy use from the development of the the Ardacrusha power plant, rolling out of the Rural Electrification Scheme, to the discovery of our natural gas fields off the coast of West Cork to our current ambitions to harness our island's potential for wind and wave energy.

10 | Awards & Recognitions

ERI DIRECTOR APPOINTED FIRST FEMALE HEAD OF THE UCC COLLEGE OF SEFS

Congratulations to ERI Director Professor Sarah Culloty (ERI, MaREI, AFDC) on her appointment as Head of the College of Science, Engineering and Food Science - making her the first female Head of College in STEM at UCC.

ERI ACADEMIC RECEIVES THE ANDREW LIGHT AWARD FOR PUBLIC PHILOSOPHY

Congratulations to Dr Kian Mintz-Woo (ERI, Department of Philosophy) who has been awarded the 2021 Andrew Light Award for Public Philosophy by the International Society for Environmental Ethics for his sustained commitment to publicly engaged philosophy and contributions that provide a distinctive example of critical contemporary work in public environmental philosophy.

UCC THE ONLY IRISH UNIVERSITY TO MAKE THE TOP 10 OF THE WORLD'S 'GREENEST UNIVERSITIES'

Congratulations to Dr Maria Kिरrane (UCC Sustainability Officer), the UCC Green Campus team and UCC Buildings and Estates as UCC is ranked the 8th most sustainable University in the World in the UI GreenMetric World University Ranking. This is up from the previous position of 9th in 2020 and consistently maintaining UCC's position as the only Irish University in the top ten.

ERI ACADEMIC APPOINTED VICE-PRESIDENT OF ELECTROCHEMICAL SOCIETY

Congratulations to Prof Colm O'Dwyer (School of Chemistry, ERI) who has been elected 3rd Vice-President of the Electrochemical Society (ECS). Prof O'Dwyer also chairs the ECS Electronics and Photonics Division, and previously served on the ECS Interdisciplinary Science and Technology Subcommittee.

ERI ACADEMIC ELECTED PRESIDENT OF AGRINATURA

Congratulations to Dr Stephen Onakuse (CUBS, ERI) who has been elected President of the European Alliance on Agriculture knowledge for Development (Agrinatura) – a grouping of European universities and research organizations with a common interest in supporting agricultural development in a sustainable manner in order to improve people's lives.

ERI PLAYS HOST TO ENVIRON 2021

Congratulations to Dr Jean O'Dwyer, Dr Tim Sullivan, Dr Paul Bolger, Dr Aoife Corcoran, Helen McMahon and steadfast volunteers Irene O'Callaghan, Hannah Binner, Luisa Andrade and Carlos Chique on the organisation and execution of ENVIRON 2021. The scale and success of the event was made possible only by the dedication of the team behind the scenes.

PRIZE FOR RADICAL PROJECT RESEARCHER AT ENVIRON 2021

Congratulations to PhD researcher Vaishali Vardhan (ERI, School of Chemistry), who was awarded the 'CIWM Best Wastes and Resources Management Presentation Award' for her presentation on the EU-funded RADICAL project at Environ 2021. Vaishali is developing a brand-new way of detecting atmospheric radicals in real-time using small, low-cost electronic sensors.

ERI ACADEMICS RECOGNISED BY IRC AWARDS

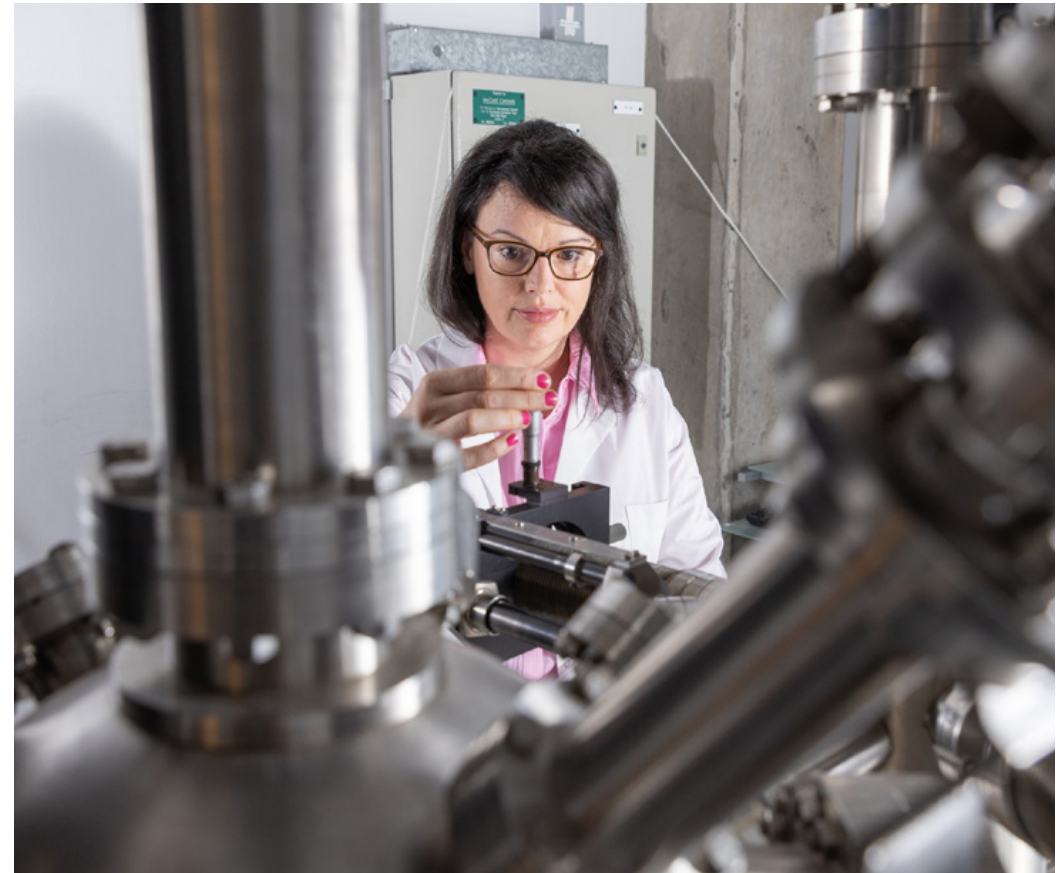
Congratulations to Dr Jean O'Dwyer (ERI, BEES), Dr Tim Sullivan (GEMS, ERI, BEES) and Dr Dug Cubie (ERI, Centre for Law and the Environment) who received IRC Researcher of the Year Awards in 2021, which highlight IRC-funded researchers who are making highly significant, valuable contributions to knowledge, society, culture and innovation.

CORK ENVIRONMENTAL FORUM HONOURS UCC ACADEMIC

Congratulations to Dr Ger Mullally (ERI, Dept of Sociology & Criminology) on being awarded a 'Lifetime Achievement' award by Cork Environmental Forum, in recognition of his very significant contribution & leadership over many years through both his academic work at UCC and his outreach activities in supporting sustainability.

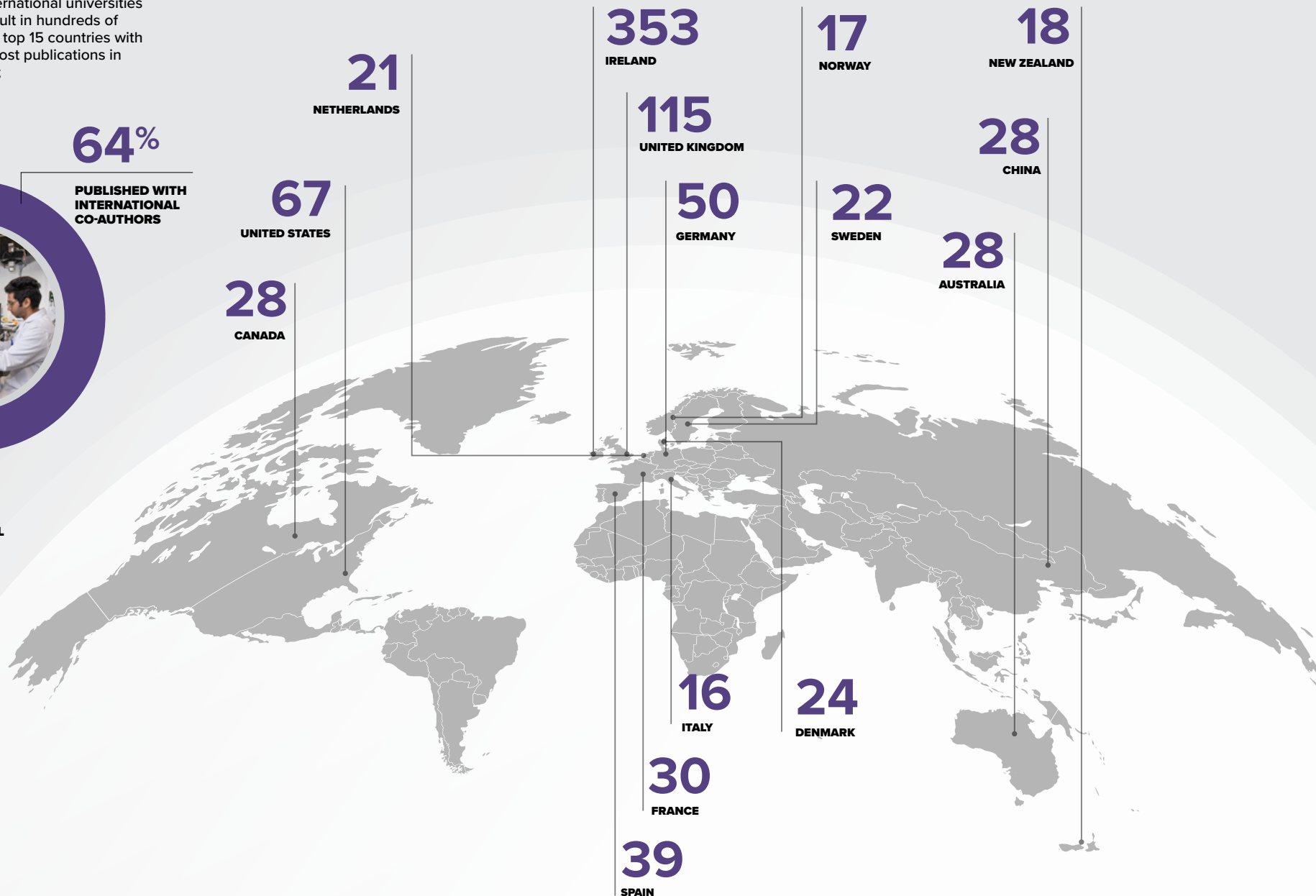
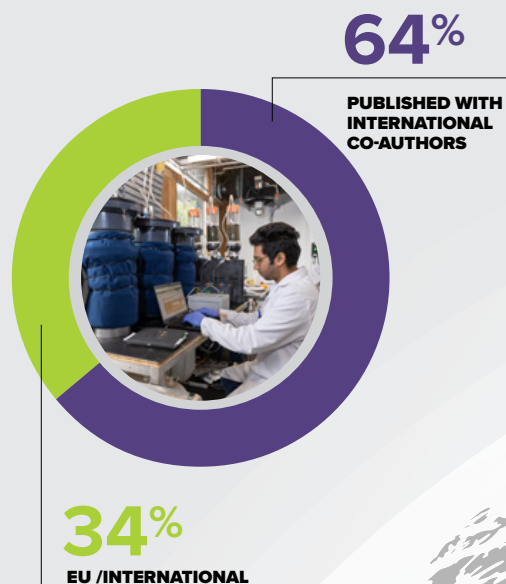
COASTAL ATLAS OF IRELAND LAUDED AT IRISH BOOK AWARDS

Congratulations to Prof Robert Devoy (ERI, MaREI, School of Geography) and Dr Val Cummins (MaREI, BEES, ERI) editors of the Coastal Atlas of Ireland (published by Cork University Press) which won the *Journal.ie Best Irish-Published Book of The Year 2021*.



11 | ERI Around the World in 2021

The ERI has collaborative partnerships with over 500 national and international universities and companies, which result in hundreds of publications annually. The top 15 countries with which we produced the most publications in 2021 are highlighted here;



12 | ERI 2021 PhD and Research Masters Awards

POSTGRADUATE		QUALIFICATION	SUPERVISOR(S)
Alvarez Armada	Nidia	PhD (Science)	Professor Maria McNamara, Dr David Jarvis
Bennison	Ashley	PhD (Science)	Dr Mark Jessop, Professor John Quinn
Bowen	Maeve Anne	PhD (Social Science)	Dr Seamus O'Tuama, Dr Gerard Mullally
Boyle	Evan James	PhD (Arts)	Dr Gerard Mullally, Professor Brian Ó Gallachóir
Brinkerink	Maarten Johannes Maria	PhD (Engineering)	Professor Brian Ó Gallachóir, Dr Paul Deane
Broughton	Roisin Catherine	MSc	Dr Niall O'Leary
Byrne	Keith	MSc	Dr Patrick A Meere, Dr Kieran Mulchrone
Colgan	Judith-Ann	MSc (Commerce)	Dr Stephen Onakuse, Professor Joe Bogue
Costello	Katie Ellen	PhD (Science)	Professor Sarah Culloty, Dr Sharon Lynch, Prof Rob McAllen, Prof Ruth O' Riordan
Cowhig	Kieran Stephen	Master of Research	Dr Simon Harrison
Curley	Richard Alan	PhD (Science)	Professor Justin Holmes
Davitt	Fionan Padraig Liam	PhD (Science)	Professor Justin Holmes, Professor Martyn Pemble
De La Torre Cerro	Ruben	Master of Research	Dr Fiona Cawkwell, Dr Paul Holloway
Fitzgerald	Micheál Pádraig	MSc	Dr Mark Jessop, Dr Sharon Lynch
Garcia	Adria	PhD (Science)	Professor Justin Holmes
Garvey	Shane Edward	PhD (Science)	Dr Brenda Long, Professor Justin Holmes
Gilmartin	Sarah Hannah	MSc (food Science and Technology)	Professor Nora O'Brien
Giralt Paradell	Oriol	PhD (Science)	Professor Emer Rogan
Goulding	David Anthony	PhD (Food Science and Technology)	Dr Seamus O'Mahony, Professor Nora O'Brien
Heenan Daly	Darren William	PhD (Science)	Dr Barbara Doyle-Prestwich
Hughes	Aoife	MSc (Commerce)	Professor Edmond Byrne, Dr Claire O'Neill, Dr Gerard Mullally, Dr Niall Dunphy, Dr Maria Kirrane

POSTGRADUATE		QUALIFICATION	SUPERVISOR(S)
Kerin	Igor	PhD (Engineering)	Dr Eamon McKeogh, Dr Damir Bakic, Dr Paul Leahy
Lonergan	Alex Thomas	PhD (Science)	Professor Colm O'Dwyer, Professor Justin Holmes
Luck	Cian James	PhD (Science)	Dr Michelle Cronin, Professor Emer Rogan, Dr Mark Jessop
Mac Carthaigh	Ruaidhrí Tomás	MSc	Professor Sebastian Wieczorek, Dr Kieran Mulchrone
Mahony	Kate	PhD (Science)	Professor Sarah Culloty, Dr Sharon Lynch
McCarthy	Odhran Nathan	PhD (Science)	Dr Patrick Meere
Nathamuni Suresh	Apoorva	Master of Research	Dr Paul Young
O'Brien	Ciara	MSc	Dr Justin McCarthy, Dr Paul Young
O'Connor	Christopher	PhD (Science)	Dr Andreas Amann, Professor Sebastian Wieczorek
O'Mahony	Evan Cornelius	MSc	Professor Andrew Wheeler
O'Sullivan	Leanne	PhD (Science)	Dr Paul Young, Professor Mary Cahill, Professor Rosemary O'Connor
O'Sullivan	Ronan James	PhD (Science)	Dr Thomas Reed, Professor Philip McGinnity
Olmedo	Luca	PhD (Commerce)	Dr Mary O'Shaughnessy, Professor Thia Hennessy
Olowoseje	Samuel Ayokunle	PhD (Engineering)	Dr Paul Leahy, Dr Alan Morrison
Patry	Sloane	PhD (Science)	Professor Alan Dobson
Rhatigan	Stephen James	PhD (Science)	Professor Colm O'Dwyer
Shwaiki	Laila Nora	PhD (Food Science and Technology)	Professor Elke K Arendt, Dr Shane Crowley
Strachan	Ruairhí Eoin	MSc	Dr Aaron Lim, Dr Patrick A Meere, Professor Andrew Wheeler
Van Twuijver	Mara Willemijn	PhD (Commerce)	Dr Mary O'Shaughnessy, Professor Thia Hennessy

13 | ERI 2021 Peer-Reviewed Publications

1. Acosta, K., Appenroth, K.J., Borisjuk, L., Edelman, M., Heinig, U., Jansen, M.A.K., Oyama, T., Pasaribu, B., Schubert, I., Sorrels, S., Sree, K.S., Xu, S., Michael, T.P. and Lam, E. (2021) *Return of the Lemnaceae: duckweed as a model plant system in the genomics and postgenomics era*, *Plant Cell*, 33 (10) 3207-3234.

2. Adrita, M.M., Brem, A., O'Sullivan, D., Allen, E. and Bruton, K. (2021) *Methodology for Data-Informed Process Improvement to Enable Automated Manufacturing in Current Manual Processes*, *Applied Sciences*, 11 (9) 3889.

3. Al Khalaf, S.Y., O'Reilly, É.J., McCarthy, F.P., Kublickas, M., Kublickiene, K., Khashan, A.S. (2021) *Pregnancy outcomes in women with chronic kidney disease and chronic hypertension: a national cohort study*, *American Journal of Obstetrics and Gynecology*, 225 (3) 298.e1-298.e20.

4. Albalawi, I., Hogan, A., Alatawi, H. and Moore, E. (2021) *A sensitive electrochemical analysis for cadmium and lead based on Nafion-Bismuth film in a water sample*, *Sensing and Bio-Sensing Research*, 34, 100454.

5. Albuixech-Martí, S., Culloty, S.C. and Lynch, S.A. (2021) *Co-occurrence of pathogen assemblages in a keystone species the common cockle Cerastoderma edule on the Irish coast*, *Parasitology*, 148 (13) 1665-1679.

6. Albuixech-Martí, S., Lynch, S.A. and Culloty, S.C. (2021) *Connectivity dynamics in Irish mudflats between microorganisms including Vibrio spp., common cockles Cerastoderma edule, and shorebirds*, *Scientific Reports*, 11 (1) 22159.

7. Alkhatib, H., Lemarchand P., Norton, B. and O'Sullivan, D.T.J. (2021) *Deployment and control of adaptive building facades for energy generation, thermal insulation, ventilation and daylighting: A review*, *Applied Thermal Engineering*, 185, 116331.

8. Alkhayou, H., Tyson, R.C. and Wiecek, S. (2021) *Phase tipping: How cyclic ecosystems respond to contemporary climate*, *Proceedings of the Royal Society B: Biological Sciences*, 477 (2254) 20210059.

9. Allen, J., Iglesias, G., Greaves, D. and Miles, J. (2021) *Physical modelling of the effect on the wave field of the wavecat wave energy converter*, *Journal of Marine Science and Engineering*, 9 (3) 309.

10. Alsgallaghefi, S., Balbaied, T. and Moore, E. (2021) *Electrochemical development of an immunosensor for detection polychlorinated biphenyls (Pcbs) for environmental analysis*, *Chemosensors*, 9 (11) 307.

11. Amorós, J.E., Cristi, O. and Naudé, W. (2021) *Entrepreneurship and subjective well-being: Does the motivation to start-up a firm matter?*, *Journal of Business Research*, 127, 389-398.

12. An, Y., Liu, Y., Liu, Y., Lu, M., Kang, X., Mansfield, S.D., Zeng, W. and Zhang, J. (2021) *Opportunities and barriers for biofuel and bioenergy production from poplar*, *GCB Bioenergy*, 13 (6) 905-913.

13. Analakkattillam, S., Langsi, V.K., Hanrahan, J.P. and Moore, E. (2021) *Comparative Study of Dissolution for Cannabidiol in EU and US Hemp Oil Products by HPLC*, *Journal of Pharmaceutical Sciences*, 110 (8) 3091-3098.

14. Archer, L.C., Hutton, S.A., Harman, L., Russell, Poole, W., Gargan, P., McGinnity, P. and Reed, T.E. (2021) *Associations between metabolic traits and growth rate in brown trout (Salmo trutta) depend on thermal regime*, *Proceedings of the Royal Society B: Biological Sciences*, 288 (1959) 20211509.

15. Arndt, J., Healy, R.M., Setyan, A., Flament, P., Deboudt, K., Riffault, V., Alleman, L.Y., Mbengue, S. and Wenger, J.C. (2021) *Characterization and source apportionment of single particles from metalworking activities*, *Environmental Pollution*, 270, 116078.

16. Arosio, R., Collier, J.S., Hawes, J., Gupta, S. and Sperry, J. (2021) *New perspectives on the English Channel megaflood hypothesis: High-resolution multibeam and seabed camera imaging of submarine landforms in the Northern Palaeovalley*, *Geomorphology*, 382, 107692.

17. Aryanpur, V., Ó Gallachóir, B., Dai, H., Chen, W. and Glynn, J. (2021) *A review of spatial resolution and regionalisation in national-scale energy systems optimisation models*, *Energy Strategy Reviews*, 37, 100702.

18. Backer, C.D., Teunissen, L., Cuyck, I., et al. (2021) *An Evaluation of the COVID-19 Pandemic and Perceived Social Distancing Policies in Relation to Planning, Selecting, and Preparing Healthy Meals: An Observational Study in 38 Countries Worldwide*, *Frontiers in Nutrition*, 7, 621726.

19. Ball, S., Butler, F., Caravaggi, A., Coughlan, N.E., Keogh, G., O'Callaghan, M.J.A., Whelan, R. and Kelly, T.C. (2021) *Hares in the long grass: increased aircraft related mortality of the Irish hare (Lepus timidus hibernicus) over a 30-year period at Ireland's largest civil airport*, *European Journal of Wildlife Research*, 67 (5) 80.

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23. Bao, X., Xiao, W., Li, S. and Iglesias, G. (2021) *Parametric study and optimization of a two-body wave energy converter*, *IET Renewable Power Generation*, 15 (14) 3319-3330.

24. Basurrah, A., Lambert, L., Setti, A., Murphy, M., Warren, M., Shrestha, T. and Di Blasi, Z. (2021) *Effects of positive psychology interventions in Arab countries: A protocol for a systematic review*, *BMJ Open*, 11 (7) e052477.

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26. Beltran, R.S., Kendall-Bar, J.M., Pirodda, E., Adachi, T., Naito, Y., Takahashi, A., Cremers, J., Robinson, P.W., Crocker, D.E. and Costa, D.P. (2021) *Lightscares of fear: How mesopredators balance starvation and predation in the open ocean*, *Science Advances*, 7 (12) eabd9818.

27. Benetti, S., Chiverrell, R.C., Cofaigh, C.Ó., Burke, M., Medialdea, A., Small, D., Ballantyne, C., Bateman, M.D., Callard, S.L., Wilson, P., Fabel, D., Clark, C.D., Arosio, R., Bradley, S., Dunlop, P., Ely, J.C., Gales, J., Livingstone, S.J., Moreton, S.G., Purcell, C., Saher, M., Schiele, K., Van Landeghem, K. and Weilbach, K. (2021) *Exploring controls of the early and stepped deglaciation on the western margin of the British Irish Ice Sheet*, *Journal of Quaternary Science*, 36 (5) 833-870.

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30. Bolger, P. (2021) *Delivering on the promise: how are sustainability research institutes enabling interdisciplinary research?*, *International Journal of Sustainability in Higher Education*, 22 (8) 167-189.

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32. Bose, A., O'Shea, R., Lin, R. and Murphy, J.D. (2021) *A comparative evaluation of design factors on bubble column operation in photosynthetic biogas upgrading*, *Biofuel Research Journal*, 8 (2) 1351-1373.

33. Bose, A., O'Shea, R., Lin, R. and Murphy, J.D. (2021) *Design, Commissioning, and Performance Assessment of a Lab-Scale Bubble Column Reactor for Photosynthetic Biogas Upgrading with Spirulina platensis*, *Industrial and Engineering Chemistry Research*, 60 (15) 5688-5704.

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35. Boudou, M., O'hAiseadha, C., Garvey, P., O'Dwyer, J. and Hynds, P. (2021) *Breakpoint modelling of temporal associations between non-pharmaceutical interventions and symptomatic COVID-19 incidence in the Republic of Ireland*, *PLoS ONE*, 16 (7 July) e0255254.

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38. Boyle, E., Ó Gallachóir, B. and Mullally, G. (2021) *Participatory network mapping of an emergent social network for a regional transition to a low-carbon and just society on the Dingle Peninsula*, Local Environment.
39. Boyle, E., Watson, C., McGoekin, C., Deane, A., de Bhalis, D., McElligott, C., O'Hara, S., Tuohy, B., Mullally, G. and Ó Gallachóir, B. (2021) *Reflecting on a collaborative approach to a regional sustainability transition: Dingle Peninsula 2030*, Reflective Practice, 22 (3) 415-429.
40. Boyle, E., Watson, C., Mullally, G. and Ó Gallachóir, B. (2021) *Regime-based transition intermediaries at the grassroots for community energy initiatives*, Energy Research and Social Science, 74, 101950.
41. Boyle, E.J. (2021) *Myth Beyond Metaphor: Myths in Transition*. In: Hughes, I., Byrne, E., Mullally, G. and Sage, C. (Editors), *Metaphor, Sustainability, Transformation: Transdisciplinary Perspectives*, Routledge, London.
42. Bradfield, T., Butler, R., Dillon, E., Hennessy, T. and Kilgarriff, P. (2021) *The Effect of Land Fragmentation on the Technical Inefficiency of Dairy Farms*, Journal of Agricultural Economics, 72 (2) 486-499.
43. Brem, A., O'Sullivan, D.T.J. and Bruton, K. (2021) *Advancing the Industrial Sectors Participation in Demand Response within National Electricity Grids*, Energies, 14 (24) 8261.
44. Bremerkamp, I., Ramos, A.V., Lu, P., Patange, A., Bourke, P. and Sousa-Gallagher, M.J. (2021) *Combined effect of plasma treatment and equilibrium modified atmosphere packaging on safety and quality of cherry tomatoes*, Future Foods, 3, 100011.
45. Brennan, M., Hennessy, T., Meredith, D. and Dillon, E. (2021) *Weather, Workload and Money: Determining and Evaluating Sources of Stress for Farmers in Ireland*, Journal of Agromedicine, 27 (2) 132-142.
46. Brinkerink, M., Ó Gallachóir, B. and Deane, P. (2021) *Building and Calibrating a Country-Level Detailed Global Electricity Model Based on Public Data*, Energy Strategy Reviews, 33, 100592.
47. Brunt, B., Keane, M. and Meredith, D. (2021) *People, Agriculture and the Coast*. In: Devoy, R., Cummins, V., Brunt, B., Bartlett, D. and Kandrot, S. (Editors), *The Coastal Atlas of Ireland*, Cork University Press, Cork.
48. Butler, D., Butler, R. and Eakins, J. (2021) *Expert performance and crowd wisdom: Evidence from English Premier League predictions*, European Journal of Operational Research, 288 (1) 170-182.
49. Byrne, E. (2021) *Why the metaphor of complementary dualism, and metaphor itself, are foundational to achieving sustainability*. In: Hughes, I., Byrne, E., Mullally, G. and Sage, C. (Editors), *Metaphor, Sustainability, Transformation: Transdisciplinary Perspectives*, Routledge, London.
50. Byrne, E., Doyle, E. and Hobbs, J. (2021) *Network diversity, distance and economic impact in a cluster: visualising linkages and assessing network capital*, Competitiveness Review, 31 (5) 863-882.
51. Calvert, S., Popovici, E. and Leahy, P. (2021) *Using Environmental Data based Communication Protocol for improved Quality of Service in LoRaWAN Applications*, 2021 32nd Irish Signals and Systems Conference, ISSC 2021, 9467858.
52. Canwat, V., Oelofse, M., Onakuse, S. and de Neergaard, A. (2021) *Agroecological intensification: Can organic conversion improve the production efficiency? A perspective from smallholder kale production systems Kenya*, Cleaner Environmental Systems, 3, 100048.
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54. Caravaggi, A., Olin, A.B., Franklin, K.A. and Dudley, S.P. (2021) *Twitter conferences as a low-carbon, far-reaching and inclusive way of communicating research in ornithology and ecology*, Ibis, 163 (4) 1481-1491.
55. Carral, L., Tarrío-Saavedra, J., Iglesias, G. and San-Cristobal, J.R. (2021) *Evaluation of the structural complexity of organisations and products in naval-shipbuilding projects*, Ships and Offshore Structures, 16 (6) 670-685.
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57. Carroll, E.L., McGowen, M.R., McCarthy, M.L., et al. (2021) *Speciation in the deep: Genomics and morphology reveal a new species of beaked whale Mesoplodon eueu*, Proceedings of the Royal Society B: Biological Sciences, 288 (1961) 20211213.
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61. Cawkwell, F. (2021) *Satellite remote sensing of the coastal regions of Ireland*. In: Devoy, R., Cummins, V., Brunt, B., Bartlett, D. and Kandrot, S. (Editors), *The Coastal Atlas of Ireland*, Cork University Press, Cork.
62. Cele, L.P., Hennessy, T. and Thorne, F. (2021) *Evaluating farm and export competitiveness of the Irish dairy industry: post-quota analysis*, Competitiveness Review, 32 (7) 1-20.
63. Chandran, S., Dixneuf, S., Orphal, J. and Ruth, A.A. (2021) *Experimental observation of the v2+4v3 bands of HD16O and HD18O between 14975 and 15275 cm⁻¹*, Journal of Molecular Spectroscopy, 375, 111395.
64. Chen, W. and Venables, D.S. (2021) *Broadband optical cavity methods*. In: Chen, W., Venables, D.S. and Sigrist, M.W. (Editors), *Advances in Spectroscopic Monitoring of the Atmosphere*, Elsevier, Oxford, pp. 95-158.
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