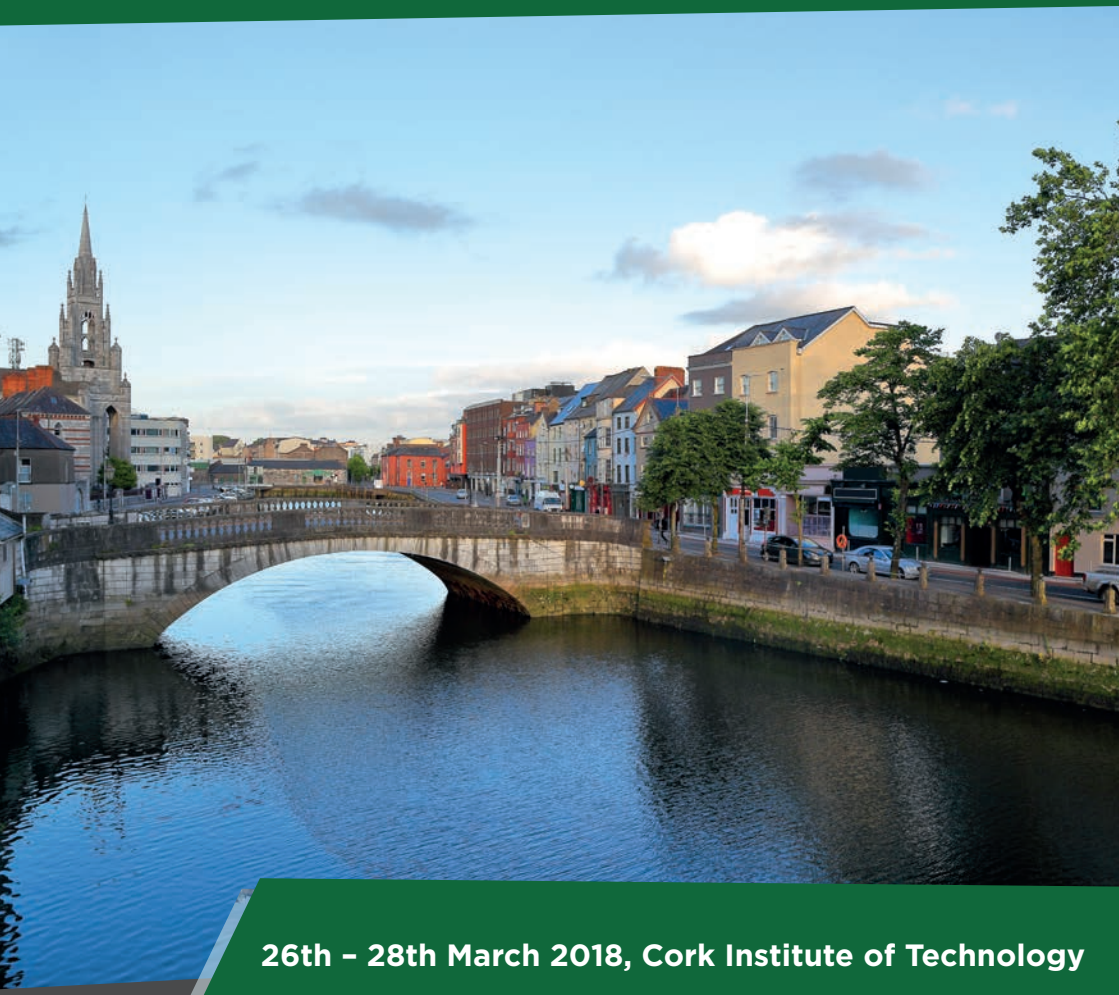
Environ 2018

Arriving at a Sustainable Future



26th – 28th March 2018, Cork Institute of Technology

28th Irish Environmental Research Colloquium

CIT CORK INSTITUTE OF TECHNOLOGY

INSTITIÚID TEICNEOLAÍOCHTA CHORCAÍ

esai

Environmental Sciences Association of Ireland

CORK INSTITUTE OF TECHNOLOGY
INSTITIÚID TEICNEOLAÍOCHTA CHORCAÍ

BISHOPSTOWN CAMPUS MAP

LEGEND

1 A-Block
Classrooms, Labs, Staff Offices & Workshops

2 B-Block
Classrooms, Labs, Staff Offices

3 C-Block
Atria (East and West)
Chaplaincy Info Desk
Classrooms and Laboratories
Food Court
Shop (An Siopa)

4 D-Block
Caretakers
Chapel
Chaplaincy Office
James Barry Exhibition Centre
Reception
Rory Gallagher Performance Theatre

5 CREATE Building

6 E-Block

7 F-Block

8 Sports Hall

9 Berkeley Centre
Library 11
IT Centre 12
IT Lecture Theatres 1-5
IT Labs
IT Open Access Centre
IT ServiceDesk

10 Student Centre

Ground Floor
Access Service
Bank of Ireland & ATMs
Bistro
Card Office
Copy Centre
Extended Campus
International Office
Nexus Hall
Nexus Market

First Floor
Accommodation Office
Chaplaincy Office
Common Room
Curve Gallery
Medical Centre
Societies Office
Sports Office
Students' Union

Second Floor
Careers & Counselling

11 Administration Centre

Ground Floor
Enquiries Desk 1
Admissions, Registrations
Enquiries Desk 2
Fees, Grants & Accounts Payable
Development Office
Research Office
Industry Liaison Office
Alumni Association
Erasmus Office

First Floor
Office of VP Finance & Admin
Buildings & Estates
Registrar & VP Academic Affairs
Graduate Studies Office

Second Floor
Office of the President
Council Room
Finance & Payroll
Human Resources

12 Tourism Building

13 G-Block

14 Melbourn Building
Exams Office, Exam Centre & Architecture Factory

15 Nimbus Centre

16 Rubicon Centre

17 Sports Stadium & Pitches

18 Athletics Stand & Track

Reserved Parking

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Disability Parking

Bike Parking

Parking Barriers

Bus Stops

Restaurants

Contents

CIT Convenors Welcome to ENVIRON 2018

Dear Delegate,

The ENVIRON 2018 Organising Committee welcomes you to the 28th Irish Environmental Researchers' Colloquium (ENVIRON 2018) at Cork Institute of Technology. The ENVIRON colloquium is the largest gathering of environmental researchers in Ireland with over 300 researchers attending this year. This event is a wonderful opportunity for environmental researchers both new and experienced to share their research with an audience drawn from academia, government bodies, industries and perhaps most importantly, the general public.

The world in 2018 is at a critical juncture regarding several issues including climate change, global access to clean water, the rise of antibiotic resistant microorganisms and the insidious ecotoxocity of micro plastics to name but a few. The theme of this year's colloquium is "**Arriving at a Sustainable Future**" and we will address in this colloquium many of the key issues required for us to arrive at this juncture.

The conference will begin on Monday 26th March with two afternoon workshops and a field trip to the Haulbowline Island Remediation Project (Kieran Ruane, CIT and Dr. Cormac Ó Súilleabháin, Cork County Council). The workshops are: "Bringing Research to the next level – Commercialisation, Code of Conduct, IP and Technology Transfer" (Ronan Coleman, CIT and Kevin Fitzgibbon, CIT WSSIC) and "Statistical Analysis for Research – Using SPSS Statistical Software" (Dr. Catherine Palmer, CIT).

ENVIRON will open to the public on Monday 26th March with a questions and answers style public engagement debate entitled "Flooding in the Cork Region – Impacts and Solutions". This topic is of both national and local interest. This debate will be chaired by Mr. Jonathan Healy and the podium speakers are Mr. Ezra MacManamon (Office of Public Works), Mr. Ken Leahy (Arup Consulting Engineers) and Ms. Claire Nash (Nash19).

The academic proceedings of the colloquium will be formally opened on Tuesday 27th March by Mr. Michael Loftus (Head of Faculty of Engineering and Science, CIT), Dr. Joe Harrington (Conference Joint Convenor, CIT), Dr. Niamh Power (Conference Joint Convenor, CIT) and Dr. Frances Lucy (ESAI Chairperson). Four concurrent sessions will follow over the course of the next day and a half at which over ninety papers and seventy posters will be presented under 17 topic areas; Air Quality and Urban Development, Biodiversity and Ecosystems, Climate Change, Ecotoxicology, Energy, Environmental Management, Environmental Policy and Communication, Human Health, Invasive Species, Marine and Coastal, Nanotechnology and the Environment, Smart Technology for the Environment, Sustainable Infrastructure, Sustainable Land Use and Agriculture, The Human Built Environment, Waste Management, Water Quality and Resources.

We hope that you will find ENVIRON 2018 stimulating for your own research and that you also enjoy the various social activities at our award winning CIT campus.

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

Dr. Joe Harrington and Dr. Niamh Power

ENVIRON 2018 Joint Convenors

On behalf of the ENVIRON 2018 Organising Committee

ESAI Welcome to ENVIRON 2018 Delegates

On behalf of the Environmental Sciences Association of Ireland (ESAI), the ESAI Council extends to you a warm welcome to the 28th Irish Environmental Researchers colloquium (ENVIRON) at Cork Institute of Technology (CIT)

We are delighted that the ENVIRON Colloquium is being held in CIT which is a national leader in environmental research. This year's theme for Environ is 'Arriving at a Sustainable Future'.

ENVIRON provides a platform for researchers to present to a wide audience and also gives an opportunity to engage with the general public. Environmental news is now mainstream with topics such as climate change, particularly flooding, biodiversity, water and waste management regularly featuring on both social media and on traditional platforms. For the last number of years, the colloquium has been open to the public on the first evening of the event in the form of a debate with a Q&A Session. This year the theme is on "Flooding in the Cork Region – Impacts and Solutions" to be held in the Frank O'Connor theatre at 8pm on March 26th.

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

The ESAI wishes to sincerely thank Dr. Joe Harrington, Dr. Niamh Power, and the CIT committee for hosting ENVIRON and for assembling a very comprehensive programme. We also wish to thank Ms. Sinead Macken for providing excellent administrative support to the event as always.

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

Dr Frances Lucy
ESAI Chairperson

Environ 2018 Organising Committee

Joint Conference Convenors

Dr. Joe Harrington and Dr. Niamh Power

Cork Institute of Technology Planning & Scientific Committee

Mr. Donal O' Dwyer	Ms. Denise Barnett
Dr. Garrett O' Sullivan	Mr. Leonard O' Driscoll
Mr. Brian O' Rourke	Mr. Des Walsh
Mr. Kieran Ruane	Dr. Mary Moloney
Mr. John J. Murphy	Dr. Vesna Jaksic
Dr. George Murphy	Dr. Ambrose Furey
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Mr. Noel Duffy	Mr. Eamon Butler
Mr. Cormac Gebruers	Dr, Nikolay Petkov
Prof. John Barrett	Mr. Joseph Croke
Mr. Eoin Callanan	Ms. Denise O' Keeffe
Ms. Carmel Collins	Ms. Norma Welch

Environmental Sciences Association of Ireland (ESAI)

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

ESAI Council

On the ground assistance at Cork Institute of Technology

A special thank you to:

CIT Postgraduate Research Students and Undergraduate Students, Building and Estates, Caretakers, IT and Audio-Visual Services and the CIT Marketing Unit.

Thanks to the ENVIRON 2018 Sponsors and Exhibitors

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Department of Communications, Climate Action & Environment

Soil Science Society of Ireland

RIA
Acadamh Ríoga na hÉireann
Royal Irish Academy

CIWM

CIEEM
Chartered Institute of Ecology and Environmental Management

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

AQUATT
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Environmental Sciences Association of Ireland

CIT CORK INSTITUTE OF TECHNOLOGY
INSTITIÚID TEICNEOLAÍOCHTA CHORCAÍ

Environ 2018

Cork Institute of Technology

March 26th – 28th 2018

Arriving at a Sustainable Future
28th Irish Environmental Research Colloquium

DELEGATE INFORMATION

Registration

The ENVIRON 2018 Registration Desk will be open at the following times:

Monday March 26th	13.00 – 18.00	Tourism & Catering Building
Monday March 26th	18.30 – 20.00	Frank O'Connor Theatre
Tuesday March 27th	08.15 – 18.00	Tourism & Catering Building
Wednesday March 28th	09.00 – 11.00	Tourism & Catering Building

Delegate Badges

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

Locations

Registration	as above
Public Event	Frank O'Connor Theatre
Plenary sessions	T101
Conference sessions	T101, T103, T104, T105
Poster sessions and exhibitors	T136
Tea/Coffee	T136
Lunch	Food Court
Haulbowline Island Remediation Project	Registration Desk
Bringing Research to the next level	T103
Statistical Analysis for Research	C150
ESAI AGM	T106

Delegates giving oral presentations

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

Posters

The poster presentation area is located in T136. When you arrive at the registration please indicate that you have a poster for presentation and we will guide you to the poster area.

Posters can be erected on Monday March 26th (14.00 – 17.00) or on Tuesday morning March 27th (8.15 – 10.30). All posters should be in place by 10.30 on Tuesday, March 27th. Please do not remove posters until the end of the final poster session on Wednesday morning. There will be 3 poster sessions throughout the colloquium. To ensure that colloquium delegates can meet poster presenters we would strongly encourage poster presenters to be by their posters for these sessions to answer any questions. Each presenter is assigned a unique poster ID number (check ID in poster abstract section). Your poster should be mounted on the poster board assigned to your ID.

WIFI

Cork Institute of Technology has Eduroam for those from other colleges. There will also be a temporary log-in available during Environ. This will be provided on signs in the conference zones.

Tea/ Coffee/ Lunch

Teas/coffees at all breaks will be available in Room T136. A hot lunch will be served on Tuesday and Wednesday in the Food Court.

ATM

There is a Bank of Ireland ATM on campus located in the Student Centre.

Parking

Free parking is available in the main carparks on campus.

Local Transport

There is a bus service from the CIT Campus to Cork City centre every 15 minutes (Bus Number 205).

Taxi services include

Yellow Cabs	021 4877777
ABC Cabs	021 4961961
Wilton Cabs	021 4346666
Sun Cabs	021 4292929
Lee Cabs	021 4393977

ENVIRON 2018 CONFERENCE PROGRAMME

	Conference Programme Monday March 26th 2018
13.00 - 18.00	**Registration: CIT Tourism and Catering Building**
18:30 - 20.00	**Registration: Frank O'Connor Theatre (IT3)**
14.00 - 17.00	**A: Field Trip: Haulbowline Island Remediation Project** Facilitators: Mr. Kieran Ruane (CIT) and Dr. Cormac Ó'Súilleabháin (Cork County Council)
14.00 - 17.00	**B: Bringing research to the next level - Commercialisation, Code of Conduct, IP & Technology Transfer** Facilitators: Mr. Ronan Coleman (CIT) and Mr. Kevin Fitzgibbon (CIT WSSIC)
14.00 - 17.00	**C: Statistical analysis for research - using SPSS statistical software** Facilitator: Dr. Catherine Palmer (CIT)
19.15 - 20.00	**Drinks Reception: CIT**
20.00 - 21.30	**Public Engagement Debate: Frank O'Connor Theatre (IT3), CIT** **"Flooding in the Cork Region – Impacts and Solutions"** **Followed by Q&A Session** Panel: Mr. Ezra MacManamon, OPW Mr. Ken Leahy, Arup Ms. Claire Nash, Nash19 Chairman: Mr. Jonathan Healy

ENVIRON 2018 CONFERENCE PROGRAMME

	Conference Programme Tuesday March 27th 2018			
08.15	**Registration – CIT Tourism and Catering Building**			
9.15 - 9.30	**Opening of Environ 2018: T101 Lecture Theatre** Opening Address: Michael Loftus, Head of Faculty of Engineering & Science, CIT Environ 2018 Conference Convenors: Dr. Joe Harrington and Dr. Niamh Power Dr. Frances Lucy, ESAI Chairperson			
09.45 -10.45	**Plenary Session** Lecture Theatre T101 Dr. Jonathan Derham, EPA Director Eamon Ryan, Green Party			
10.45 - 11.30	**Coffee, Poster Session 1 & Meet the Exhibitors Room T136**			
11:30 - 13:00	Marine & Coastal **Room T101**	Ecotoxicology & Invasive Species **Room T103**	Energy **Room T104**	Environmental Management **Room T105**
13.00 - 14.00	**Lunch CIT Food Court**			
14.00 - 15.30	Water Quality and Resources 1 **Room T101**	Human Health **Room T103**	Sustainable Land Use & Agriculture 1 **Room T104**	Environmental Policy & Communication **Room T105**
15.30 - 16.15	**ESAI College Liaisons Meeting: Room T106**			
15.30 - 16.15	**Coffee Poster Session 2 & Meet the Exhibitors Room T136**			
16.15 - 17.15	Water Quality and Resources 2 **Room T101**	Biodiversity & Ecosystems **Room T103**	Sustainable Land Use & Agriculture 2 **Room T104**	Nanotechnology & the Environment **Room T105**
17.30 - 18.00	**ESAI AGM & Presentation by Postgraduate Researcher of Year Award Winner: Room T106**			
19.00 - 20.00	**Drinks Reception & Live Music: The Tivoli Suite, Clayton Hotel, Silver Springs**			
20.00	**Conference Dinner followed by music: The Tivoli Suite, Clayton Hotel, Silver Springs**			

ENVIRON 2018 CONFERENCE PROGRAMME

	Conference Programme Wednesday March 28th 2018			
09.15 - 11.00	**Registration CIT Tourism and Catering Building**			
09.30 - 10.00	**Plenary Session** Lecture Theatre T101 **Dutch experience of wastewater sludge incineration and phosphates recycling pathway – practice, legislation/permitting** Josien Ruijter, NV. HVC, The Netherlands			
10.00 -11.00	Waste Management 1 **Room T101**	Air Quality & Urban Development 1 **Room T103**	Sustainable Infrastructure **Room T104**	Smart Technology for the Environment **Room T105**
11.00 - 11.45	**Coffee, Poster Session 3 & Meet the Exhibitors Room T136**			
11.45 - 12.45	Waste Management 2 **Room T101**	Air Quality & Urban Development 2 **Room T103**	The Human Built Environment **Room T104**	Climate Change **Room T105**
12.45 - 13.30	**Lunch: CIT Food Court**			
13.30 - 14-15	**Prize Giving & Close of Environ 2018**			

Environ 2018

Cork Institute of Technology

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BIOGRAPHIES

Field Trip and Workshop Sessions

Haulbowline Field Trip

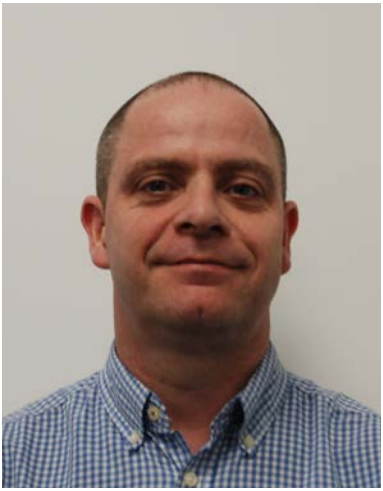
Kieran Ruane

Kieran Ruane is a Chartered Civil and Structural Engineer and a lecturer at Cork Institute of Technology. He is a former director of RPS Consulting Engineers Ltd. where he was Lead Civil Engineer for the Preliminary Design and Detailed Design Phases of the Haulbowline Island East Tip Remediation Project. Kieran is currently Chairman of the Institution of Structural Engineers – Republic of Ireland Regional Group.

Dr. Cormac Ó Súilleabháin

Dr. Cormac Ó Súilleabháin is a Senior Engineer with Cork County Council. Cormac is Project Manager for Haulbowline Island Remediation Project.

Bringing Research to the Next Level Workshop



Ronan Coleman

Ronan Coleman is Commercialisation Specialist with Cork Institute of Technology responsible for promoting awareness, identifying, managing and commercialising Intellectual Property (IP) created by Institute research active personnel. Ronan has strong industrial experience with Start-ups, SME's and MNC's including numerous new product development roles including project, portfolio and programme management. He managed a global, cross-functional, matrix team of 20+ direct and indirect reports in the development of new products for the payments industry with project budgets in excess of €1million.

Kevin Fitzgibbon

Kevin Fitzgibbon is a Chartered Engineer with Engineers Ireland. He graduated with a Bachelor of Civil Structural & Environmental Engineering from University College Cork, and subsequently obtained a Master of Engineering Science degree; as well as postgraduate diplomas in Environmental Engineering, Company Direction, and Sustainable Energy. He has worked for over 20 years in the private sector, mainly as MD of a multi-disciplinary Consulting Engineering practice. From 2013 Kevin has been Coordinator of the Water Systems & Services Innovation Centre, Nimbus Research Centre, Cork Institute of Technology, where he manages a portfolio of water-related research and innovation projects. His areas of expertise include: environmental impact assessment; renewable energy, particularly wind energy; and energy system cost optimisation.

Statistical Analysis for Research Workshop

Dr. Catherine Palmer

Dr. Catherine Palmer is a lecturer in the Department of Mathematics at CIT. Catherine has degrees in Quantitative Ecology (PhD, University College Cork), Probability Theory (M.Sc. University College Cork) and Mathematics (B.Sc. University College London). She teaches on a wide range of courses, from first year to post graduate level in both Mathematics and Statistics, including the H.Dip. and M.Sc. in Data Analytics run by the Department of Mathematics in CIT. Catherine has experience in the application of a variety of statistical models and is particularly interested in the area of Community Ecology.

Public Event

Chairman: Jonathan Healy

After graduating with a degree in law from University College Cork, Jonathan Healy worked in radio, television and online media for two decades.

He has been a presenter with Newstalk 106-108fm and a senior correspondent with Sky News, with his work featuring prominently on both stations.

Jonathan also has experience working with TV3, RTE, FM104, The Cork Independent and Cork's 96fm.

Having conducted thousands of interviews with people from all works of Irish life, he is a skilled interviewer and proven cross-platform content creator with extensive contacts across politics, business and public relations throughout the country.

Jonathan is also a proven event facilitator and engaging MC.

He has also delivered high impact voice-over work for corporate videos and campaigns.

In a shifting world of communications, he can help make your story stand out and ensure your message is heard.

Public Event

Ezra Mac Manamon

Ezra Mac Manamon is a Civil Engineer with the Office of Public Works (OPW). He graduated from UCG in 1985 and is a Chartered Engineer. After some years working in both the Private and Public Sectors in the UK he joined the Irish Civil Service in 1996. Since then he has spent time providing structural engineering advice to the National Monuments Service, the National Parks and Wildlife Service and the Waterways Service as well as Waterways Ireland, when these functions were part of Dúchas the Heritage Service. Since 2006 he has worked in the flood relief section of the OPW and has represented OPW on the Steering Committees of the Flood Relief Schemes in Mallow, Fermoy, Bandon, Skibbereen, Douglas, Glanmire, Blackpool and Cork City. He is based in Cork City.

Ken Leahy

Ken Leahy B.E. DipConLaw C. Eng MIEI MICE, is a Chartered Engineer and an Associate Director of Arup. He leads Arup's Flood Management business in Ireland and has 20 years' experience in leading and managing major multidisciplinary infrastructure projects, particularly the delivery of major flood relief schemes.

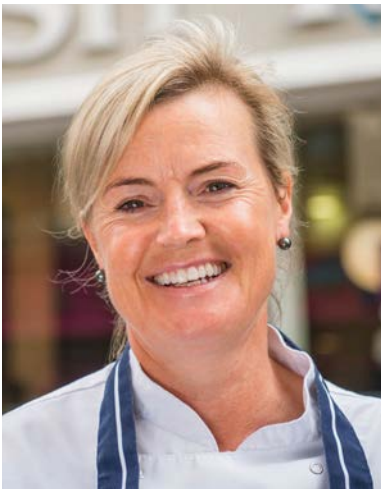
His experience includes project management, project execution planning and permitting, civil and structural design, procurement, contract administration, construction management, and stakeholder management.

Ken was project manager for the now successfully completed Mallow Flood Relief Scheme (FRS) which has already protected Mallow from flooding on over twenty occasions. Ken received the Engineers Ireland Engineering Excellence Award for his technical paper on 'The Design and Implementation of Mallow FRS'.

He is currently the project manager for the Cork City Flood Relief Scheme, which is the largest flood relief scheme to be proposed in Ireland. In this role, he has directed the work of a multidisciplinary team of experts, in undertaking the hydrological assessment, hydraulic modelling, and options appraisal for the scheme. In addition, Ken is the project director for a number of other flood relief schemes, including King's Island FRS and Midleton FRS.

Ken has been a regular industry lecturer at both Cork Institute of Technology and University College Cork, and has been an expert witness in the area of flood risk management at oral hearings and in litigation proceedings.

Public Event



Claire Nash

Claire Nash was born in the late sixties in Pallasgreen, Co Limerick. She went to Oola National School, Co Limerick and the Ursulines Secondary School, Thurles, Co Tipperary.

At the young age of only 13 Claire developed her passion of food by spending a few summers in the kitchen of Ballymaloe with Myrtle Allen. Claire still regards Myrtle as her inspiration and steel magnolia.

In Claire's fifth year of school holidays Claire had a little café in her family lodge serving simple treats from her mum's garden to passing tourists and the likes.

Claire studied in Cathal Brugha Street and received a Higher Diploma in Hotel and Restaurant Management and a BSc Management Degree from Trinity College, Dublin.

She went to Atlanta Georgia and became deputy manager in Cherokee Town and Country Club, a private members only club in the Deep South. She took Business Management Institute 1 and 2 at Georgia State University.

Claire returned to Ireland in 1990 due to family circumstances. In late 1991 she acquired a premises at 19 Princes Street, Cork and opened Nash 19 Restaurant in February 1992. The restaurant created 11 jobs in the city centre when the minimum wage was 2.26 Irish pounds per hour a far cry from Bertie's Celtic Tiger bonuses!

In the early years she became very involved in People in Need in the Cork Region. She joined Cork Business Association and was President in 2008. She took on a Directorship of the association in 2009.

She had the pleasure in receiving an Honorary Masters in business from UCC. She served as director of Cork Business Association for a two year second term. She served a seven year term on the board of Cork Opera House and she currently sits on CORE AT City Council and also is on the council of Cork Airport.

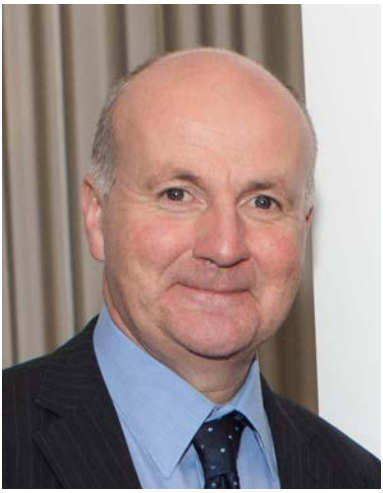
In 2009 Nash 19 opened its food shop. When purchasing for the restaurant she is acutely aware of buying locally in a sustainable fashion, contributing to the overall long-term viability of her suppliers right back to the farmers.

In early 2014 the restaurant was completely renovated after sustaining another flood. This time she opened the Stern view gallery and extended the food shop. She currently employs 22 staff.

The restaurant has been flooded 3 times and also experienced a fire. The past refurbishment post flood cost circa 330 thousand.

We currently have zero flood cover despite our expenditure on flood defence and our overall insurance bill more than doubled.

Opening Event



Michael Loftus

Michael Loftus, currently holds the position of Head of Faculty of Engineering & Science at Cork Institute of Technology (CIT). In this role, he holds overall responsibility for all aspects of Faculty development and operations. Since joining CIT in 2001, Michael has held the positions of Lecturer in Computing, Head of School of Computing & Mathematics and Head of Faculty of Science prior to taking up his current position.

Michael worked in industry from 1985 to 2001 and, during this time, was employed as a software engineer, researcher, project manager and IT consultant. He worked for organisations ranging from large scale multinationals to smaller scale indigenous businesses and he has conducted IT consultancy assignments with both public and private sector organisations in Ireland, Europe, the United States and the Middle East. During this period, he developed an IT consultancy business which, with co-owners, he sold to Gartner Group where he subsequently held the position of Director (Consultancy). He is chairman of the board of directors of Cosmos Education CLG, the legal entity which operates Blackrock Castle Observatory. He is a former member of board of directors of it@cork, European Tech Cluster, where he led the development of the Adopt-a-School programme. He is also a former member of the board of directors of Cork Chamber.

Michael is a Chartered Engineer and a Fellow of Engineers Ireland.

Opening Event

Dr. Joe Harrington

Dr. Joe Harrington is Head of School of Building & Civil Engineering at Cork Institute of Technology. He was educated at University College Cork and the University of California, Berkeley. He is a Chartered Engineer and Fellow of Engineers Ireland.

Dr. Harrington has over 25 years of teaching and research experience and leads the Sustainable Infrastructure Research & Innovation Group at Cork Institute of Technology. His own research interests include sediment behaviour, modelling and management in the river, estuarine and coastal environments. Dr Harrington has published widely and he has led and coordinated a wide range of national and internationally funded research projects including the CEAMaS, PHOS4You and SURICATES projects.

He has served as External Examiner for Undergraduate Programmes and Research Master and PhD Theses across the Higher Education Sector in Ireland. He has served on a wide range of Engineers Ireland Professional Accreditation Panels and QQI Programme Validation Panels.

Dr. Harrington has been an invited speaker on the topic of Sediment Behaviour and Management at International Conferences and was awarded the Hromodka Medal for an Outstanding Contribution to Water Resources Research at the River Basin Management Conference in 2013.

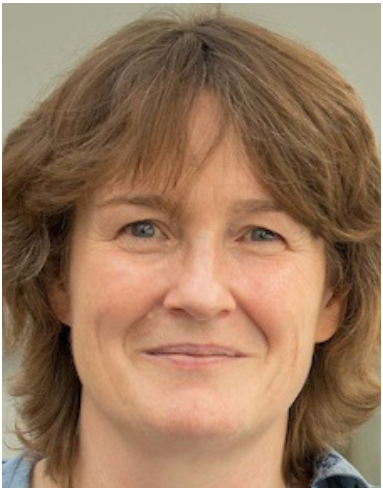
Dr. Harrington is a member of the EPA Dumping at Sea National Advisory Committee and a member of the Accreditation Board of Engineers Ireland. He is also a member of Council of the Environmental Sciences Association of Ireland and is a member of the Lean Construction Ireland Leadership Group.

Opening Event

Dr. Niamh Power

Dr. Niamh Power is a Lecturer in Civil, Structural & Environmental Engineering, in Cork Institute of Technology, Ireland.

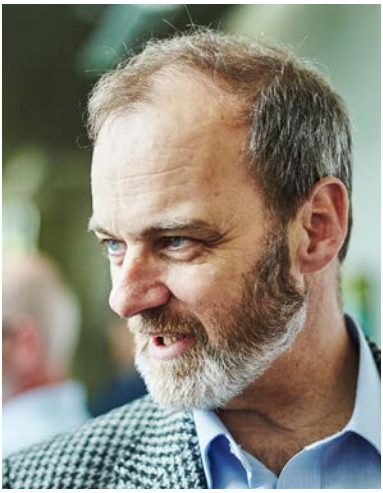
She received an honours degree in Civil & Structural Engineering and was subsequently awarded a prestigious Irish Research Council Scholarship to pursue her PhD in the area of biogas as a transport fuel. She is an active member of the Sustainable Infrastructure Research and Innovation Group in CIT. Her research interests are; biogas, anaerobic digestion, renewable energy from wastes & crops, transport & CHP, Life Cycle Analysis and policies & drivers for change. She is involved in a number of large-scale EU research projects including Phos4You and ReNu2Farm.



Professor Frances Lucy

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

Plenary Sessions



Dr Jonathan Derham

Dr Jonathan Derham, Environmental Protection Agency (EPA) is a NUI sciences graduate (Cork & Galway) with a Master's Degree in Public Service Management. Jonathan has worked for over 27 years in the environmental field for public and private sector employers in Ireland and UK, and has broad experience of environmental policy and regulation nationally and in the EU. He currently heads up the Evidence & Assessment Programme in EPA incorporating Research, Climate Change, SEA, Analytics, and Assessment & Reporting, and which included production of the latest State of Our Environment Report.

Eamon Ryan

Eamon Ryan was elected to represent Dublin Bay South in the 2016 General Election.

He was born in Dublin and raised in Dundrum and Dartry. He studied commerce in UCD before taking a job managing a marketing course in the university's School of Business. He went on to found a cycling tourism company, Irish Cycling Safaris, in the late 1980's and in 1996 won the Ernst & Young Entrepreneur of the Year award. The business still trades successfully as Cycling Safaris.

He was the founding chairperson of the Dublin Cycling Campaign and began his political career as a Dublin City Councillor for the Rathgar – Rathmines ward. He then went on to serve both as a TD for Dublin South and as a Government Minister for Communications, Energy and Natural Resources.

In recent years, Eamon has worked for a European climate organisation (www.e3g.org) and chaired the digital policy group in the Institute of International and European Affairs (www.iiea.com). He is currently leader of the Green Party/ Comhaontas Glas (www.greenparty.ie) and is married to writer Victoria White, they have four children.

Plenary Sessions

Josien Ruijter

Josien Ruijter is a water and earth scientist with a MSc degree from the Faculty of Earth & Life Sciences of the Vrije Universiteit Amsterdam, The Netherlands, recently added with courses on industrial engineering. She has extensive experience in environment, water resource management, environmental services strategies, and rural and urban drinking water development, of which an important part in Indonesia's semi-arid and wet tropical areas.

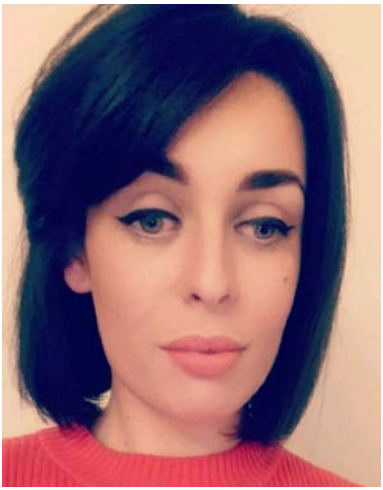
Since 2017 she is working for HVC's business line 'Energy from Waste' in The Netherlands, as business developer on resource recovery from sewage sludge and involved in strategic developments on sewage sludge processing for and with Dutch water authorities. From this position she is also involved in the Interreg-NW Phos4You program, on identification and showcasing P recycling pathways.

ESAI AGM Guest Speaker - ESAI Postgraduate Researcher of Year 2017

Philip Shine

Philip Shine graduated with a first class honours degree in Sustainable Energy Engineering (BEng) in 2014 from Cork Institute of Technology. Currently a doctoral student within the MeSSO research group in CIT, Philip aims to complete his research in 2018 which focuses on energy and water consumption in the Irish dairy industry. More specifically, Philip's research investigates the utilisation of machine-learning algorithms, a branch of artificial intelligence, for optimising energy and water predictions on dairy farms. Philip's research interests include future smart grid technologies and the development and implementation of decision support tools and machine-learning models for reducing the environmental impact of agricultural activities. Over the course of Philip's research programme, he has presented his research findings at three international conferences, published his first research article in the Applied Energy journal titled "Electricity & direct water consumption on Irish pasture based dairy farms: a statistical analysis", disseminated his research findings to Irish dairy farmers through coordinated workshops, undertaken numerous collaborative work with both Teagasc and the Sustainable Energy Authority of Ireland all the while representing CIT as a STEM Ambassador.

Invited Presenter - ESAI Best Oral Presentation 2017



Aoife Hayes

Aoife Hayes – Design Engineer - Project & Programme Management – ARUP

Having completed her undergraduate degree in Interior Architecture, Aoife developed a strong interest in how people live in the world. Her preliminary undergraduate research began to explore the idea of enhancing the human experience within the built environment through the use of technology. Later in 2015, Aoife returned to Cork Institute of Technology to carry out an MSc by Research. Her research once again, heavily revolved around the human experience within the built environment, but focused on developing educational content to allow the architectural and engineering disciplines to better understand how to cater for the human experience, both physiologically and psychologically. This meant collating multidisciplinary information from various fields including, architecture, environmental psychology, neuroscience, anthropology and of course education.

Since graduating in October 2017, Aoife has started working with Arup, Ireland's largest engineering consultancy firm who have just become the first workspace in Ireland, and ninth in Europe, to receive the certification from the International WELL Building Institute (IWBI), bringing human health and wellness to the forefront. Aoife is currently working on the wellness team at Arup to promote occupant centred design across the industry, ultimately creating better space for people.

"Our mission at IWBI is to bring human health and wellness to the forefront of building practices globally, and it is industry leaders like Arup that are putting people at the centre of design decisions and helping to advance this movement globally."

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ORAL AND POSTER PRESENTATION SCHEDULE

ENVIRON 2018 CONFERENCE PROGRAMME

	ORAL PRESENTATIONS SESSIONS **Tuesday March 27th 11.30 – 1.00**			
	Marine & Coastal **T101**	**Ecotoxicology & Invasive Species** **T103**	**Energy** **T104**	**Environmental Management** **T105**
11:30 - 11.45	Chair Address: **Dr Niall McDonough** Marine Institute	Chair: **Professor Frances Lucy** IT Sligo Investigation of Carbamazepine and Ibuprofen toxicological effects on algae by multifactorial analysis **Zaniel Procopio** Glasgow Caledonian University	Chair Address: **Dr. Lucy Corcoran** SEAI Sustainable Energy Authority of Ireland (SEAI) – An overview of research supports and case studies of SEAI supported research from 2007–2017	Chair: **Liam Curran** Enterprise Ireland A water resources planning model for Dublin to assess impacts of socio-economic growth and climate change **Mohammed Yassin** DIT
11:45 - 12.00	The application of satellite-borne remote sensors for monitoring coastal erosion and ecosystems in Ireland **Daithí Maguire** NUIG	Filter-feeding invertebrates as drivers of the conjugative transfer of antimicrobial resistance in Enterococcus faecalis in aquatic environments **Temilola** Olanrewaju Ulster University	Interlocked electrodes (ILE) for breaking the limit of cathode specific surface area in microbial fuel cells (MFCs) **Dunzhu Li** TCD	A real-time alert system for predicting and managing short-term pollution and bathing water quality at Enniscrone beach **Wayne Egan** IT Sligo
12.00 - 12.15	Are Microplastics Disrupting the Biological Pump? **A.M. Wieczorek** NUIG	Cold as Ice: a novel eradication and control method for invasive Asian clam, Corbicula fluminea, using pelleted dry ice **Neil Coughlan** QUB	Developing Principles for a Fair and Inclusive Energy Transition in Europe: Results from an Interdisciplinary Delphi-Panel of Academic Experts **Alexandra Revez** UCC	Use of an acoustic camera for monitoring seaward spawning migrations of European eel (Anguilla anguilla) in Irish rivers **Eamon Lenihan** NUIG

ENVIRON 2018 CONFERENCE PROGRAMME

	ORAL PRESENTATIONS SESSIONS **Tuesday March 27th 11.30 – 1.00 *Cont.***			
	Marine & Coastal **T101**	**Ecotoxicology & Invasive Species** **T103**	**Energy** **T104**	**Environmental Management** **T105**
12.15 - 12.30	Trends and Variability in sea water level along the coastline of Ireland: A comparative study **Arunima Sarkar** TCD	Using citizen science to understand a difficult to study species: the Portuguese man o' war (Physalia physalis) **J. L. Headlam** NUIG	Smart Meters, Smart Choice? **Christine Gaffney** UCC	Comparative life cycle assessment of alternative feed in Irish rainbow trout (Oncorhynchus mykiss) production **Ronan Cooney** NUIG
12.30 - 12.45	The impact of UV-B radiation on Pacific oyster (Crassostrea gigas) health system **Gary Kett** UCC	Using Innovative Remote sensing techniques to monitor the treatment of Invasive Alien Species **Eithne Davis** IT Sligo	Upscaling Energy Management from Buildings to Districts' **Alan McGibney**	A methodology for water risk management in the Irish industrial sector **Shane Merritt** CIT and Central Solutions
12.45 - 13:00	European Best Practice for Inland Waterway Maintenance Dredging Works **Joe Harrington** CIT	Poster 1 Minute Oral Presentations **L Murana-Scoe EI1** **A Mateos-Cardenas EI2** **E O' Neill EI3** **F Cazer EI4** **C Quinn EI5**	Poster 1 Minute Oral Presentations **B Gunes EN3** **P McNama EN6** **S. O' Connor EN10**	Poster 1 Minute Oral Presentation **H Liu EM1** **R Nag EM3**
13.00 - 13.15	Macroalgal biodiscovery and culture optimization in Ireland: a case study of current research at NUI Galway **Marianela Zanolla** NUIG			
13.15	Poster 1 Minute Oral Presentations **C Suo MC2** **M Ihua MC3** **A Long MC4** **G Devarapu MC6**			

ENVIRON 2018 CONFERENCE PROGRAMME

	ORAL PRESENTATIONS SESSIONS TUESDAY MARCH 27TH 14.00 – 15.30			
	Water Quality & Resources 1	**Human Health**	**Sustainable Land Use & Agriculture 1**	**Environmental Policy & Communication**
14.00 - 14.15	Chair: **Dr. Liam McCarton** DIT Assessing the optimal calibration data frequency for the GOTM lake physical model **Tadhg Moore** DKIT	Chair: **Chris Finnegan** IT Carlow Effect of abiotic factors on selected microalgae strains for omega-3 PUFA production **Justine Aussant** NUIG	Chair: **Dr. Vesna Jaksic** Effect of Soil-setTM on entomopathogenic nematodes in the laboratory and on the growth of tomato plants in the greenhouse **Anusha Pulavarty** IT Carlow	Chair: **Leonard O' Driscall** Interventions to reduce or avoid the risk of human disease from contaminated private groundwater systems – A global meta-analysis **Simon Mooney**
14.15 - 14.30	The study of Asterionella dominated diatom bloom in the drinking water source reservoir, Ireland **Yunhong Shi**	**H**ospital effluent and municipal wastewater in Ireland: reservoirs for carbapenemase-producing *Enterobacteriaceae* **N Cahill NUIG**	Novel Antimicrobial for Treatment of Bovine Mastitis **Conor Larkin** NUIG	Sustainable Transition Pathways and the Role of Higher Education Institutions **William Horan** UL
14.30 - 14.45	Realising the True Value of Water in order to Arrive at a Sustainable Future **Brendan Walsh** CIT	Recreational water consistently contaminated with carbapenemase-producing *Enterobacteriaceae*, Ireland, 2016-2017 **B Mahon** NUIG	International Association for Plant Biotechnology – Being hosted in Ireland for the first time in August 2018 **Barbara Doyle** UCC	NUI Galway Sustainability Strategy 2017-2020 LEARN LIVE LEAD **M. O'Dowd Lohan** NUIG
14.45 - 15.00	Source and pathways of microplastics to freshwater and the environmental consequences **Linda Heerey** UCD	Use of whole genome sequencing to characterise and compare ESBL producing-E. coli isolated from recreational water and sewage **B Mahon** NUIG	Eucalyptus survival, growth rates and potential impacts on hydrology and nutrient cycles in blanket peat catchments **Mark O' Connor** TCD	Applied socio-hydro(geo)logy: Model-based survey on health-related flood risk perception amongst groundwater-reliant Irish population **Luisa Andrade** UCD

ENVIRON 2018 CONFERENCE PROGRAMME

	ORAL PRESENTATIONS SESSIONS TUESDAY MARCH 27TH 14.00 – 15.30 *Cont.*			
	Water Quality & Resources 1	**Human Health**	**Sustainable Land Use & Agriculture 1**	**Environmental Policy & Communication**
15.00 - 15.15	Quantitative assessment of human exposure to antibiotic-resistant bacteria **E. O' Flaherty** UCD	Novel Antimicrobial for the Control of Dental Plaque **Martin Gordon** NUIG	National extent of cattle exclusion from watercourses **Paul Kilgarriff** Teagasc	Systematic approach for rural community contributions to low carbon transitioning **Susan Byrne** UL
15.15 - 15.30	Assessing the impacts of cattle access to watercourses on water and sediment faecal contamination in farmland streams **Patrícia Antunes** DKIT	Environmental pollution with antibiotics and resistant microbial species from the agricultural and veterinary sectors **Elaine Meade** IT Sligo		Development of a web based decision support aid to facilitate sustainable urban communities in Ireland **Anne Bennett** UL
15.30 - 15.45		Poster 1 Minute Oral Presentations **C Allen HH1** **M Ryan HH2**		To eco-effectiveness (and beyond)? Sustainability reporting in different types of organisation **Aideen O' Dochartaigh** UCD

ENVIRON 2018 CONFERENCE PROGRAMME

	ORAL PRESENTATIONS SESSIONS TUESDAY MARCH 27TH 16.15 – 17.15			
	Water Quality & Resources 2	**Biodiversity & Ecosystems**	**Sustainable Land Use & Agriculture 2**	**Nanotechnology & the Environment**
16.15 - 16.30	Chair: **Kevin Fitzgibbon** Sustainable production of protein-rich Lemna minor on aquaculture wastewater - Preliminary experiments in an Irish perch farm **Simona Paolacci** UCC	Chair: **Dorothy Stewart** EPA Biodiversity Citizen Science and Irish National Parks **Orla Ní Dhúill** DCU	Chair: **Dr. John Gallagher** TCD Identifying critical source areas of soil phosphorus losses for over 500 farms in the Upper Bann catchment using LiDAR DEMs and big data **IA Thomas** Agri-Food & BioSciences Institute	Chair: **Dr. Garrett O' Sullivan** Activated charcoal as a capture material for silver nanoparticles in environmental samples **E. McGillicuddy** NUIG
16.30 - 16.45	Assessing the efficiency of treatment of alkaline bauxite residue leachate using a constructed wetland **G. O' Connor** UL	Factors driving Syrphid abundance, diversity, and community composition in arable cropping systems **Sarah Gabel** TCD	Rhizobacterial Volatile Organic Compounds from Irish Potato Soils Display Potential as Fungal Pathogen Growth-Inhibitors and Plant Growth-Promoters **Darren Heenan Daly** UCC	Estimating aggregation potential of PVP coated silver nanoparticles to surrogate colloid under environmentally relevant water conditions **David Shevlin** UCD
16.45 - 17.00	Water Reuse in the Context of the Circular Economy in Ireland **Eoin Byrne** CIT WSSIC	Modelling species use and functional connectivity of Greenway corridors to enhance their biodiversity corridor function **Julien Carlier** IT Sligo	Effect of silage harvest date and fertilizer rate on modelled N2O and total greenhouse gas emissions from pasture based suckler beef systems **J Herron** Teagasc	

ENVIRON 2018 CONFERENCE PROGRAMME

	ORAL PRESENTATIONS SESSIONS TUESDAY MARCH 27TH 16.15 – 17.15 *Cont.*			
	Water Quality & Resources 2	**Biodiversity & Ecosystems**	**Sustainable Land Use & Agriculture 2**	**Nanotechnology & the Environment**
17.00 - 17.15	Poster 1 Minute Oral Presentation **J O'Connor WQ3** **O Akinsanmi WQ5**	CPoster 1 Minute Oral Presentation **T Gorman BE5**	CPoster 1 Minute Oral Presentation **G Smith SL2** **C Griffin SL4** **T Hochstrasser SL7** **M P Logakrishnan SL8** **S Ruas SL13**	

ENVIRON 2018 CONFERENCE PROGRAMME

	ORAL PRESENTATIONS SESSIONS WEDNESDAY MARCH 28TH 10.00 – 11.00			
	Waste Management 1	**Air Quality & Urban Development 1**	**Sustainable Infrastructure**	**Smart Technology for the Environment**
10.00 - 10.15	Chair: **Dr. Niamh Power**	Chair Address: **Dr Micheal Fogarty** Katestone Environmental	Chair: **Dr. Mary Moloney**	Chair: **Kieran Ruane**
	Waterboards on the way to recycle phosphorus **Marie-Edith Ploteau** Emschergenossenschaft/ Lippeverband, Germany	The use of appropriate dispersion modelling techniques and representative meteorological data for the assessment of odour nuisance at the planning stage of developments in Ireland	The Renewable Engine Project: Supporting Research and Innovation Action in the Renewable Energy Sector **Ehiaze Ehimen** IT Sligo	Development of a lab-on-chip electrochemical immunosensor for detection of Polycyclic Aromatic Hydrocarbons (PAH) in environmental water **Shifa Felemban** Tyndall Institute
10.15 - 10.30	Biosorbents produced from waste crab carapace, oyster and mussel shell: Potential for phosphate removal and recovery from wastewater **Sabolc Pap** University of the Isles & Highlands, Scotland	Source Apportionment of Ambient Fine Particulate Matter (PM2.5) in the Greater Dublin Area: A Focus on Emissions from Diesel Vehicles **Meabh Gallagher** TCD	Reframing Nature-based Solutions **Cian White** TCD	Separation of Organophosphate Nerve Agents by Capillary Electrophoresis and Microchip Capillary Electrophoresis **Xi Cao** Tyndall Institute
10.30 - 10.45	Phos4You - Chlamydomonas acidophila as an alternative for Phosphorous recovery from wastewater **Lena-Dorothea Reichelt** Glasgow Caledonian University	AmmoniaN2K: Assessing the impact of ammonia emissions from poultry production in Ireland **David Kelleghan** UCD	Identification and Mapping of Water-related Infrastructure in Ireland **Eoin Byrne** CIT WSSIC	A promising process to increase P recovery as mineral fertilizer from sewage sludge by bio-acidification **M Saoudi** Irstea, France

ENVIRON 2018 CONFERENCE PROGRAMME

	ORAL PRESENTATIONS SESSIONS **WEDNESDAY MARCH 28TH 10.00 – 11.00 *Cont.***			
	Waste Management 1	**Air Quality & Urban Development 1**	**Sustainable Infrastructure**	**Smart Technology for the Environment**
10.45 - 11.00	Valorisation strategies for wastewater treatment sludge **L. Fraikin** University of Liege	Black Carbon in Ireland; Have we progressed from "the Dark Ages"? **Paul Buckley** UCC	Poster 1 Minute Oral Presentation **C Farrell SI2**	Associations between mutations responsible for Citrullinemia, Jersey Haplotype 1, Congenital Muscular Dystonia 1 and udder health in dairy cattle **David Flores** AIT
11.00				Poster 1 Minute Oral Presentation **A Lace ST1** **M Damaskou ST3**

ENVIRON 2018 CONFERENCE PROGRAMME

	ORAL PRESENTATIONS SESSIONS WEDNESDAY MARCH 28TH 11.45 – 12.45			
	Waste Management 2	**Air Quality & Urban Development 2**	**The Human Built Environment**	**Climate Chnage**
11.45 - 12.00	Chair: **Donal O' Dwyer** Cost assessment of different routes for phosphorus recovery from wastewater using data from pilot and production plants **A. Nättorp** FNHW Switzerland	Chair: **Dr Micheal Fogarty** Katestone Environmental Assessing the impact of emissions from diesel vehicles on air quality by using micro-simulation studies **Bidroha Basu** TCD	Chair: **Brian O' Rourke** Sponsored by the Cement Manufacturing Industry (CMI) CMI Video Presentations	Chair Address: **Dr Conor Sweeney** UCD Earth Institute Developing a Collective Vision for Community Led Energy Transition **Rosemary Byrne** UL
12.00 - 12.15	Biomethane potential assays to maximise biogas productivity by co-digestion of Grass silage (GS) and Chicken litter (CL) **Navodita Bhatnagar** IT Carlow	AmmoniaN2K: Monitoring ambient ammonia concentrations on Natura 2000 sites in Ireland **Padraig Keating** UCD	Institutional properties in Cork county borough **Garrett O' Sullivan** CIT	Social Acceptance of Renewable Energy: Exploring a Citizen Centric Paradigm **Paul O' Brien** CIT
12.15 - 12.30	Food Waste in the Irish Commercial Food Industry **Sarah Broderick** CIT	Poster 1 Minute Oral Presentation **M Fennelly AQ1** **L Hung AQ2**	A comparative analysis of simulated and measured overheating patterns in an NZEB dwelling using Passivhaus standard protocols **Evan Finnegan** CIT	The potential and limitations of negative emissions technologies at a small nation scale **Alwynne McGeever** TCD

ENVIRON 2018 CONFERENCE PROGRAMME

	ORAL PRESENTATIONS SESSIONS WEDNESDAY MARCH 28TH 11.45 – 12.45 *Cont.*			
	Waste Management 2	**Air Quality & Urban Development 2**	**The Human Built Environment**	**Climate Chnage**
12.30 - 12.45	Poster 1 Minute Oral Presentation **A Fricke** WM1 **E Walsh** WM2		Social Sustainability in the management of Irish construction projects **Kevin Coleman** CIT	Estimating National Carbon Quotas and Modelling Compatible Emission Pathways at a Small Nation Scale **Paul Price** TCD
12.45 - 13.00			Catering for the human (user) experience within the built environment in the age of information technology **Aoife Hayes** Arup/CIT	ECCO Creating new Energy Community COoperations – An overview **Gerard Kelly** CIT
13.00 - 13.15			Co-Design for Energy Efficient Buildings **Rosemarie MacSweeney** UCC	

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ORAL PRESENTATION ABSTRACTS

Marine & Coastal

The application of satellite-borne remote sensors for monitoring coastal erosion and ecosystems in Ireland.

Daithí Maguire, National University of Ireland Galway, Email: d.maguire11@nuigalway.ie

Eugene Farrell, National University of Ireland Galway, Email: eugene.farrell@nuigalway.ie

Advances in the resolution and availability of imagery from satellite-borne remote sensors provide an opportunity to utilise the data for near real-time monitoring of coastal erosion and ecosystems. This research project focuses on developing a technique for measuring changes in coastal geomorphology and vegetation cover using a combination of EO synthetic aperture radar and multispectral imagery.

The technique is being developed, tested and refined using data collected from two study sites on the west coast of Ireland (County Kerry & County Mayo). Extracted shoreline positions are validated using orthorectified aerial photography archives, LiDAR imagery and repeat field survey data. Time series analyses are used to determine localised erosion rates and forecasting techniques will be utilised to produce predicted shoreline positions for years 2020, 2030 and 2050. These results will be benchmarked against equivalent shoreline predictions published in the Irish Coastal Protection Strategy Study (OPW, 2013).

The imagery will be used to generate vegetation maps for the purposes of monitoring the ecological status of coastal habitats (with respect to the EU Habitats Directive) as well as identifying and delineating areas of invasive vegetation species such as sea-buckthorn (Hippophae rhamnoides) and Chilean-rhubarb (Gunnera tinctoria).

The results will be of wider interest to coastal ecologists, geomorphologists, managers, and engineers involved in coastal research and conservation. In particular, the research can inform coastal management strategies for coping with the increased storminess predicted by future scenarios described in many climate models.

Marine & Coastal

Are Microplastics Disrupting the Biological Pump?

A.M. Wieczorek1, 2, F. Lombard3 , P.L. Croot1, Sheahan, J.4, Madin, L.P.5, and T.K. Doyle 2, 6
[1]Earth and Ocean Sciences, School of Natural Sciences, National University of Ireland Galway, Ireland
[2]Zoology, School of Natural Sciences, National University of Ireland Galway, Ireland
[3]Observatoire Océanographique de Villefranche, Villefranche sur Mer, France
[4]School of Mathematics Statistics & Applied Mathematics, National University of Ireland Galway, Ireland
[5]Woods Hole Oceanographic Institution, Woods Hole, MA, United States
[6]School of Biological, Earth and Environmental Sciences, Environmental Research Institute, University College Cork, Ireland

Corresponding author email address: A.Wieczorek1@nuigalway.ie

Microplastics are a ubiquitous pollutant that have been found in all marine environments, including the Antarctica and on remote beaches of Pacific islands (Barnes et al., 2009). Research over the past few decades has clearly demonstrated that the ingestion of microplastics is known to cause physical harm to marine organisms (Lusher, 2015). However, few studies have investigated how microplastics may impact ecosystem processes (Wright et al., 2013; Cole et al., 2016). Here we investigate the impact of microplastic ingestion by salps and its potential effect on the biological pump. Salps are pelagic jellyfish-like organisms which feed on phytoplankton and are responsible for a significant amount of carbon sequestration to the ocean floor due to the uniquely fast sinking rates of their dense faecal pellets (Bruland & Silver, 1981). The alteration of these sinking rates, when exposed to different types and concentrations of environmentally relevant microplastics, was investigated via feeding trials on Salpa fusiformis sampled at the Ocean Observatory in Villefranche sur Mer during March of 2017. Our results show that faecal pellet sinking rates decreased by an average of 2-fold when microplastics were incorporated in the faecal pellets. This decrease in sinking rates may slow down the carbon flux to the ocean floor and cause some faecal pellets to be recycled in the surface waters and captured carbon to be re-released in the form or CO2. Thus, our findings demonstrate that microplastics are a potential threat to the functioning of the biological pump and may enhance global warming.

Keywords: Microplastics, Salps, Biological Pump, Carbon Transport, Microbial Loop

Marine & Coastal

Trends and Variability in sea water level along the coastline of Ireland: A comparative study.

Arunima Sarkar[1], Bidroha Basu[2], Laurence Gill[2]
[1]School of Natural Sciences, Trinity College, Dublin, Ireland.
[2]Dept of Civil, Structural & Environmental Engineering, Trinity College, Dublin, Ireland.

Corresponding Author Email Address: sarkara@tcd.ie

Coastlines are obviously vulnerable to changes in sea level rise. The primary cause of sea level rise is linked to global climate warming, attributed to the release of greenhouse gases in the atmosphere by climate scientists. The noticeable impact of climate change has resulted in melting of polar ice which has resulted in raising sea level. Furthermore, it has been observed that global warming of 2°C will result in 20 cm of global ocean rise. Such a sea level rise over the next few decades will result in inundation of coastlines and shorelines. Although the potential impact of sea level rise may vary from region to region, the changes caused by impact of water level fluctuations can have devastating consequences on the population dynamics of coastal ecosystems as a result in loss of habitat, in addition to the impacts resulting inform more frequent extreme weather events such as Tsunamis, hurricanes, floods etc. This research has investigated changes in sea level over the last two decades along the coastline of Ireland by performing moving-average trend analysis using data obtained from Irish tidal gauges. The changes in trend at temporal scale for different gauges were extrapolated by using spatial interpolation along the coastline of Ireland. The analysis of sea level has been able to identify the significant variations in sea water level surge in various regions in Ireland, both on a spatial and temporal scale. Furthermore, water level variations along the coastline have been analysed with respect to the cause of the variations and the surge occurring in the regions and its impact. The statistical trends and variability in sea level rise obtained in spatio-temporal scale across Ireland enable us to perform further investigation on its causal factors. These changes and it quantification will allow future projection of sea level rise across Ireland to make predictions of future risks and vulnerabilities.

Keywords: sea level rise, Ireland coastline, climate change.

Marine & Coastal

The impact of UV-B radiation on Pacific oyster *(Crassostrea gigas)* health.

Gary Kett
Sharon Lynch, Sarah Culloty
School of Biological, Earth & Environmental Sciences, and Aquaculture & Fisheries Development Centre, Environmental Research Institute, University College Cork, Ireland.

Corresponding Author Email Address: gary.kett@ucc.ie

Increased levels of ultraviolet radiation of wavelength 280-320 (UV-B) have been observed at Earths surface, due to depletion of the ozone layer from increased levels of greenhouse gas emissions. UV-B negatively interacts with macromolecules such as proteins, DNA and cellular structures and so can lead to adverse animal health on cellular, individual and population levels. This study looked at the impact of increasing UV-B levels in a changing climate on the health of an intertidal organism the Pacific oyster. The Pacific oyster (Crassostrea gigas) is an intertidal bivalve mollusc which plays a vital role in both the Irish and global aquaculture industry. C. gigas aquaculture in Ireland was worth €41 million in revenue in 2017 and employs over 800 people. Mass mortalities of oysters have been recorded in summer months throughout Europe which have been linked to viral and bacterial infections as well as increased temperatures, water quality and cultivation practices. Exposure to UV-B is highest during the summer months and the effect of this stress on oysters has not been thoroughly investigated. In this study, three laboratory trials were carried out in which juvenile and seed oysters were exposed to different doses of UV-B radiation administered through custom UV-B bulbs. Oysters were exposed to UV-B for three days and recovery was monitored for six consecutive days. Pathogens were screened using molecular techniques and the physiological response of the animals to the exposure was measured. Preliminary results show a notable physiological response from groups of oysters exposed to UV-B radiation when compared to control groups indicating that increased exposure may impact negative on aquatic animal health.

Marine & Coastal

European Best Practice for Inland Waterway Maintenance Dredging Works.

Joe Harrington[1]
[1]School of Building & Civil Engineering and Sustainable Infrastructure Research & Innovation Group, Cork Institute of Technology

Corresponding Author Email Address: joe.harrington@cit.ie

The maintenance of waterways by dredging is essential for many inland waterways for a range of reasons including ensuring navigable access and providing flood relief. This maintenance dredging may be required on a frequent and regular basis or may be required on a more infrequent and intermittent basis.
This research paper, based on work undertaken for the Environmental Protection Agency and the Office of Public Works, presents a review of best practice maintenance works across a range of European countries including England, Scotland, Northern Ireland, The Netherlands and Germany. It presents the general context within and the extent to which maintenance dredging works is undertaken for each country and identifies the authorities with responsibility for managing and licensing such works.
The paper outlines the relevant policies and legislative approaches applied for each country and presents the permissions required including management considerations, nationally designated sites and habitats and screening and appropriate assessment measures implemented.
Current best practice for each country in the context of river maintenance guidelines and standards, sediment management and strategies including waste exemptions and river maintenance operational matters is also presented.

Keywords: Inland Waterways, Maintenance Dredging, Policy, Sediment Management

Marine & Coastal

Macroalgal biodiscovery and culture optimization in Ireland: a case study of current research at NUI Galway.

Marianela Zanolla[1] (marianela.zanolla@nuigalway.ie) & Dagmar Stengel[1] (dagmar.stengel@nuigalway.ie)

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Biodiscovery of marine metabolites with potential use in industry is growing exponentially due to the development of novel analytical techniques. Within the marine realm, seaweeds produce a plethora of bioactive compounds (more than 3,300 already characterized), with applications ranging from food to pharmaceutical industries as well as agriculture. However, the use of seaweeds as a source of bioactive compounds still faces the handicap of a limited supply of biomass with stable chemical composition, which diminish their potential for industry application. Biomass from natural seaweed populations presents seasonal and geographical variation in metabolite quality and quantity and, additionally the harvesting of natural populations of seaweeds may not be environmentally sustainable. These handicaps will be overcome by in-depth studies of targeted species, uncovering optimal culture conditions for specific metabolite production and by developing environmentally friendly and low-cost technologies of biomass production to provide a stable product. We will present preliminary results of an ongoing sampling strategy aiming to reveal geographical and seasonal variation of several red algal species proven to produce interesting bioactive compounds and present our efforts in seaweed culture optimization carried out at NUI Galway. This work focuses on the red algal genus Asparagopsis which produces secondary metabolites active against bacteria, viruses, protozoans and even with potential to reduce methanogenesis in livestock. We provide data on the effect of several environmental parameters in the production of valuable compounds in Asparagopsis armata, and preliminary results, at pilot scale, of biomass production. Results are discussed in light of its actual exploitation state worldwide and its feasibility as a source of compounds in Ireland.

Keywords: Asparagopsis, bioactive compounds, biodiscovery, cultures, culture optimization, Ireland, seaweeds, sustainable resources.

Ecotoxicology & Invasive Species

Investigation of Carbamazepine and Ibuprofen toxicological effects on algae by multifactorial analysis.

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Micro-pollutants are a massive and escalating range of anthropogenic or natural substances, including pharmaceuticals residues (PR), personal care products, steroid hormones, industrial chemicals, pesticides and many other compounds. Discharging these products into aquatic environments, in particular PR, leads to serious concerns due to their possible effects on living organisms. Two algae, Chlorella vulgaris and Raphidocelis subcapitata, were selected for this study due to their natural abundance in UK water sources and extensive application in aquatic toxicology research. Carbamazepine and Ibuprofen were chosen based on their occurrence in domestic wastewaters and persistency in biological treatment processes. These were tested at concentrations ranging from 1/8th representative environmental concentration (EC) to 4x EC over 96hr exposure.

A multi-factor analysis was conducted taking into consideration cell size, photosynthetic capacity as well as growth rate. Data obtained was combined into a simplified single entity: "the effect index". This approach enabled the quantification and practical visualization of the effects associated to the presence of the selected drugs. It was observed that Carbamazepine induced stimulation of approximately 20%, after 48 hours exposure, with Chlorella and exactly the opposite effect with Raphidocelis in the first 24 hours. Ibuprofen caused a 20% inhibition of Chlorella after 96 hour experiment; while Raphidocelis was stimulated by around 40% after 24 hours however after 96 hours the effect was lost and neither stimulation nor inhibition can be observed.

Overall, by utilisation of the effect index approach both acute and chronic effects were observed after exposure to the selected pharmaceuticals. Also combining effects can aid the understanding of the potential environmental response to repeated exposure to pharmaceuticals.

Ecotoxicology & Invasive Species

Filter-feeding invertebrates as drivers of the conjugative transfer of antimicrobial resistance in Enterococcus faecalis in aquatic environments.

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The increased frequency of emerging multi resistance among nosocomial pathogens has triggered a search for potential environmental sources for such organisms and feedback routes into human society. As conduits for antimicrobial residues and antimicrobial resistant bacteria, aquatic environments are likely hotspots for horizontal transfer of antimicrobial resistance. Biofiltration by aquatic invertebrates may enhance bacterial aggregation and horizontal gene transfer but its contribution to the ecological evolution of antimicrobial resistance remains unknown. Therefore, this research investigated the propensity of two groups of filter-feeders, the benthic freshwater sponge and Daphnia, as zooplankton organisms to facilitate the transfer of vancomycin resistance between a vancomycin-resistant donor strain and a rifampicin-resistant recipient strain of Enterococcus faecalis. Microcosm experiments exposed filter-feeders to donor and recipient E. faecalis strains, and transconjugants were detected on double selection agar plates. Treatments with laboratory-grown sponges had significantly higher transconjugant numbers than the control. However, transconjugant numbers from treatments using live sponges and dead sponges were not significantly different. Selective staining confirmed the presence of E. faecalis clusters in the sponge cell matrix. In experiments with two Daphnia species, donor and recipient E. faecalis strains were first fed simultaneously to Daphnia, followed by a phase of gut evacuation by feeding on the recipient strain only. There was no significant difference between transconjugant numbers obtained from the feeding phase and the gut evacuation phase. Experimental results demonstrated that aquatic invertebrates can facilitate the emergence of multi resistant bacteria through different processes. The recovery of transconjugants in Daphnia trails after gut evacuation appears to be the first direct evidence in support of the theoretical concept that filter-feeding can facilitate horizontal resistance transfer in aquatic environments.

Keywords: Antibiotic resistance, antibiotic resistance transfer, enterococci, biofiltration, filter feeders, porifera, Daphnia

Ecotoxicology & Invasive Species

Oral Presentations Session
Tuesday March 27th 11.30 – 1.00

Cold as Ice: a novel eradication and control method for invasive Asian clam, Corbicula fluminea, using pelleted dry ice.

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Since its first detection on the in April 2010, the Asian clam, Corbicula fluminea, (Müller, 1774), a high impact freshwater invader, has been confirmed present at seven sites across the Island of Ireland. Globally, despite repeated efforts to mitigate spread and implement substantial population control measures, C. fluminea continues to invade and disperse. Accordingly, effective population eradication and control measures are urgently required. In a series of five experiments, we examined the efficacy of commercially available dry ice (DI) pellets (i.e. solid CO2 pellets at -78 °C) to kill C. fluminea, when both directly (water absent) or indirectly applied (clams submerged).
Experiment 1 revealed the ability of 9 mm DI pellets to induce substantial C. fluminea mortality, with a direct application of 300 g DI at 5 min exposure inducing 100% clam mortality. While experiments 2 and 3, have shown that 9 mm DI pellets induced higher clam mortality than 3 mm pellets, DI slices and mixed DI pellet sizes (3 and 9 mm) at simulated clam densities of 1179 and/or 3930 individuals m-2, especially when clams were submerged. Experiments 4 and 5 showed that DI application was highly effective even with clams that were covered in gravel or mud, due to the freezing of their surrounding substrate. Accordingly, these results demonstrate that DI can potentially be used for effective, rapid response control and eradication of C. fluminea populations. Whilst promising, our laboratory results require scaling up to field application and examination of the effects of water current, substrate, increased water depth, and greater C. fluminea population densities.

Keywords: invasive alien species, biosecurity, dry ice, thermal shock, population control, eradication.

Ecotoxicology & Invasive Species

Using citizen science to understand a difficult to study species: the Portuguese man o' war (Physalia physalis).

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Some animals are more difficult to study than others. This may be due to their rarity, having unpredictable mass emergences or being located in difficult to access environments. The Portuguese man o' war (Physalia physalis) is a siphonophore that has an above-water float (pneumatophore) and various below-water feeding and reproductive structures used for capturing prey. Importantly, these structures include very long stinging tentacles that make this animal so well-known and feared. Records of its occurrence across the Atlantic are sporadic and are typically related to large numbers washing up on popular bathing beaches. Due to its oceanic distribution and unpredictable nature of its mass occurrences, collecting valuable natural history data for this species has proven difficult. Here we used citizen science to document the mass occurrence of Portuguese man o' war (Physalia physalis) strandings over a two year period (2016 and 2017) in Irish waters. We used two separate digital platforms (a social media page and a national biodiversity citizen science portal) to solicit reports of sightings or strandings of Physalia. In total, over 3000 individual Physalia records were collected, from 191 beaches, from a total of 217 unique observers. The data collected captured the first strandings of the siphonophores and the subsequent rise in strandings and peak stranding. Comparison of the two digital platforms revealed that much more information could be collated from the biodiversity citizen science platform (i.e. more detailed information), however, the social media platform could engage much more rapidly with the observers and directly request additional information. In summary, this study illustrates how citizen science platforms are transforming the way in which we can capture information on unusual and difficult to study species.

Keywords: Citizen Science; Digital platforms; Jellyfish stranding; Social media; Physalia

Ecotoxicology & Invasive Species

Using Innovative Remote Sensing Techniques to Monitor the Treatment of Invasive Alien Species.

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Biodiversity worldwide is under threat from the impacts of Invasive Alien Species (IAS). This series of experiments, focuses on the treatment of a single problematic species, Petasites fragrans (Winter heliotrope), about which relatively little is known. Our aim is to inform best practice guidelines both for public bodies who require efficient, cost-effective, wide-scale management techniques, and private individuals who wish to engage in smaller-scale, domestic management of this plant.

Petasites fragrans is an invasive terrestrial plant which is becoming increasingly common on our roadsides and verges. A dioecious perennial, the plants found in Ireland are exclusively male, and therefore the plant spreads by vegetative means only. It is notoriously difficult, if not impossible, to eradicate. It has an unusual biology, with its' principal growth season occurring between October and March. This gives it a strong competitive advantage over native flora when the principal growing season begins in spring. The objectives are:

1. To identify the most appropriate treatment methods and their timing for maximum impact, thus minimizing the quantity of herbicides released into the environment.
2. To explore the value of using digital imagery and existing, open-source software in an innovative way to analyse the results of ecological experiments.

Our experiments used carefully controlled treatment plots. The individual plots were monitored using both traditional methods of numerical data collection, as well as state-of-the-art imaging techniquesA pilot project was undertaken to test the methods developed, and this was completed in 2016.

This presentation outlines the results so far, which show that readily-available herbicides, used correctly, can impact the growth and spread of P. fragrans. We describe the process by which the pilot project was monitored and analysed, and the usefulness of digital images and open-source, freely-available software in monitoring ecological experiments.

Keywords: Remote sensing, Ecological management, IAS, Biodiversity, Biosecurity Energy

Energy

Sustainable Energy Authority of Ireland (SEAI) – An overview of research supports and case studies of SEAI supported research from 2007–2017.

Lucy Corcoran, Ph.D; Phil Hemmingway, Ph.D.

SEAI is Ireland's national sustainable energy authority, investing in and delivering appropriate, effective and sustainable solutions to help Irelands transition to a clean energy future. SEAI also funds a range of research, development and demonstration (RD&D) activities relating to the production, supply and use of energy. SEAI's remit is to lead and support excellent research, development, demonstration & innovation activities, to be at the forefront of knowledge generation relevant to the energy sector, and to promote its application in policy and practice. SEAI also support the participation of Ireland-based researchers in Horizon 2020 and other international activities (e.g. IEA activities, ERA-NETs).

Climate change is the most significant threat faced by our world today. Critical to meeting Ireland's legally binding energy and carbon emissions targets are innovative market, policy and technical solutions that will reduce our carbon emissions and support a thriving and efficient clean energy sector. The SEAI RD&D Fund supports innovative and targeted actions to assist in the delivery of the following policies and plans: National Energy Efficiency Action Plan (NEEAP); National Renewable Energy Action Plan (NREAP); The 2015 Energy White Paper and the National Mitigation Plan.

This paper presents details of a research impact analysis of research undertaken and supported through the SEAI RD&D Programme over the 10-year period 2007-2016. Analysing the impact of a suite of RD&D projects involving differing technologies and organisations, required a combination of methods. Methods employed in this impact analysis were: (i) Collection and collation of internal SEAI project data; (ii) Design of a Research Impact Survey; (iii) Collection of Survey Responses; (iv) Analysis of Survey Feedback and (v) Case Studies of Selected Projects. The SEAI RD&D Programme began in 2002 and currently has an annual budget of €2.5m with plans to significantly increase activity levels and the amount of impact generated by the Programme in the coming years.

Energy

Interlocked electrodes (ILE) for breaking the limit of cathode specific surface area in microbial fuel cells (MFCs).

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Cathode specific surface area (CSSA) is the critical limit for MFCs development. The invention of graphite fiber brush (GFB) is a breakthrough for the anode. However, GFB could significantly limit the increase of CSSA since the cathode can only separate or surround to the GFB anode and it is almost impossible to form a compact structure, such as sandwiched electrodes. Hence, the interlocked electrodes (ILE) configuration with different CSSA (41-509 m2/m3) were developed here to form a novel impact configuration and break through this limit. The maximum power density was improved from 23 ± 2 W/m3 to 46 ± 1 W/m3 when the configuration was changed to ILE. Significant improvement (increased by 248%) was also obtained when the CSSA increased to 219 m2/m3. However, a sharp decrease appeared when the CSSA was further increased to 509 m2/m3. The combined increases of occupied space in anode and CSSA led to this change. COD removal rate showed good agreement with first-order degradation kinetic regardless of CSSA differences. However, MFCs with larger CSSA obtained higher rate constant (-0.0807 h-1 for 41 m2/m3, -0.3152 h-1 for 509 m2/m3) and significant advantage for rapid organic matters removal. The MFC with low CSSA (41 m2/m3) demonstrated a very high stability at a long-term operation (over 2230 h). Due to oxygen crossover, the power of MFCs with high CSSA (104-509 m2/m3) showed a reversible change. Based on these results, large MFCs (0.3 Liter) with full ILE configuration were built to treat dairy wastewater. Compared with all MFCs' studies with dairy WW, the ILE-MFCs produced relatively high current and power. More importantly, the highest coulombic efficiency (CE, around 40%) was achieved by the ILE-MFCs. This study demonstrates the great potential of ILE configuration for simplifying MFC structure, increasing CSSA and improving power performance simultaneously.

Energy

Developing Principles for a Fair and Inclusive Energy Transition in Europe: Results from an Interdisciplinary Delphi-Panel of Academic Experts.

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The future of the energy system in Europe is guided by the motivation to transition away from fossil-based energy sources. However, there is a large degree of uncertainty concerning the social and political structure of a low carbon energy system. In particular in terms of the management of energy as a public good on which people's welfare and livelihoods depend on. Developing a set of expert validated principles helps establish critical standards, which will ensure that energy transition evolves in consonance with adequate systems of governance that are underscored by a concern to promote fairness and inclusion. The aim of this paper is to establish a set of core principles for a fair and inclusive energy transition that will contribute to future energy and sustainability transition strategies. A modified Delphi-panel technique was used to assess the applicability and refine the content of an initial list of drafted principles, which were based on public consultation analysis from six communities across Europe. The use of the Delphi-panel in this context is highly valuable as the process of inquiry that it enables promotes a process of consensus amongst the research participants by means of feedback loops and iterative knowledge development. The Delphi-panel consisted of two anonymised online surveys. From this two-stage process a final iteration of the principles was compiled. Results from the Delphi-panel offer a set of standards that have been validated by the inputs and comments of a panel of interdisciplinary expert academics with a diversified and extensive knowledge of this field. This work helps promote consensus around core social and political dimensions in energy system change. The interdisciplinary range of the comments offered in the Delphi-panel further confirms the significance of these principles with additional recommendations presented to implement adequately these guidelines into policy.

Keywords: Energy transition, Delphi-Panel, Europe, Fairness, Inclusion

Energy

Smart Meters, Smart Choice?

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The EU is committed to a mandatory roll-out of smart meters across Member States with the requirement that 'intelligent metering' is installed in 80% of homes by 2020. The Irish government has announced that the roll-out of smart meters nationally will begin in 2019 with the goal to eventually install them in 2.3 million residences and businesses across the country.

ENTRUST is an interdisciplinary research project exploring the human factor in the energy system. Our team is looking at how people interact with the energy system, and how our everyday practices around energy are shaped by both technical and socio-demographic factors, including in particular: age, gender, and socio-economic privilege.

We are working in six varied communities in five different European countries: an Irish rural community; a diverse urban community in a large Spanish city; a cohort of university students; residents of an eco-neighbourhood in a major French city; a disadvantaged suburban neighbourhood in the UK; and the residents of an Italian port town. These communities provide a diverse range of socio-demographic characteristics, life experiences, and policy contexts.

Delivering an intersectional analysis of the smart metering project, this paper draws on the dialogues with participants from our communities of practice to explore the proposed roll-out of smart meters across Europe, including the roll-out plan for Ireland. Comparing and contrasting the findings from our community dialogues with the research undertaken by CER in Ireland, the paper will explore the rationale for both the undertaking and the consultation process of the smart metering project; and will identify potential pitfalls and unanticipated problems, as well as the unintended consequences.

Keywords: sustainable energy transition, smart meters, energy practices, socio-demographics, gender, intersectionality, participatory research, public consultation, community engagement.

Energy

Oral Presentations Session
Tuesday March 27th 11.30 – 1.00

Upscaling Energy Management from Buildings to Districts.

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EU and National directives demand continuous progress towards our 2020-2030 energy and emissions targets, making energy management a critical concern for building-owners. Consequently, the management of energy is evolving rapidly, becoming more decentralised to reduce the dependency on central grids while leveraging local renewable generation to achieve efficiencies, driving a need to move beyond individual buildings towards district level approaches that can collectively manage blocks of buildings, providing increased flexibility, energy and cost savings.

Significant advances have been made in building related ICT systems and the Internet of Things (IoT), which are expected to play a major enabling role in continuing to increase efficiencies and flexibility in smart energy grids, while enhancing comfort for building occupants. Complexities associated with the integration, operation and management of heterogeneous energy systems remains a significant barrier in allowing buildings to become active participants in a wider district-level energy landscape. These challenges can be addressed by leveraging existing IoT architectures and Blockchain technology to eliminate vertical data silos, enable holistic management and verification of district level energy usage. This results in a platform that can:

- increase visibility and controllability of building systems/assets addressing energy efficiency and comfort via interaction with building stakeholders (occupants, managers, etc.)
- facilitate automated fault detection faults in distributed energy systems
- automate key performance indicator calculation through continuous auditing
- support advanced data driven modelling approaches to minimise the gap between predicted and actual energy usage
- support the deployment of smart contracts and independent verification of energy transactions using Blockchain.

The authors will present the TOPAs open-IoT platform, which provides a reference architecture for district level integration and the SmartBlocks energy service suite, developed to address the scalability of energy management at district level. This platform is currently being validated across three test sites in Ireland and France.

Keywords: Energy Management, Internet of Things, Blockchain, District Energy

Environmental Management

A water resources planning model for Dublin to assess impacts of socio-economic growth and climate change.

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This paper describes development, calibration and validation of an integrated water resources management model for the Dublin region. The model was built using the Water Evaluation and Planning software (WEAP21) by integrating water supply catchments, sectoral water uses, and water supply infrastructure in one model. The main water supply catchment, the Liffey and Dublin bay catchment, which accounts for approximately 85% of water supplies within the region, was divided into a number of contiguous sub-catchments. The rainfall-runoff modelling in each sub-catchment was driven by monthly climate time-series which allows simulating flows at abstraction points in the catchment. In terms of water uses, the model accounted for domestic and non-domestic water uses, hydropower generation, and ecosystem uses. Water demand for these uses in the model was satisfied from available water calculated by the rainfall-runoff modelling in the supply catchment. To quantify domestic and non-domestic water uses, the region was divided into water supply zones each of which was connected to a water source in the catchment. The model parameters were derived using several datasets including hydrology, climate, land-use, census, water uses and infrastructure. Following model parameterisation, the most sensitive parameters were determined and subsequently calibrated in order to obtain a satisfactory matching between the actual historical flows and corresponding modelled values during the simulation period. A number of goodness of fit statistics were used to assess the performance of the model in reproducing the actual flow values at select locations within the catchment. Results show that the model was able to reasonably estimate the regional water balance including natural and managed flows and water uses. The model can now be used to predict future behaviour of the water supply system of Dublin under different scenarios of population and industrial growth, climate change, land-use change, and changes in water policies and infrastructure.

Keywords: hydrology, water uses, water resources management, WEAP21

Environmental Management

A real-time alert system for predicting and managing short-term pollution and bathing water quality at Enniscrone beach.

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Under the Bathing Water Directive [2006/7/EC] there is a new highest microbiological quality classification of "Excellent" that is much more stringent than the highest classification of the old directive. This has serious implications for some beach resorts in Ireland as they may now struggle to attain the highest classification which is required to qualify for a "Blue Flag" eco label.
Enniscrone, a major sea-side resort in Co. Sligo has failed to attain this highest classification and has lost its "Blue Flag". The cause was a large flux of faecal indictor organisms (FIO) from an imputting river which grossly affected a compliance sample in 2014, and thus the current overall classification. These events are defined in the directive as predictable "short-term pollution" (STP).
The directive with its stronger focus on protecting public health encourages beach managers to be much more pro-active in managing bathing water quality. In Enniscrone's case, to attain "Excellent" status appropriate early-warning systems to predict and manage health hazards like STP must be established. The incentive for managers is that results from compliance samples taken during predicted STP can be disregarded from overall classification.
This study developed and ran real-time bathing water predictions for Enniscrone Beach for the 2016 and 2017 bathing seasons. This was achieved by installing automatic hydrometric monitoring stations in the river catchment to measure hydrograph events which were compared to FIO levels analysed in the bathing water. The hydrometric instrumentation was configured to predict STP events and automatically communicated real-time alerts to the author. The FIO results confirmed a 100% prediction rate for STP with no false positives or missed events. A further "now-casting" element can also be utilised.
This risk management method if employed immediately in an official capacity will help ensure that Enniscrone regains and retains a "Blue Flag" expeditiously.

Keywords: bathing water quality, pollution risk prediction, real-time alert

Environmental Management

Use of an acoustic camera for monitoring seaward spawning migrations of European eel *(Anguilla anguilla)* in Irish rivers.

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The European eel (Anguilla anguilla, L.), with its largely nocturnal activity and extensive trans-Atlantic migrations, has long attracted the attention of fishermen, naturalists and fisheries scientists. However, recruitment levels to freshwater eel populations and analyses of fisheries yield statistics show that the species has been declining throughout its range since the 1980's. Numerous anthropogenic and natural causes, which can operate in either the oceanic or continental phases of its life-history, have been linked to this decline. In accordance with a specific EU regulation (EC no 1100/2007), Ireland, like other EU member states, has implemented Eel Management Plans for its river basin districts, including trans-boundary river basins. Eel conservation measures adopted in the Republic of Ireland include: Closure of all eel fisheries; facilitation of upstream migration by juvenile eels; extensive eel surveys and mitigation of effects of hydropower on spawning migrations of adult eels. Since 2009 we have been monitoring downstream migration of eels on the Rivers Erne and Shannon, to estimate annual spawner biomass escapement. This has involved mark-recapture experiments at lower river experimental fishing sites and monitoring of conservation fishing undertaken to transport eels past hydropower dams. This "trap and transport" conservation measure presents good opportunities for analyses of the population biology of downstream migrating eels and for the development of new monitoring protocols. With a view to improving the annual monitoring, we have successfully developed a new eel survey method which involves use of an underwater acoustic camera (DIDSON ®). This allows direct observations of eels at night and in turbid water. Results obtained on the Rivers Erne and Shannon will be presented. The use of sonar technology for investigation of effects of regulated discharge on swimming behaviour of migrating eels in the vicinity of hydropower dams, will be illustrated. Likewise, more extensive use of this new approach for quantitative surveying of seaward migrating eels, that represent Ireland's contribution to the reproduction of European eel at their Sargasso Sea spawning area, will be recommended.

Keywords: European eel, Migrations, conservation, escapement, acoustic camera.

Environmental Management

Comparative life cycle assessment of alternative feed in Irish rainbow trout *(Oncorhynchus mykiss)* production

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Rainbow trout (Oncorhynchus mykiss Walbaum 1792) production is expected to increase in Ireland due to recent government expansion plans (Food Harvest 2025 & National Strategic Plan for Sustainable Aquaculture Development) and due to an increase in demand, locally and globally, for fish products by consumers. Aquaculture species are currently produced using feeds which comprise large amounts of fish meal and oil from capture fisheries (standard feed). This depletion of wild fisheries to feed farmed fishes remains one of the key obstacles in the pursuit of sustainable aquaculture. The dietary demands of carnivorous finfish has long meant that fish meal was the only viable source of protein for aquaculture. Recently meal from the reduction of insects such as the Black Solider Fly (Hermetia illucens) has been identified as a potential alternative to wild fish derived feeds. In life cycle assessment (LCA) studies of aquaculture, standard feed production has consistently dominated the impacts associated with aquaculture. A comparative LCA was carried out to assess which of the feeds, insect-based or standard, had a lower environmental impact on the life cycle of one tonne of farmed trout at the farm gate. This comparison also considered the environmental burden associated with feed production scenarios, where feeds manufactured in Ireland and Denmark were evaluated. Results from this study determined that standard feed produced in Ireland led to a reduced environmental burden when compared with Danish feed, 86.3-100% reduction across all impact categories. This was due to the reduced transportation distances involved with delivering feed to the farm studied. Conversely, insect derived meal produced and transported to Ireland was 66.2-100% lower than the Irish scenario. This reduction was due to the high use of renewable energy sources by Danish electricity producers. From an environmental perspective, where countries use large amounts of renewable energy sources, insect meal is a very real alternative as it has a lower environmental burden when compared with standard feed.

Keywords: aquaculture, life cycle assessment, aquafeed and insect protein

Environmental Management

A methodology for water risk management in the Irish industrial sector

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The adoption of **holistic water management** concepts like water stewardship is expected to improve water management practices, however more effort is required to encourage their uptake, particularly in the Irish industrial sector which is considered to be a heavy water user.

Through practice based **action research**, this research has developed a generic risk management model capable of assessing the level of operational risk associated with key water process linked to the industrial sector.

This action research methodology is a group based process where problems are solved through an evidence based collaborative process of action, observation, evaluation and reflection. The development of this model has been done on a phased basis across a number of different industry test sites in the pharmaceutical and food and beverage sectors.

The water risk management model utilises three specific components to assess the level of **water risk** associated with industrial water processes; cooling towers, purified water plants, steam boilers and wastewater treatment. The specific components of this risk management model are a Microsoft Excel interface used in conjunction with in-situ water metering data gathered from test sites and a compendium of water risk parameters that are associated with the operation of the selected industrial water processes.

Through an iterative design process, each of the water processes that form part of this risk management model are tested at a number of locations to help validate the concept and identify potential improvements.

Keywords: Holistic Water Management, Water Stewardship, Action Research, Water Risk

Water Quality & Resources 1

Assessing the optimal calibration data frequency for the GOTM lake physical model

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The PROGNOS project aims to develop a modelling framework to forecast water quality, specifically algal blooms and pulses in dissolved organic carbon, in lakes and reservoirs. The models will take data in near real time from high frequency monitoring buoys, together with local weather forecast data, and output water quality information for the coming days. These forecasts require accurate simulations of the lake thermal regime. The General Ocean Turbulence Model (GOTM), a physical model that can be applied to lakes, requires high resolution local meteorological data and data on measured lake thermal profiles. A key question for water resource managers would be identifying the optimum temporal frequency for in-situ temperature measurements that is most cost-effective, but still maintains a high degree of accuracy in the model simulations. The impact of differing temporal resolutions of water temperature validation data, from hourly to 8-weeks, has been assessed to provide recommendations for optimal performance for lake thermal regime forecasts.

Water Quality & Resources 1

The study of Asterionella dominated diatom bloom in the drinking water source reservoir, Ireland

Yunhong shi[1], Liwen xiao[1]

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Vartry reservoir is a very important drinking water source in Ireland and consists of two connected parts, the upper lake and the lower lake. Since 2013, Asterionella dominated diatom bloom has been occurring in spring which leads to serious clogging of the slow sand filters in the Vartry water supply scheme. As a result, the potential exists for a shortage of drinking water. The diatom bloom occurred in spring and the highest recorded abundance was 4940 count/ml in the upper lake in 2017. In the lower lake, the peak number was 1878 count/ml in 2016 and 821 count/ml in 2017. Asterionella has a good tolerance for phosphorus and the concentration of soluble reactive phosphorus (SRP) in the reservoir was lower than 1 µg/L. Silica was required for the growth of diatom so the concentration of silica reduced significantly during the diatom bloom. In 2017, the highest amount of diatom was achieved when the concentration of silica was 0. In Vartry reservoir, SRP and nitrogen were not the major factor influencing the growth of diatom and the limitation of silica existed in 2017. Stratification occurs in the Vartry reservoir normally from May to August every year. The amount of diatom reduced significantly since the onset of thermal stratification. In 2017, the thermal stratification maybe the major reason for the end of diatom bloom. Daphnia, rotifer, copepods were the major zooplankton in the reservoir. The peak density of zooplankton in the lower lake in 2017 was 115 individual/L which was much higher than that in 2016 (about 40 individual/L). Considering similar nutrient availability and thermal stratification condition in 2016 and 2017 in the lower lake, grazing caused by the zooplankton can not only limit the growth of diatom but also delay the diatom bloom.

Keywords: Diatom bloom; Reservoir

Water Quality & Resources 1

Oral Presentations Session
Tuesday March 27th 14.00 – 15.30

Realising the True Value of Water in order to Arrive at a Sustainable Future

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In order to arrive at a sustainable future, it is necessary to appreciate the criticality of water-management. The necessity to analyse the available data is becoming increasingly more apparent. One of the main consumers of water worldwide is industry, with specific sectors dominating the profile in different regions. The true value of the water utilised encompasses all the costs incurred including extraction, treatment, pumping, storage, purification and disposal. Knowledge of the costs incurred allows suitable management. However the true cost or true value of the water being used heretofore has not been known.

In order to address this and improve environmental systems, a novel framework for establishing the true value of water has been developed and demonstrated by application to a specific water system in a case-study manufacturing facility. The framework may also be similarly applied to other water life-cycle stages and indeed to other water systems within facilities. A Simulink model was created and monthly data over a three year period was analysed. It was determined that the true value of the Deionised Water was, on average, €13.20/m3. The Value Added Factor relevant to this system is 14.05, originating from a raw water supply cost of €0.94/m3. The primary constituent components of the true value were system maintenance (30%), equipment depreciation (19%) and energy consumption (18%).

The methodology may also be applied to other services and other industries thereby assisting with the transition to more sustainable practices. Scenario analysis may be performed in order to evaluate and provide justification for proposed modifications, thus enabling benefits to water and energy consumption, waste reduction and also operational efficiencies. The results may also be used to contribute to water foot-printing, system/regulation compliance and facility benchmarking thereby enabling the arrival at a sustainable future.

Keywords: Value-system, Water-management, Water footprint, Industrial Sustainability.

Water Quality & Resources 1

Source and pathways of microplastics to freshwater and the environmental consequences

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The prevalence of microplastics (MPs), typically characterised as polymeric materials of particle size between 5mm and 1µm, are an increasing concern in our marine and freshwater systems. International research efforts to date have focused mainly on the abundance, characteristics and implications of plastic pollution in marine settings, with the transport and fate of plastics in terrestrial and freshwater systems being less well understood. The pathway from land to sea is significant in the Irish context given the widespread use of MPs rich biosolids in agricultural land treatment. This gap is being addressed in the recently commenced, 3-year, EPA funded, research project, "Sources, Pathways and Environmental Fate of Freshwater Microplastics", led by Galway-Mayo Institute of Technology (GMIT), and involving University College Dublin (UCD) and Wageningen University, the Netherlands. This presentation will primarily introduce this project, outline its overall objectives and present the experimental methodologies developed to address these objectives. The project will characterise MPs from different sources and industries (construction, bio-pharmaceuticals etc.) but importantly, will also characterise MPs that are abundant in wastewater treatment works (WwTW), terrestrial and river systems. The overland (through direct runoff) and vertical pathways (through infiltration and percolation) of MPs through soil will be experimentally assessed in a programme of rainfall simulation and soil column tests, and the mobilisation and deposition patterns of MPs particles that reach fluvial systems will be explored in a large-scale experimental flume that will facilitate investigation under controlled flow regimes. The use of hydrological models for simulating the transport and fate of MPs will be assessed in the final work-package of the project. The project will produce a framework for modelling the critical sources and transport of MPs that will help to inform political decision making regarding environmental management in Ireland.

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

Water Quality & Resources 1

Quantitative assessment of human exposure to antibiotic-resistant bacteria

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Antibiotic-resistant bacteria (ARB) have been found in drinking water sources around the world. If antibiotic-resistant infections are contracted by humans they can be extremely difficult to treat, therefore, it is vital to limit human exposure to these types of infections. This study examines the human exposure to antibiotic-resistant Escherichia coli (E. coli) through tap water consumption from a European case study site. A human exposure model was created using a combination of site specific data and scientific literature. Data were collected on the concentration of AR E. coli at a surface water site located beside a drinking water treatment plant, the effect of environmental conditions on AR E. coli, the effect of different water treatment combinations on AR E. coli and the amount of tap water consumed by adults. Monte Carlo Simulation was performed on the model output data to characterise uncertainty and variability in the model input data. The results show the mean exposure to AR E. coli through drinking tap water for an adult varied between 3.44 × 10–7 and 2.95 × 10–1 CFU/day depending on the combination of water treatments used. In order to exceed the EU Drinking Water Directive (0 CFU/100ml of E. coli in tap water) a concentration of between 1 and 5 log CFU/ml is required in the source water. The combination of water treatments that provided the largest reduction of AR E. coli was coagulation/flocculation, sand filtration, and UV. This type of information could be used to help define monitoring criteria examining the potential exposure to AR E. coli through tap water.

Keywords: antibiotic resistant bacteria, human exposure, water

Water Quality & Resources 1

Assessing the impacts of cattle access to watercourses on water and sediment faecal contamination in farmland streams

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The most recent water quality monitoring programme conducted by the Environmental Protection Agency concluded that the general quality of surface waters in Ireland has been steadily decreasing, with 48% of rivers classified as impacted (i.e. moderate or worst ecological status), mainly due to agricultural activities. Livestock, in particular cattle, has been described as having a wide range of effects on watercourses, including water and sediment contamination with potentially pathogenic faecal organisms. In Ireland, 90% of agricultural land is devoted to animal grazing and forage, however very few studies have analysed the impacts of livestock on freshwater quality in an Irish context. This study investigated the impact of direct cattle access to farmland streams on water and sediment faecal contamination. Levels of faecal indicator bacteria (Escherichia coli) were measured at cattle access sites and upstream of these sites (with no cattle access) in five agricultural catchments across Ireland, in mid-grazing season (June 2016) and late grazing season (November-December 2016). Average sediment E. coli concentrations varied from 6.3 x 102 CFU.g-1 DW to 1.6 x 107 CFU.g-1 DW in mid-grazing season and from 0 CFU.g-1 DW to 8.2 x 104 CFU.g-1 DW in late grazing season. A parallel high temporal resolution experiment was conducted to investigate the immediate impacts of cattle access on water faecal contamination. Cattle in-stream activity, including sediment disturbance and direct defecation into waters, led to an increase of water E. coli concentrations of up to two orders of magnitude, from 102 to 104 CFU.100 ml. These results indicate that stream faecal contamination in Ireland is widespread and that cattle access to watercourses has the potential to significantly aggravate this pollution, with implications to both animal and human health.

Keywords: water quality, agriculture, faecal indicator bacteria, E.coli, sediments

Human Health

Effect of abiotic factors on selected microalgae strains for omega-3 PUFA production

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Microalgae are considered a promising source of various high-value products with health benefits. For instance, microalgae synthesize and produce large amounts of omega-3 long-chain polyunsaturated fatty acids (n-3 LC-PUFA), with eicosapentaenoic (EPA, 20:5 n-3) and docosahexaenoic (DHA, 22:6 n-3) acids being of particular interest. This project focused on microalgal n-3 LC-PUFA as a sustainable alternative to the traditional fish oil production. Investigations addressed the relative influence of environmental factors (i.e. light, temperature and nutrients) on microalgal biochemical composition and determined optimum culture conditions to reach a balance between omega-3 accumulation and efficient growth rate.
Eight algal species were selected according to their potential for favourable EPA and DHA production. Microalgae were batch-cultivated in triplicate under four different temperatures (8, 14, 20 and 26 °C), with constant light (100 µmol.m-2. s-1), and over a period of 14 days. Growth (optical density) and biomass (dry weight), nitrate uptake and medium pH were monitored every 2-4 days, pigments assessed spectrophotometrically, and fatty acid methyl esters (FAME) analysed by Gas Chromatography Coupled with Flame Ionisation Detector (GC-FID) after direct transmethylation of the algal-biomass. Results highlight the outstanding potential of two particular species: Nannochloropsis oculata for EPA production, and Isochrysis galbana for DHA production. Additional experiments were conducted to assess the effect of nitrate and phosphate concentrations and ratios and the effect of photoperiod on their EPA and DHA contents and respective productivities. Further, strain improvement of Nannochloropsis oculata for EPA productivity was undertaken using natural selection performed by serial dilution under specific growth conditions.

Keywords: Microalgae, PUFA, Environment

Human Health

Hospital effluent and municipal wastewater in Ireland: reservoirs for carbapenemase-producing *Enterobacteriaceae*

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Carbapenemase-producing Enterobacteriaceae (CPE) represent a major health threat as certain strains are resistant to almost all antibiotics. The research aim was to examine hospital effluent (HE) and municipal wastewater from an urban area in Ireland for the presence of CPE. Samples of HE (n=5), and wastewater pre (n=5) and post (n=4) entry of the effluent to the wastewater stream were collected over 8 weeks (May-July 2017). Samples were screened for CPE using Brilliance CRE agar (Oxoid). Suspect CPE were identified using MALDI-TOF, and tested for susceptibility to 16 antimicrobial agents, in accordance with EUCAST criteria. Suspect CPE were examined for the presence of blaKPC, blaOXA-48, blaNDM, blaVIM and blaIMP by real-time PCR. CPE was detected in HE (n=5), pre-hospital (n=1) and post-hospital (n=3) wastewater samples. 13/15 CPE detected in HE harboured one carbapenemase-encoding gene (3 Klebsiella pneumoniae (2 blaOXA-48, 1 blaIMP), 1 Klebsiella oxytoca (1 blaOXA-48), 4 Citrobacter freundii (2 blaKPC, 2 blaOXA-48) and 5 Enterobacter cloacae (3 blaOXA-48, 1 blaIMP, 1 blaVIM)), while 2, (both Enterobacter cloacae) harboured two genes; blaIMP and blaOXA-48. During the same period, in the hospital where HE was collected, 8 blaOXA-48, 4 blaVIM and 1 blaIMP were detected in clinical samples. In post-hospital samples, 8 CPE were detected (2 Klebsiella pneumoniae (1 blaOXA-48, 1 blaIMP), 1 Klebsiella oxytoca (blaVIM), 3 Citrobacter freundii (2 blaKPC, 1 blaOXA-48), and 2 Enterobacter cloacae (both blaOXA-48)). 1 CPE (NDM-producing E. coli) was detected in pre-hospital samples. Hospital and post-hospital wastewater routinely contains a diverse range of CPE, whereas, pre-hospital wastewater does not, indicating a contrast between hospital, post-hospital and general urban wastewater. In this era of CPE, there is a new dimension of risk to the discharge of untreated hospital wastewater. Testing of hospital effluent may have applications in monitoring for unrecognised CPE dissemination in healthcare settings.

Keywords: antimicrobial resistance, carbapenemase-producing Enterobacteriaceae, hospital effluent, municipal wastewater

Human Health

Recreational water consistently contaminated with carbapenemase-producing Enterobacteriaceae, Ireland, 2016-2017

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The rapid, global dissemination of carbapenemase-producing Enterobacteriaceae (CPE) poses a significant threat to human health. We recently reported the detection of New Delhi metallo-beta-lactamase (NDM)-producing Enterobacteriaceae in Irish recreational waters, between July 2016 and January 2017 (Euro Surveill. 2017; 22(15): pii = 30513). Findings indicated that the source of the CPE was human sewage. The aim of this study was to determine if the recreational waters ('Beach A' and 'Beach B') continue to be contaminated with CPE. Sampling was carried out between February and September 2017. Seawater and freshwater sampling locations included: Beach A (n=7); Beach B (n=2); the mouth of a river which flows into Beach B (n=2); and four points further up the river (each sampled once). The sewage system was also sampled (n=2). As per the original study, 30L samples of water were taken and filtered using the CapE filtration system. 200mL samples of sewage were taken. Samples were examined for CPE using Brilliance CRE agar (Oxoid). Isolates were tested for susceptibility to 16 antimicrobial agents (EUCAST criteria). Suspect CPE were examined for carbapenemase-encoding genes by real-time PCR. NDM-producing Enterobacteriaceae (E. coli and/or Klebsiella pneumoniae) were detected in 6/7 of Beach A samples, 2/2 of Beach B samples and 2/2 of sewage system samples. Both samples taken at the mouth of the river were positive for NDM-producing K. pneumoniae, while CPE was not detected further up the river (upstream of the town). This study reveals consistent contamination of recreational water with CPE for a period exceeding 14 months. These findings support the conclusion that human sewage is the single source and that there is no contribution from upstream contamination. Global dissemination of antimicrobial resistance highlights the need to cease discharge of untreated human sewage into the environment.

Keywords: antimicrobial resistance, carbapenemase-producing Enterobacteriaceae, recreational water

Use of whole genome sequencing to characterise and compare ESBL producing-E. coli isolated from recreational water and sewage

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Extended spectrum beta-lactamase producing-E. coli (ESBL-PE) are associated with human infections. Studies indicate that they are widespread in the aquatic environment. The aim of this study was to use whole genome sequence (WGS) analysis to characterise and compare ESBL-PE isolated from recreational waters and sewage in the same area. A total of 25 ESBL-PE were selected from a collection of 44 environmental ESBL-PE, for WGS (Illumina). Isolates were obtained between May 2016 and March 2017. The sources of the isolates include; seawater sources; 'Beach A' (n=3) and 'Beach B' (n=3), freshwater sources; 'Stream A' (n=1), 'Stream B' (n=8) and 'River A' (n=4), sewage sources; 'Sewage A' (n=3), 'Sewage B' (n=1), 'Sewage Storage Tank' (n=1) and 'Sewage Outflow Point'(n=1). Isolate genomes were hosted and analysis was performed using BIGSdb. Core genome multi-locus sequence typing was used to compare isolates at 2513 loci. A total of 10 seven locus sequence types (ST) were identified. ST131 and ST90 (both 6/25) which are strongly associated with human infection were the most prevalent. The most common blaCTX-M genes identified were blaCTX-M-15 (11/25) and blaCTX-M-27 (10/25). Overall, considerable diversity was found within the collection, with differences at up to 2417/2513 loci. However, high levels of homology were also found among several ESBL-PE originating from different sources. Three ST131 ESBL-PE (from 'Sewage A', 'Sewage B' and 'Beach B') were identical at all 2513 loci. Six ST90 ESBL-PE (from 'River A', 'Beach B' and 'Stream B' outflow) matched at between 2505 and 2513 loci. Two ST2003 ESBL-PE (from 'Sewage Storage Tank' and 'Beach A') matched at 2512 loci. These findings suggest that environmental contamination with ESBL-PE in this setting is likely from human sewage, which may contribute to further dissemination of ESBL-PE within the human population.

Keywords: antimicrobial resistance, extended spectrum-beta-lactamase producing-E. coli, recreational water, whole genome sequencing

Human Health

Novel Antimicrobial for the Control of Dental Plaque

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The human mouth is one of the most heavily colonised surfaces of the body and plays host to a diverse, dynamic and highly interactive microbial community that composes the 'oral microbiome'. The oral microbiome plays a significant role in human health and disease as complex interactions between bacterial community members help establish polyspecies biofilms, known as dental plaque, on the enamel surface of teeth, and the interactions of certain plaque bacteria with dietary constituents is responsible for the onset of dental caries, the most prevalent oral infectious disease. The emergence of antibiotic resistant bacteria has made common oral infections more difficult to treat, and has in turn has led to an increased demand for novel antimicrobial therapies. A novel, non-antibiotic, antimicrobial has recently been developed by Westway Health with potential application as a mouthwash to control dental plaque and reduce bacterial loads. It is inspired by the lactoperoxidase-catalysed antimicrobial systems prevalent in nature and is a fast-acting, potent, 'resistance-resistant' antimicrobial with a broad spectrum of activity against bacteria, fungi and viruses. Initial experiments, including release profiles and biofilm studies using a Modified Robbins Device, confirm it is effective against common oral bacteria in both planktonic and biofilm physiologies. The minimum inhibitory concentration is comparable to chlorhexidine, the current 'gold standard' for the chemical control of dental plaque, and it does not promote development of resistance to the antimicrobial or cross-resistance to any tested antibiotics. Furthermore, the addition of fluoride to the formulation does not impact antimicrobial activity and widespread adoption of the product could potentially reduce the need to artificially fluoridate our public water systems. While further investigation is still required, initial results are promising and could suggest this antimicrobial as an alternative to chlorhexidine for the control of dental plaque.

Keywords: Oral Microbiome; Biofilms; Antimicrobials

Human Health

Environmental pollution with antibiotics and resistant microbial species from the agricultural and veterinary sectors

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The over use and misuse of antibiotics has generated a serious global pandemic, with no immediate solution in sight. The appearance of an ever-increasing range of microorganisms showing resistance to a collective array of antimicrobial drugs presents a serious threat to public health safety. Prolonged infectious diseases such as pneumonia and tuberculosis are becoming more difficult to treat and often fatal as antibiotics become less effective against deadly resistant pathogens. Human antibiotic use is a major source of antimicrobial resistance (AMR), however, the intensive use of antibiotics in veterinary for animal farming and agriculture are greatly proliferating the problem. Veterinary antibiotics are being heavily administered to healthy animals for growth promotion and for therapeutic, prophylactic (disease prevention) and metaphylactic (infection control) use. Environmental pollution with these drugs and resistant strains possess a serious health threat, resulting in higher morbidity and mortality rates in animal and human species as well as increasing economic costs. In addition, the selection and proliferation of antibiotic-resistant strains can be disseminated to the environment via animal waste enhancing the resistance reservoir that exists in the environment. The environmental aspect of AMR is given low priority, but is a long term human health concern that needs to be addressed. Here we present a concise detailed summary of the relationship between veterinary use of antibiotics, environmental pollution and its impact on human health. Initial studies on 20 samples from companion and food producing animals (sheep) showed that 70% of disease and infection states in the animal could be attributed to a resistant strain with many isolates (ca. 40%) showing multidrug resistance. Resistance was shown to vancomycin, erythromycin, methicillin and kanamycin. AMR strains identified included Klebsiella, ESBL E. coli, MRSA and Pseudomonas, all listed as priority pathogens and a major cause for concern by the World Health Organisation (WHO).

Keywords: Antibiotic resistance, environmental microbiome, pathogens, public health

Sustainable Land Use & Agriculture 1

Effect of Soil-setTM on entomopathogenic nematodes in the laboratory and on the growth of tomato plants in the greenhouse

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The work presented here is part of a larger collaborative project between IT Carlow and Alltech, on the development of sustainable nematode management alternatives. Soil-setTM commercial formulation (Alltech) was evaluated against three strains of entomopathogenic nematodes (EPN): Steinernema feltiae (SB12 (1); a wild enviroCORE strain), Steinernema feltiae (commercial form e-NEMA) and Steinernema carpocapsae (commercial form e-NEMA). Laboratory bioassays were conducted to determine lethal and sub-lethal concentrations (LD50) of Soil-setTM for each EPN strain. The sensitivity of the EPN to the product was tested by estimating the mortality and survival percentage of infective juveniles (IJ), after 24-hrs treatment with four different Soil-setTM dilutions (4%, 7%, 8%, 10%), compared to those in untreated IJs (control, only water with no product) in 96-well plates. There was no significant difference in survival percentage of IJs treated with up to 4% Soil-setTM concentrations when compared to that of control. Whereas, two-fold and ten-fold reduction in survival was monitored at 7% and 8% treatment concentrations, respectively, compared to control. The 10% concentration of Soil-setTM could be considered as lethal for all the three EPN strains, as treatment with concentrations above 10% caused 100% mortality in all cases. The effect of Soil-setTM on the growth of tomato seedlings was also evaluated in terms of shoot height (SH) (cm), root height (RH) (cm), number of leaves (NL) and fresh weight (FW) (mg), in greenhouse trials. Our results indicate that Soil-setTM could be a sustainable soil health product causing no harm to beneficial nematodes (EPN) at treatments below 7%.

Keywords: Entomopathogenic nematodes, Soil-setTM, tomatoes, mortality percentage, bioassay

Sustainable Land Use & Agriculture 1

Novel Antimicrobial for Treatment of Bovine Mastitis

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Bovine mastitis is one of the most common and critical diseases affecting the dairy industry. It is an intramammary infection caused by a variety of microbes, e.g. Staphlococcus aureus, Streptococcus uberis, and Escherichia coli. Mastitis results in reduced milk production, premature drying-off and possible loss of infected quarters; it is a major cause of cow illness and fatality worldwide. Mastitis costs the Irish dairy industry €20 million per annum, and approximately €2 billion in the EU. Current treatment relies heavily on antibiotics; this is costly to the farmer due to the subsequent milk withdrawal and the reduced effectiveness of antibiotics over time (resistance), which can lead to culling.

A novel, non-antibiotic, antimicrobial agent has recently been developed by Westway Health and is expected to combat both the milk-withdrawal period and the development of resistance. This novel antimicrobial targets bacterial cells via the generation of the hypoiodite ion. Results show that this hypoiodite ion quickly kills any microbes present, both in vitro and in vivo. This technology leaves no residues, permitting the addition of the milk to the bulk tank.

In vitro experiments determined the MIC to be 6-15 mgL-1, which is comparable to antibiotics currently used to treat mastitis. Due to the excipient the active ingredients are slowly released, allowing bactericidal effects over a 24-hour period; this is maintained even when challenged with additional bacteria. This gives the antimicrobial time to spread throughout the udder as it fills, killing any bacteria present in between milkings. This is currently being tested in vivo which, so far, shows that the clinical signs of mastitis are significantly reduced and infections cleared with no negative long-term impacts on the cow, no negative changes to the SCC, and minimal iodine residues. Overall, initial results show excellent potential for a non-antibiotic approach to treating bovine mastitis.

Keywords: Mastitis; Antimicrobial; Hypoiodite

Sustainable Land Use & Agriculture 1

International Association for Plant Biotechnology – Being hosted in Ireland for the first time in August 2018

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The International Association for Plant Biotechnology founded in 1963, in Pennsylvania, boasts over 700 members worldwide (>50 countries). Every four years the association holds an international meeting. The meeting has never been held in Ireland and the last time the meeting was in Europe was in 1994. This talk will outline the history and development of the association – which through its network, its quadrennial meetings and its Springer publication of its peer reviewed journal has contributed enormously to the field of plant biotechnology and sustainability. Apart from the talk, more information on the society can be found here: www.iapbhome.com and on the conference here: www.iapb2018.com We are delighted to have an excllent line up of keynotes and our conference will be opened on Sunday 19th August 2018 by Professor Ada Yonath, Nobel Laureate 2009 (who shared the Nobel that year for her work on elucidating ribosome structure and function). We hope to see you for what promises to be a fantastically stimulating and scientifically rigorous meeting in the Convention Centre in Dublin's Spencer Dock from 19th to 24th August 2018.

Sustainable Land Use & Agriculture 1

Eucalyptus survival, growth rates and potential impacts on hydrology and nutrient cycles in blanket peat catchments

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Conifer plantations have been identified as having negative impacts on the water quality draining from blanket peat catchments. This can have major implications in decision processes affecting forest managers to downstream utility managers, and stakeholders dependent on the ecosystem services provided within. Current efforts to curtail these impacts can include sensitive harvesting methods, introducing riparian/ buffer zones and restoration practices, however, this can often prove costly, impractical or ineffective and result in the reduction of some positive services provided. Here we propose that alternative 'exotic' species may have a role as a management tool to mitigate some of the negative effects of monocultural conifer plantations. Following a four year field trial of four species (Eucalyptus nitens, Eucalyptus rodwayi, Eucalyptus subcrenulata and Picea sitchensis) on elevated second rotation Atlantic blanket peat, we find, contrary to conventional wisdom and recommendations, that some eucalyptus species (Eucalyptus rodwayi, Eucalyptus subcrenulata) appear capable of adapting to peatland environments and juvenile survival and growth rates are at least comparable to, if not outperform, that of Sitka spruce (Picea sitchensis). To assess possible environmental impacts, complementary microcosm experiments were performed observing five species (Eucalyptus nitens, Eucalyptus rodwayi, Alnus cordata, Picea sitchensis and Pinus contorta) over two growing seasons monitoring leachate water quality parameters, peak hydrological demands and water use efficiency values for biomass accumulation. As expected, the faster growing species had higher water demands and reduced leachate phosphorous (P) concentrations. Italian alder (A.cordata) was confirmed as a potential nitrogen (N) source, while E.nitens was identified as the least efficient in its water use per unit of biomass accumulated. Interestingly, significant differences in leachate dissolved organic carbon (DOC) concentrations were observed with E.rodwayi recording the lowest values. These results provide evidence that targeted introduction of alternative species may have the potential to positively impact the ecosystem services provided by peatland forestry and focus efforts towards a more sustainable model of catchment development.

Keywords: eucalyptus, peatlands, ecosystem services, catchment management, nutrient cycles

Sustainable Land Use & Agriculture 1

National extent of cattle exclusion from watercourses

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The 4th NAP of the Nitrates Directive will require derogation farms to prevent cattle from having direct access to a water course by 2021. This research employs a GIS methodology to examine the extent of the number of farms bordering a water course in Ireland. Utilising Ordinance Survey Ireland's (OSi) Prime2 dataset, The Department of Agriculture, Food and the Marine (DAFM) Land Parcel Identification System (LPIS) dataset is merged into Prime2 to create a new farm boundary layer for Ireland; P2 Farm. P2 Farm is the first Irish dataset which contains individual farm boundaries. Whereas LPIS parcels are contiguous blocks of particular land-use farmed, P2 Farm contains individual fields along with detail of land-use. An examination of the OSi 1:50,000 discovery series river network highlighted a spatial mismatch with aerial photography. Farmers however will fence from the real watercourse and not an artificial representation of a river centre line. River width is therefore required. The river polygon and stream line data from Prime2 were found to be more spatially representative. The OSi 1:50,000 discovery series river network is overlaid with Prime2 river polygons to create a spatially rich river dataset. One advantage of using Prime2 data is the seamless nature of the data polygons. Combining the P2 Farm layer with the new river polygon layer; the total number of farms bordering a water course can be quantified. The results show that approximately 60% of farms border a length of river. Overall the total length of on-farm watercourse bank is ~55,000km.

Keywords: GIS, spatial analysis, agriculture, data

Environmental Policy & Communication

Interventions to reduce or avoid the risk of human disease from contaminated private groundwater systems – A global meta-analysis

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Groundwater represents the largest reservoir of accessible freshwater in the world with groundwater contamination thus posing a significant global health risk and an escalating concern due to climate change, shifts in land-use patterns and inconsistent or absent regulation. Populations residing in rural areas and reliant on unregulated domestic supplies (i.e. private wells) are particularly vulnerable due to the ubiquity of potential contaminant sources and the geographical/infrastructural obstacles hindering "top-down" groundwater management. As the onus to protect private rural groundwater lies largely with non-expert users, awareness raising and behaviour promotion represent the most viable means of ensuring high rural groundwater quality, contamination risk reduction, and a healthy population. However, in spite of growing acknowledgement that enhanced public engagement is necessary, frameworks and behavioural theories for groundwater risk communication (leading to bottom-up mitigation) remain elusive. Numerous recent studies have highlighted the behavioural and contextual barriers to private well stewardship, however few have examined corresponding interventions and the determinants of their efficacy.

Accordingly, the current study sought to quantify the performance of global private well interventions during the period 1990-2017 via a systematic review and meta-analytical approach. The PICO (Population-Intervention-Comparison-Outcome) method was adopted to provide a robust, replicable framework for literature identification. Relevant studies were screened in accordance with explicit inclusion/exclusion criteria and coded for >50 key variables. A total of 43 articles were included for meta-analyses, with a majority of studies originating from South Asia (N=26), followed by North America (N= 15) and Africa (N=2). Preliminary analyses indicate higher rates of groundwater stewardship are associated with locally-focused interventions, while lower levels of efficacy are related with impersonal (media-based) initiatives. Final results will provide a baseline for authorities both in Ireland and further afield for increasingly effective public health communication and groundwater protection strategies, and contribute to the emergent interdisciplinary sphere of socio-hydrogeology.

Keywords: Groundwater contamination, human health, public engagement, risk communication, socio-hydrogeology

Environmental Policy & Communication

Sustainable Transition Pathways and the Role of Higher Education Institutions

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Higher education institution (HEI) campuses have the capacity to experiment with and demonstrate innovative sustainability solutions in a 'real-world' context, that may serve as possible pre-configurations of sustainable communities. While there is potential for HEIs to improve their own campus sustainability by experimenting with innovative sustainability solutions, the greatest potential of HEIs is their multiplier effect on catalysing wider society's transition towards sustainable communities. On-campus actions include experimentation and demonstration of sustainability solutions in the domains of energy, mobility, waste and water. Multiplier actions include education surrounding these transitions, research into innovative sustainability ideas and techniques, and outreach through dissemination of best practice coupled with engagement and collaboration with government agencies, industry and the general public through public, private and people partnerships. To evaluate the HEI sectors potential contribution towards catalysing wider society's transition to sustainable communities, no single perspective is adequate due to the multi-dimensional nature of sustainability transition pathways. As a result an integrated approach is applied, in this paper, to the HEI sector in Ireland to evaluate how it may catalyse national sustainability transitions utilising the perspectives of initiative-based learning (or living lab), sociotechnical analysis and quantitative systems modelling. By utilising this integrated approach, a fuller picture is achieved by bridging the partial understanding obtained from each of these perspectives as to how HEIs may contribute to society's transition towards sustainability.

Keywords: Sustainability Transitions, Higher Education, Living Labs, Sociotechnical Transitions, Integrated Approach.

Environmental Policy & Communication

NUI Galway Sustainability Strategy 2017-2020
LEARN LIVE LEAD

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NUI Galway recognises that arriving at a sustainable future requires the University to achieve environmental, social and economic sustainability and that campus policy, operations, people, communication and engagement will play a key role in this. The NUI Galway Sustainability Strategy 2017-2020 was launched in 2017 and sets out a vision of establishing the University as a top-class, green, smart and healthy campus. The Strategy was developed by the Community and University Sustainability Project Team (CUSP) following a yearlong comprehensive and inclusive communication and engagement process. Views of the University and wider communities were gathered through a four step approach including awareness, outreach, action and empowerment.

The Strategy sets out policies, objectives and targets for the next three academic years. The Strategy is based on a Learn-Live-Lead model whereby the University will build on its core strengths in teaching and research to learn about the environment and new techniques, analyse campus operations, building performance and user habits to live more sustainably and connect to the broader community and other institutions, to lead by example. The Learn-Live-Lead model is organised around six themes (Research and Learning, Energy and Greenhouse Gas Emissions, Nature and Ecosystems, Health and Wellbeing, Built Environment and Governance and Leadership), each comprising objectives and targets for our journey towards sustainability. The Strategy identifies 20 measures for success, which serve as indicators for more extensive work under each theme and an annual Sustainability Report will be produced outlining progress against targets.

Good governance and continuous engagement with the campus community will ensure the effectiveness of the Strategy over three years. This is NUI Galway's inaugural Sustainability Strategy and is the first steps in the journey towards a sustainable campus as part of a transition towards a sustainable community.

Keywords: strategy, learn, live, lead, communication, engagement

Environmental Policy & Communication

Applied socio-hydro(geo)logy: Model-based survey on health-related flood risk perception amongst groundwater-reliant Irish population

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Significant flooding events have the potential to inflict major social, infrastructural and environmental damage. However, the human gastrointestinal health implications of these events, receive far less attention. Flooding can mobilize environmental pathogens via short-circuiting of hydrogeological pathways and/or negation of natural attenuation processes. While both surface and groundwater contamination represent public health issues, the latter poses more complex challenges. Groundwater occurrence, transport and contamination remain poorly understood processes among non-expert users and human-water systems operate at a micro-level (e.g. private well-owners). Accordingly, an enhanced understanding of human-groundwater interactions at the individual/household level is required, with Ireland representing a particularly relevant case-study due to high levels of private groundwater reliance (>720,000 private well-users), climatic and geological diversity, ubiquitous environmental pathogen sources, and increasing flooding occurrences. An integrative online survey was developed using two existing psychological models, namely, the "Risk-Attitude-Norms-Ability-Self-regulation" (RANAS) and Health-Belief (H-B) models. Preliminary results (n = 247), demonstrate the complexity of risk-based human-water interactions; for example, among well owners that had not experienced local flooding, 29% believe water testing represents the most important post-event action. Conversely, no respondents that had experienced flooding (n = 45), proceeded to have their water tested, while 62% took no post-event action of any kind. Findings also suggest that optimism bias comprises a significant impediment to "healthy behaviours" and that socio-economic characteristics (e.g. property ownership, presence of vulnerable populations in the household, etc.) are predictive of post-event actions. Results from RANAS and H-B psychological models provide a promising two-pronged framework for applied socio-hydrogeology, and may be used to develop increasingly successful, spatially and demographically bespoke interventions, for example, within the promotion of protective health behaviours in face of hydrogeological-related risks.

Keywords: Flood, Groundwater contamination, Gastrointestinal Illness, Survey, RANAS, Health Belief Model

Systematic approach for rural community contributions to low carbon transitioning

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To ensure Europe remains on a sustainable path, a stepping up of efforts require new and innovative solutions. Citizens, businesses and other stakeholders need to address the challenges faced. Additionally, opportunities need to be seized, to address not only local but also global issues which affect all citizens. Rural communities have a very significant part to play in the transition towards a low carbon society and have been overlooked in the literature as research places more emphasis on urban sustainability. Rural and urban communities differ greatly in terms of population density, availability of services, land use and natural resources. Rural communities are not those which are solely based on agricultural land use, there is much diversity including coastal and marine communities. With 38% of the Irish population living in rural areas, rural communities represent a significant contribution to CO2 emissions. Community energy transition projects not only address greenhouse gas emissions, they are instrumental in bringing ideas and actions in the area of sustainability in environment and socio-economics to fruition. Many community groups, nationally and internationally, have successfully come together to improve their immediate environment, however in doing so, they can also have a significant effect on sustainability and the transition towards a low carbon society. The actions of these community groups can be far reaching in that they can inspire other groups to follow and mimic their actions and demonstrate that actions are feasible and significant. This paper will present the challenges facing community groups, and discuss solutions to assist rural communities map out and systematically address strategies, targets, policies, measures and schedules.

Keywords: low carbon transition, rural, community, energy transition

Environmental Policy & Communication

Development of a web based decision support aid to facilitate sustainable urban communities in Ireland

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Climate change, increasing consumption of resources and dependence on fossil fuels pose significant risks to communities, nations and the world as a whole. Sustainable development has long been recognised as a strategy to counteract these negative impacts. Previous studies have stressed the need to involve voluntary communities at local level in implementation of successful sustainable development programmes in order to achieve national and EU targets for reduction of Greenhouse Gas (GHG) emissions. This work focuses on the implementation of Sustainable Urban Development programmes by Irish urban-based voluntary communities. Within the context of EU countries, Ireland has one of the poorest records for GHG reduction and increased renewable energy strategies, therefore urgent improvement is necessary to meet environmental policy targets. The Centre for Environmental Research in the University of Limerick, in partnership with Irish communities, undertook a study to identify what aids and restricts the transition towards sustainability in urban communities. Previously published results show that a lack of information, technical, legal and financial, was a major obstacle. The work reported here relates to the provision of a web based decision support aid that provides users with this technical, financial and legal information in order to bridge the predetermined knowledge gap. The information will be categorised into several sections including Community Group Development, Community Projects, Glossary of Terms and Gaining Recognition, to allow ease of navigation and enhancement of human computer interaction. Additionally the web based support aid will be freely accessible and interactive in order to cater to all levels of expertise and understanding.

Keywords: sustainable urban development, decision support aid, financial and legal constraints

Environmental Policy & Communication

To eco-effectiveness (and beyond)? Sustainability reporting in different types of organisation

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An increasing number of organisations report on their environmental interactions, with 90% of the global top 250 organisations now producing an annual stand-alone "Sustainability" Report. The sustainability reporting literature suggests, however, that these reports have little to do with environmental sustainability in the sense of containing human activity within planetary boundaries. Instead, these reports typically reflect an organisation-centric, "business case" approach to the organisation's environmental interactions, where environmental issues are engaged with only if it is "good" for the business. This means that issues unlikely to benefit the organisation, e.g. some of the core elements of sustainability, such as ecological limits and intergenerational equity, are framed out of the narrative. But the existing literature is focused primarily on large PLCs, and it is increasingly suggested that organisations with broader objectives, such as social enterprises and values-based enterprises, and with alternative ownership structures, such as co-operatives or partnerships, may be more likely to engage with core elements of sustainability. In this study, we use the content analysis method to examine the nature of engagement, if any, with elements of planetary sustainability in the sustainability disclosures of forty organisations of varying objectives and ownership structures, namely large PLCs, values-based SMEs, social enterprises and co-owned businesses. The results suggest that the dominant issues engaged with in sustainability reporting, regardless of entity class, are "low-hanging fruit" such as eco-efficiency, social responsibility and environmental sustainability, with more substantive issues engaged with only superficially. This leads us to question the connection between language and action in sustainability engagement across the spectrum of organisations, and we urge scholars and practitioners to engage critically with organisations and give a voice to key elements of planetary sustainability.

Keywords: corporate sustainability, sustainability reporting, sustainability accounting, content analysis, planetary sustainability

Sustainable production of protein-rich Lemna minor on aquaculture wastewater - Preliminary experiments in an Irish perch farm

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Preliminary information on the potential to use Lemnaceae in Ireland for the treatment of aquaculture wastewater and for the production of protein was gained in this study. A local strain of Lemna minor was used to carry out two experiments (one in August and one in November) at a small perch farm in Co. Sligo. The aim of the study was to test the nutrient uptake ability of Lemnaceae in different seasons, their protein content and the influence of harvesting on their growth.
L. minor was grown outdoor, in tanks filled with aquaculture wastewater. Nutrients concentration and area covered by L. minor were monitored during the experiment. The protein content of this strain was also determined. In the experiment carried out in August, L. minor covered the full surface available in 20 days. The growth reached a peak when around the 25% of the area of the tank was covered. At the end of the experiment the concentration of nitrates had dropped from 20 to 5 mg/l. The concentration of phosphates had decreased from 2.5 to 0 mg/l. In the experiment carried out in November the plants never covered the full surface of the tank as the low temperature limited the growth. The highest growth reached by L. minor was 0.12 day-1 during the first week. The water chemistry did not change during the second experiment. This strain, in optimal conditions, can contain 26±2 mg of protein per g of dry biomass.
It was concluded that the strain of L. minor analysed showed a high ability to remove nutrients from aquaculture wastewater and a protein content comparable to other strains analysed by different authors. The temperature represents a limitation, a solution could be to store the wastewater produced during cold months and save it for treatment in the warm season.

Keywords: Aquaculture, Wastewater, Phytoremediation, Duckweed, Protein

Water Quality & Resources 2

Assessing the efficiency of treatment of alkaline bauxite residue leachate using a constructed wetland

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The growing global demand for alumina has resulted with an increase in the production of bauxite residue, a by-product of the Bayer Process. High alkalinity (pH > 12) of bauxite-residue leachates presents challenges for the long-term storage and environmental management of the residue. Regulatory bodies now call for robust investigations and proof of concept for closure plans for the ultimate cessation of operations at such waste facilities. A key issue within this is the long-term treatment of drainage waters to a standard that can be discharged. Conventional treatment options for residue leachates are labour intensive requiring frequent application and maintenance.

Constructed wetlands utilise natural characteristics of wetland ecosystems such as soil, microbial and vegetative mechanisms to efficiently alter pH and elemental composition of the wastewater. Use of constructed wetlands and other passive technologies for the treatment of industrial leachates is gaining global acceptance by regulators in mine closure. However, little research has been conducted into their long-term effectiveness and maintenance requirements.

A constructed wetland trial has been in operation for over 4 years treating alkaline (ca. pH 11.3) bauxite residue leachate. Monitoring has continuously demonstrated a discharge pH of < 8.0. Further, metal impurities are also reduced in leachate waters. Key to wetland effectiveness is the precipitation of hydroxides as carbonates and this is dependent on; a) role of microbial respiration and the resulting carbonation within the wetland system, b) capacity of the soil system to remove alkalinity and leachate impurities. Results of a 4-year monitoring programme are presented and potential for long-term operations will be explored.

Keywords: Bauxite residue, alkaline leachate, constructed wetlands.

Water Reuse in the Context of the Circular Economy in Ireland

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Ireland is generally considered a 'water abundant' country in the public perception; however, there are increasing pressures on Ireland's freshwater resources due to increasing urbanisation, intensifying agricultural practices and expanding industries, further compounded by the effects of climate change. Internationally, water reuse as part of an emergent 'circular economy' has been identified as a solution with the potential to deliver environmental, economic and social benefits. The research aims to investigate the potential for water reuse in Ireland, within industrial sites and from municipal wastewater treatment plants (WWTP) for a variety of applications.

A literature review of international water reuse practices and case studies of leading countries strategies found a number of challenges to adopting water reuse in Ireland. These include: 1) there is no strategy, legislation or regulation for water reuse in Ireland; 2) the absence of available data on water stress and water reuse; 3) knowledge regarding suitable and relevant technologies and treatment trains for the Irish context; and 5) public and industry wide perception and behavioural issues around wastewater reuse. The research seeks to address these challenges and make recommendations for the future opportunities of adopting water reuse practices in Ireland.

For industrial re-use, those sectors treating large quantities of wastewater were identified, the sectors were surveyed to determine the level of water reuse, and best practice water reuse case studies were developed. For municipal water reuse, the research aimed to identify water stressed regions in Ireland, determine the level of water reuse in municipal WWTPs, and the drivers and barriers to water reuse. Interviews with stakeholders and policy makers to address key issues relating to the adoption of water reuse in Ireland are to be conducted. To gain an in-depth understanding of general public perception and opinions around wastewater reuse, social science aspects are incorporated and a survey of the public will be carried out.

Keywords: Water Reuse, Wastewater, Circular Economy, Water Stress, Stakeholder Engagement.

Biodiversity Citizen Science and Irish National Parks

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Ireland has been subject to international criticism for its failure to meet its international commitment to biodiversity reporting and monitoring. As part of its biodiversity strategy, the Irish Government established the National Biodiversity Data Centre (NBDC) that collates contributions from citizen science as well as formal studies to construct a national biodiversity database. International literature suggests that mobilising citizen scientists to engage in biodiversity reporting is a low-cost method of achieving a high geographic coverage of data collection. Citizen science is particularly effective when it is integrated with individual's leisure activities and provides a simple method of recording such as a social media app. This paper discusses the potential role of the Irish national parks, as centres of outdoor leisure activity, with an environmental protection mission, in increasing the level of biodiversity reporting by citizen scientists. It examines the existing levels of reporting in national parks using data provided by the NBDC. It examines their social media profiles for evidence of information broadcasting and engagement with the public and environmental groups on the issue of biodiversity, using a framework drawn from political communications. It finds that the national parks have a relatively weak profile in terms of broadcast information on biodiversity and a very weak profile on social media engagement. The Burren national park stands out with a higher level of reporting per visitor, explained by the parks clearer focus on a defined set of species and a higher quality of broadcast identification material. However, like the other parks it has no links with the NBDC. Biodiversity reporting could be dramatically increased in the national parks, making a contribution to Ireland's international reporting obligations, through the implementation of a communications strategy using the social media platforms Facebook and Twitter.

Keywords: biodiversity, citizen science, Ireland, national parks, biodiversity monitoring

Biodiversity & Ecosystems

Factors driving Syrphid abundance, diversity, and community composition in arable cropping systems

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Hedgerows can provide habitat for a range of beneficial invertebrates on farmland, including hover flies (Syrphidae, Diptera), which can provide both pollinating and aphid pest-controlling services to the adjacent crop. Adult syrphids feed on flowers in the hedgerows and margins of the crop, whilst the larvae of some species are aphidophagous. Syrphid abundance, richness and community composition may be driven by a range of factors, including the abundance of food resources, which can in turn be influenced by the structure and composition of hedgerows, as well as the activity of competitors.

This study investigated the relationships between hedgerow structure and composition, floral resource availability, and the abundance, richness, and community composition of syrphids, aphids, other pollinators and aphidophagous predators. Nine organic oat crop fields were surveyed across Leinster Province in the Republic of Ireland in 2017. Hedgerow structure was quantified in terms of hedge dimensions, percent gaps, and woody species diversity. Insect surveys were conducted both in the hedgerow and the adjacent crops using three methods: timed observations of floral visitors along transects, timed hand searches for pests and predators on the oat crop, and 24-hour collection of fauna in pan traps along the hedgerow. Diversity of floral families and floral abundance was also recorded.

We found that there were more syrphids than bees visiting flowers, and far more parasitoid wasps than syrphid larvae attacking the aphids on the oats. The relationships between hedgerow characteristics, floral abundance, and insect communities will be described.

As hedgerows are a means by which to encourage beneficial insects in the farmed landscape, it's useful to understand how their structure might influence invertebrate communities so that farmers can manage hedges in a way to optimize populations of ecosystem service providers.

Biodiversity & Ecosystems

Modelling species use and functional connectivity of Greenway corridors to enhance their biodiversity corridor function.

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European Greenway developments typically 'recycle' disused transport corridors into multi- use, non-motorised public infrastructure. Prior to development, these linear landscape corridors are often regained by wildlife. Bat species strongly associate with linear landscape features and broadleaf woodland habitat, but little is known about their use of Greenway corridors. We therefore conducted an extensive, multi-species study to examine the influence of local and landscape scale habitat characteristics on bat species activity and presence along a proposed Greenway route. A 70km2 baseline map of habitats occurring along the proposed international Sligo, Leitrim, Northern Counties Railway (SLNCR) Greenway project was photointerpreted and ground-truthed for accuracy. The mapping illustrated a dominance of semi natural grassland and woodland habitat, interspersed by land use intensification. Habitat condition assessments indicated that the linear woodland surveyed is of high significance, most likely due to the 'Green Lane' effect of the former railway. The semi-natural woodland network was analysed for connectivity using Morphological Spatial Pattern Analysis (MSPA) and Equivalent Connected Area (ECA), determining the relative connectivity importance of individual woodland habitat features within the network. Survey sites were selected based on a stratified random sampling basis and bat presence and activity was assessed using bat detectors along the Greenway route. We recorded 37172 bat passes of eight species in proximity to linear woodland habitats of various structure, condition and structural connectivity to woodland patches. At a landscape scale, species dispersal distance thresholds were determined to calculate the functional connectivity of the Greenway corridor using Probability of Connectivity (PC). In consideration of such structural and functional connectivity data, recommendations can be made for the design, development and maintenance of Greenways to optimise habitat linkages along and throughout their routes- contributing towards their realisation as true sustainable projects.

Keywords: Linear landscape features, bat activity, ecological corridors, morphological spatial pattern analysis, conefor, species modelling.

Sustainable Land Use & Agriculture 2

Identifying critical source areas of soil phosphorus losses for over 500 farms in the Upper Bann catchment using LiDAR DEMs and big data

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Critical source areas (CSAs) of phosphorus (P) losses from agricultural soils to waterbodies must be identified at sub-field scales to cost-effectively target mitigation measures and facilitate sustainable intensification. However, to achieve meaningful improvements in water quality at county, regional or national scales, such fine scale modelling and targeting must be implemented over wide areas using big data collection. The EU Exceptional Adjustment Aid Soil Sampling and Analysis Scheme (EAA-SSAS) is an example of this. The scheme undertook intensive soil sampling and analysis for soil nutrients (including Olsen P) on over 500 farms (8000 fields) within 11 subcatchments (136 km2) of the Upper Bann in Co. Down, Northern Ireland, from November 2017 to February 2018. It aimed to (1) provide soil nutrient advice to farmers to drive improvements in soil fertility, productivity and profitability, and (2) model P CSAs to target mitigation measures and improve water quality (currently being monitored at subcatchments outlets). The CSA Index used field scale water extractable P (WEP) concentrations (predicted using soil-specific relationships with Olsen P) as an indicator of mobile soil P available for loss in runoff. Runoff potential was estimated using a hydrologically sensitive area index which combines data on topography (slope, upslope drainage area and flow sinks derived using a 1 m LiDAR Digital Elevation Model) and soil hydrology (soil depth and drainage). Results showed the Upper Bann has high runoff potential due to drumlin topography, poorly drained soils, a dense drainage channel network, and hydrologically connected flow paths. CSAs were predicted at the sub-field scale where runoff pathways coincided with high mobile soil P concentrations (shown by WEP). Pathways and delivery points to streams were also predicted. The soil nutrient and CSA maps were sent to each individual farm with the hope of promoting both agronomic and water quality improvements.

Keywords: Critical source area, phosphorus, agriculture, pollution, LiDAR, DEM, big data.

Sustainable Land Use & Agriculture 2

Rhizobacterial Volatile Organic Compounds from Irish Potato Soils Display Potential as Fungal Pathogen Growth-Inhibitors and Plant Growth-Promoters

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Isolation of Rhizobacteria from both organic and conventional potato crops across the South coast of Ireland yielded 120 morphologically distinct isolates. These isolates display varying degrees of both direct and indirect plant growth-promoting activities through secondary metabolite production and thus are termed, plant growth-promoting rhizobacteria (PGPR). One group of these secondary metabolite are termed volatile organic compounds (VOC's), which are being intensely studied in the field of plant-microbe interactions at this time. Of the 120 isolates, five were selected to observe the effect of their VOC's on plant growth-promotion in Solanum tuberosum cv. Golden Wonder, an economically import cultivar of potato in Ireland and Britain. The rational for selection of these five isolates was based on their ability to inhibit the growth, in-vitro, of the fungal pathogen Rhizoctonia solani, which is the vector for diseases such as 'stem canker' and 'black scruf' in potato. To elucidate which VOC's may be involved in the inhibition of fungal growth and the promotion of plant growth, solid phase micro-extraction gas chromatography mass spectrometry (SPME GC/MS) analysis was carried out on the five isolates. Results returned many widely published VOC's in the literature which have antifungal activity, plant growth-promoting activity or both. Dual culture experiments utilising S. tuberosum cv. Golden Wonder and our selected isolates display plant growth-promotion as a result of exposure to rhizobacterial VOC's. With tightening of regulation around the use of synthetic biocides and fertilisers within the EU and further afield, while at the same time trying to find a sustainable solution to feed the worlds growing population, PGPR and/or their secondary metabolites could prove to be crucial in continuing to provide a sustainable solution to meeting the worlds nutritional needs.

Keywords: Rhizobacteria, Plant Growth-Promotion, Volatile Organic Compounds, Sustainability

Sustainable Land Use & Agriculture 2

Effect of silage harvest date and fertilizer rate on modelled N2O and total greenhouse gas emissions from pasture based suckler beef systems

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The objective of this study was to determine the effect of fertilizer application rate and silage harvest date on N2O emissions and sustainability of pasture based suckler to beef production systems. A hybrid greenhouse gas (GHG) and bio economical model was used to determine the economic performance, N2O emissions and total GHG emissions of suckler to beef systems. New methods to quantify grass N composition and cattle N excretion, and recently developed country specific N2O emissions factors (EF) for excreta deposited onto pasture and fertilizer application were included in the hybrid model. Intensive and extensive bull/heifer and steer/heifer suckler to beef systems were chosen as baseline scenarios. Baseline scenarios were simulated at early and late silage harvest dates and at low and high fertilizer application rates. In total, 20 scenarios were simulated (4 baseline, 16 alternative) with emissions being determined on a carcase weight (CW) basis. The total GHG emissions for the alternative scenarios ranged from 15.97 to 19.00 kg CO2e kg CW-1, much lower than previous estimates and the EU average of 22.2 kg CO2e kg CW-1. Profit per hectare and kg N2O kg CW-1 increased with fertilizer application rate. Conversely, profit per hectare reduced while kg N2O kg CW-1 increased with later silage harvest date. Bull/heifer systems emitted less kg N2O kg CW-1 than steer/heifer systems. Extensive bull/heifer systems with a higher level of fertilizer application and early silage harvest were the most sustainable. The study found the modifications made to the model significantly improved the understanding of the effect of management practices on N2O emissions and the sustainability of pasture based suckler to beef production systems, thus addressing the theme of the conference.

Keywords: Greenhouse gas emissions; N2O; Suckler; Beef; Pasture

Nanotechnology & the Environment

Activated charcoal as a capture material for silver nanoparticles in environmental samples

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Due to their antibacterial properties silver nanoparticles (AgNPs) have been incorporated into numerous consumer products recently, including; textiles, medical products, domestic appliances, food containers, cosmetics, paints, and nano-functionalised plastics. This has created an interest in the impact they may have on the environment. AgNPs can be released into the environment during any phase of the products lifecycle. Uncertainties surround the concentration, fate, and effects of AgNPs in aquatic environments. The DeTER project has examined the suitability of activated charcoal as a capture material for AgNPs from water. Samples of 100 ppb 25 nm PVP coated AgNPs (nanoComposix) were initially generated and exposed to activated charcoal (Norit® CA1 (Sigma-Aldrich)) overnight to examine the capture of the AgNP by the charcoal the decrease in Ag concentration was measured using ICP-MS. Following the initial investigation the surface area of the charcoal was increased firstly with a pestle and mortar and secondly by milling the charcoal using a ball mill running at 500 rpm for 5 minutes. It was found that the milled charcoals increasesd surface area increased the capture of the AgNP from11.9% to 63.6% on average for the 100 ppb samples. Further invesatigations were carried out examining the effect on the capture of AgNP concentration, particle coating and the effect of exposure time to the activated charcoal. It was found that the capture of AgNP increased with decreasing concentration. A HCl leeching procedure was also developed which successfully removed the captured silver from the charcoal allowing the fraction captured by the charcoal to be quantified with an average of 94.8% recovered from the charcaol. In conclusion activated charcoal represents a suitable capture material for AgNPs in water samples.

Keywords: Silver nanoparticles, Chemical analysis, Activated charcoal, nanoparticle capture.

Estimating aggregation potential of PVP coated silver nanoparticles to surrogate colloid under environmentally relevant water conditions

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Silver (Ag) engineered nano materials (ENMs), used in consumable products and processes, invariably make their way through environmental pathways, eventually depositing in water compartments (rivers, streams and lakes). The unnatural forms of Ag materials, potentially accumulating in such compartments, may have adverse effects on biological species. Silver has enhanced microbial characteristics that may negatively affect the ecosystem. In these environments, silver nano particles (AgNPs) are likely to undergo surface modification due to interactions with ubiquitous colloid material and the chemical characteristics of the media. Silver, an oxidizable metal can release toxic Ag+ ions during particle surface dissolution. In this study, aggregation potential of 25 nm PVP functionalised particles was investigated under various aquatic conditions to estimate attachment (□) to a surrogate colloid material (glass beads). The influence of a representative colloid material - organic matter (OM) and changes in physiochemical conditions of the media where assessed to determine fate and behaviour of AgNPs. Formation of hetero-aggregates with the surrogate colloid was thought to result in removal of AgNPs via sedimentation in this study. Analysis of attachment/ aggregation was conducted using UV spectrophotometry at 405 nm and 650 nm wavelengths. It was observed that PVP coated AgNPs can be stabilised to a varying degree by increasing OM concentration under increasing electrolyte concentrations. Initial particle concentration of 1 ppm indicated 95% particle removal via hetero-aggregation within the time period ~2 hrs to ~42 hrs, depending on the experimental aquatic water conditions. Stabilized PVP coated AgNPs are likely to persist in freshwater systems and be dispersed widely throughout the water body by internal water currents.

Keywords: Nanosilver, UV spectrophotometry, aggregation

Waste Management 1

Waterboards on the way to recycle phosphorus

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The German waterboards Emschergenossenschaft and Lippeverband (EG/LV) produce about 90.000 tonnes dry matter sewage sludge per year. It is home for valuable phosphorus resources that are today mostly lost. Conscious of their societal role, EG/LV aims at achieving a sustainable recycling of phosphorus while ensuring a high safety level of the sewage sludge disposal routes at affordable costs. The Phos4You project supports EG/LV to tackle this challenge.
Due to the industrial character of the Emscher Region, already in the seventies the decision was taken to incinerate 100% of the sewage sludge. However, in the more rural catchment of the Lippe, land spreading has been a major recycling route for sewage sludge for years. But, due to growing concern in relation to contaminants, such as heavy metals and micropollutants, the decision was taken also here to discontinue direct land application. Since 2017, EG/LV incinerates more than 90% of its sewage sludge, mostly in two mono-sewage sludge incinerators located in the cities of Bottrop and Lünen.
Recovering the phosphorus contained in the sewage sludge ashes (SSA) is therefore an important option for the waterboards. In a longer-term perspective, and linked to reinvestment strategies, a further option could be: selecting a new available technology that enables the production of SSA meeting the requirements of a fertilizer. In that case, the recycling pathway would spare the phosphorus extraction´s step and the SSA would be directly usable for agriculture.
Preparing the deployment of the phosphorus recycling in urban and rural areas, is the core of the Phos4You project (funded by INTERREG VB Northwest Europe).
Phos4You demonstrates innovative phosphorus recovery technologies from waste water in real-life environments and showcases pathways to provide recycled phosphorus according to users´ requirements. With an integrated and transnational approach, Phos4You contributes to secure a long-term phosphorus supply for Europe.

Keywords: waste water treatment, sludge management, phosphorus recovery, phosphorus recycling

Waste Management 1

Biosorbents produced from waste crab carapace, oyster and mussel shell: Potential for phosphate removal and recovery from wastewater

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Phosphorus (P) fertiliser is commonly essential within modern food production/intensive farming systems. The vast majority of P for the fertiliser industry currently comes from mined rock-phosphate, which is a finite terrestrial resource. Hence, the recovery and re-use of valuable P from waste is now highly desirable. P recovery from wastewater, through the adsorption of P onto natural solid waste material may provide one solution. Ideally, this would be a low cost/low energy solution that would create a P-rich material (low in other sorbed contaminants) for use in agriculture as a fertilizer. In this study, calcium-rich biosorbents were prepared with/without thermal activation. Crab carapace (CCB), oyster (OSB) and mussel shells (MSB) were activated at various temperatures and then tested for P removal potential. As these crab/shell materials are largely mineral materials (with a low carbon content) Thermal activation up to 600ºC caused very nominal loss of mass (i.e., ~2% for all materials). However, with increased activation temperature, P removal efficiency also increased, from 35 to 63 % for CCB, from 9 to 18 % for MSB and from 17 to 42 % for OSB (with no activation vs 600ºC, respectively; at 23 mg/L initial P concentration). CCB (after thermal activation at 600ºC for 2h), had the highest adsorption capacity, which was 2.66 mg/g, as obtained from the Langmuir equation. The P recovery kinetic data fitted a pseudo-second-order model for the CCB. This work showed that such waste biosorbents may have potential for P recovery, however, further research will also consider different (i.e., thermo-chemical) activation methods to improve adsorption capacities.

Keywords: phosphorous recovery, calcium-rich biosorbents, thermal activation

Waste Management 1

Phos4You - Chlamydomonas acidophila as an alternative for Phosphorous recovery from wastewater

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Phosphorous (P) is an essential, indispensable, but non-renewable, nutrient used as a fertilizer for the growth of all crops. However, excessive use and potential discharge of P into the environment can lead to eutrophication, which results in algae bloom and dead zones. Therefore, recovering P from waste streams has become a major objective.

Scotland is considered as 97% rural with around 1600 WWTP of a capacity lower than 500PE. Recovering P from these small sites face several challenges as suitable systems require robustness and low maintenance plus the variability of P in wastewater is often high. The extremophilic microalgae Chlamydomonas acidophila, which grows at a pH of 2-3, appears to have potential for P recovery at these sites, as it is able to recover PO4 and NH4 in different wastewaters around 7 mg L-1d-1 and 9 mg L-1d-1 respectively. Furthermore, this species is mixotrophic so the presence of organic carbon in the effluent improves nutrient recovery efficiency.

This study investigates different parameters which may impact on the ability of this alga to recover P. One of the limiting factors in microalgae technology is light availability and work reported demonstrates that C. acidophila requires a very low light intensity to grow (40-113µmol photons m-2s-1). Additionally, the presence of micropollutants such as pharmaceuticals in urban wastewater could inhibit biological treatment processes. Here C. acidophila is shown to be a resistant species as it is able to grow and consume nutrients in the presence of pharmaceuticals 1000 times higher concentrations than the ones reported in these effluents. Based on the results obtained in this study, it can be suggested that C. acidophila seems to be suitable treatment option for P recovery for small scale WWTP. Work is on-going to scale up this evaluation to a pilot plant treating wastewater from a 500PE site.

Keywords: Phosphorous recovery, microalgae, wastewater treatment

Waste Management 1

Valorisation strategies for wastewater treatment sludge

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The production of sludge produced by municipal wastewater treatment plants (WWTPs) is expected to exceed 13 million tonnes (dry solids) by 2020 within the European Union. Considering that sludge handling accounts for up to 50% of the total operating costs of a WWTP, the development of a sustainable management strategy has become of great concern. Following the directive on waste landfill that has planned the progressive reduction of sludge disposal in dump sites, the two most common remaining valorisation issues are energy valorisation through incineration (cement kilns, coal-fired power plants, municipal waste incinerators and mono-incinerators) and agriculture valorisation through landspreading (after composting in some cases). However, the development of innovative systems to maximize the recovery of useful materials and/or energy is still required. Some strategies are oriented toward the conversion of sludge into energy carriers using gasification or pyrolysis. Others are focusing on the recovery of nutrients, especially phosphorus. This trends has been recently enhanced as the EU added phosphate rock to its list of critical raw materials in 2014. As wastewater, and associated sludges, are estimated to be able to cover a part of mineral P needs (26% of the demand in North West Europe), the development of P recovery technologies is growing, as proposed in the Phos4You Interreg project.
In that context, this presentation will give the last figures about sludge valorisation within the EU and will summarize the emerging management routes. The critical role of sludge dewatering and drying will developed in view of the optimization of the whole sludge treatment chain.

Keywords: Wastewater treatment sludge, management routes

Air Quality & Urban Development 1

The use of appropriate dispersion modelling techniques and representative meteorological data for the assessment of odour nuisance at the planning stage of developments in Ireland

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The Environmental Protection Agency (EPA) receives more complaints about odour nuisance than other environmental issues. According to the EPA Act (1992):

- Developers of certain types of facilities above a certain size are required to submit an Environmental Impact Statement (EIS)
- Odour is defined as an environmental pollutant under Section 4(2).

The assessment of odour nuisance for an EIS at the planning stage of developments is generally done using dispersion modelling techniques in accordance with EPA guidance (Air Dispersion Modelling from Industrial Installations Guidance Note (AG4)). AG4 recommends the use of simple screening models or advanced dispersion models.

Steady-state Gaussian plume models generally produce reliable results in locations where calm or light winds occur infrequently and where meteorological conditions are uniform over the extent of the modelling domain. Non-steady-state Gaussian puff models can achieve more reliable results in these circumstances and require a gridded meteorological dataset that simulates the 3-dimensional nature of the atmosphere (includes parameters such as wind speed, wind direction, temperature and atmospheric stability).

Katestone's recent review indicates that most odour modelling studies in Ireland adopt steady-state Gaussian plume modelling techniques. Meteorological data is derived in accordance with AG4 Guidance from a Met Eireann meteorological station. An assumption in most modelling in Ireland is that calm/light wind conditions are not of great importance to odour impacts.

In countries such as Australia, modelling guidance for odour impact assessment recommends the use of non-steady-state Gaussian puff models for certain facilities. These include intensive agricultural developments, wastewater treatment and waste management plants. Non-steady-state Gaussian puff modelling techniques are also required where steady-state Gaussian plume models are not likely to produce representative results. Katestone has investigated whether calm or light wind speed conditions are important to understand odour impacts in modelling studies in Ireland.

Keywords: odour, dispersion modelling, air quality, AERMOD, CALPUFF

Air Quality & Urban Development 1

Source Apportionment of Ambient Fine Particulate Matter (PM2.5) in the Greater Dublin Area: A Focus on Emissions from Diesel Vehicles

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Particulate Matter is one of the most problematic pollutants across Ireland, and recently the associations between exposure to ambient particulate matter and adverse health outcomes have been more firmly established. Diesel vehicles in particular are known for their significant contribution to overall emissions of particulate matter (PM2.5) in the atmosphere, and therefore constitute a significant threat to public health and the environment. A recent investigation of national emissions in the road transport sector in Ireland has highlighted that private diesel passenger cars contribute the largest proportion of total emissions in both CO2 and particulate matter of all vehicle categories. Owing to the recent growth in private diesel cars since 2008, this vehicle category represents a significant pressure on the quality of the urban environment in Ireland.
Determination of the proportion of total PM2.5 concentration in urban areas, which has originated from diesel vehicle emissions, using source apportionment techniques, is invaluable in assessing the impact of diesel emissions on population exposure in Ireland. Here we present data collected between 2017 and 2018, through field measurement of ambient PM2.5 at two sites, which are representative of a mixed commercial and residential neighbourhood and a busy city centre roadside location. We aim to generate evidence on the impact of diesel vehicles on the exposure of the population to PM2.5, by utilizing Positive Matrix Factorization (PMF) to quantify sources of ambient PM2.5 in the greater Dublin area. Our results show that while burning solid fuel for residential heating is a major contributor to PM2.5 at the urban residential microenvironment, the heavily trafficked urban roadside microenvironment is overwhelmingly dominated by PM2.5 sourced from vehicular emissions. Our ultimate aim is to estimate the contribution of PM2.5 that can be attributed to emissions from diesel vehicles.

Keywords: particulate matter, PM2.5, diesel emissions, source apportionment

AmmoniaN2K: Assessing the impact of ammonia emissions from poultry production in Ireland

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Poultry farming accounts for 1.5% of total ammonia emissions in Ireland, inclusive of broilers, layers, turkeys and other poultry. Given that cattle alone (excluding slurry spreading) accounts for 60% of national emissions, the contribution of poultry farming could be considered minimal. In Ireland, bird numbers range from 34,000 to 185,000 on individual sites. International evidence has shown that farms of this scale can produce concentrations of ammonia capable of negatively impacting local ecology. In order to model and therefore predict areas likely to be impacted by this atmospheric ammonia, it is important to understand how much ammonia is produced by an individual bird; this is known as an emission factor. The Irish Environmental Protection Agency (EPA) currently use poultry emission factors based on data from the United Kingdom pre 2004. The AmmoniaN2K project has monitored intensive broiler and layer farms in order to update the emission factors used by the EPA. As the impacts of ammonia from poultry farming are generally localised, knowing the locations of farms is vitally important when addressing impacts. Previously only the locations of 97 farms housing over 40,000 birds was available through the EPA. The AmmoniaN2K project has identified the locations of over 600 additional poultry farms with less than 40,000 bird places. If a sustainable future is to be met, the current potential impact of existing poultry farms in Ireland needs to be fully assessed before additional development of the sector is implemented. This includes a better understanding of both emission rates from Irish poultry and of the locations of all poultry farms. Further details of the overall EPA-funded research project can be found at the website www.ucd.ie/ammonian2k or on twitter https://twitter.com/AmmoniaN2K.

Keywords: Ammonia, Air pollution, Environmental Impact, Poultry, Emission Factor, EPA, Air Quality

Air Quality & Urban Development 1

Black Carbon in Ireland; Have we progressed from "the Dark Ages"?

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Prior to the introduction of the smoky coal ban in 1990, Dublin experienced episodes of smog more commonly associated with megacities like London, Paris and Los Angeles. These episodes of smog had detrimental effects on air quality and the health of the local population, with increased numbers of hospital admissions and fatalities. The implementation of the smoky coal ban gave rise to a large improvement in air quality in Dublin, and the subsequent extension of the ban yielded similar improvements in other cities and large towns around Ireland. It did nothing however, to improve the air quality in the smaller towns and rural areas of the country, as highlighted in the EPA-funded SAPPHIRE project and by recent measurements released by Wexford County Council. The efficacy of the original smoky coal ban was reflected by a large decrease in concentrations of Black Smoke, a metric for air pollution from combustion. These measurements, made by Dublin City Council, date back to the 1960s and run right up to 2003. Black Smoke measurements can be converted into Black Carbon, a newer and better defined metric for combustion particles. In this work, Black Carbon has been measured at an urban background location in Dublin, as part of the EPA-funded AEROSOURCE project, coordinated by NUI Galway. The Black Carbon measurements have been compared to the historical Black Smoke measurements in order to obtain a valuable perspective on levels of particulate pollution over the last 50 years. The results clearly show greatly reduced levels of particulate pollution in Dublin over this period. However, significant amounts of Black carbon are measured in Dublin, especially in winter months when solid fuel burning is more prevalent. The levels of Black Carbon are even higher in small towns where the smoky coal ban is not in effect.

Keywords: Atmospheric particles, Black Carbon, Black Smoke, Air Quality

Sustainable Infrastructure

The Renewable Engine Project: Supporting Research and Innovation Action in the Renewable Energy Sector

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Although there is a strong presence of advanced manufacturing and engineering, and renewable energy enterprises in the border regions of the Ireland, Northern Ireland and Scotland (as evidenced by the number of anaerobic digestion, marine energy conversion, solar and wind conversion systems available in the area), these enterprises are largely observed not to be well engaged in research and innovation (R&I) activities in a strategic and collaborative way, with limited activity and innovation in new products and process development. Thus the capacity of this high value sector to create a significantly enhanced economic as well as environmental impact is not currently realised. To achieve the sustainability, continuity and overall economic viability of regional enterprises operating in the renewable energy sector, a mechanism to provide R&I infrastructures is therefore needed.

This paper will elaborate on the INTERREG VA Programme funded "Renewable Engine Project", aimed at facilitating direct knowledge transfer and technology development in the Renewable Energy and Advanced Manufacturing sectors through the provision of industrial research support and technology development grants to companies. The energy and environmental targeted R& I activities of the Renewable Engine Project will be mainly carried out under the three main segments: Energy Generation and Conversion (including next generation bio-products production and optimization of PV/Wind/ Marine operation and manufacturing processes), Energy Storage (including air energy storage and battery technology), and Energy Connectivity (including flexible energy systems and control).The Renewable Engine Project involves four research institutes with specialist knowledge in Renewable Energy and Advanced Manufacturing Technologies. Led by South West College, Renewable Engine operates across a network of research institutes including Queens University Belfast, Institute of Technology (IT) Sligo and the University of Strathclyde's High-Value Manufacturing Catapult. This paper will highlight the R&I Renewable Engine and industrial collaboration activities carried out at IT Sligo, identify the potential challenges related to the case study research, and the overall potential environmental and energy impact of the research output for the region.

Keywords: Renewable Engine Project, Renewable Energy, Advanced Manufacturing, research and Innovation.

Sustainable Infrastructure

Reframing Nature-based Solutions

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Nature-based Solutions (NbS) aim to solve problems resulting from increasing global change by harnessing benefits arising from nature to create multi-beneficial solutions to local and global societal pressures. The recent emergence of NbS means that multiple definitions exist, causing confusion between, and within, disciplines, hampering the very power of the concept andits transdisciplinarity. The rigor of these definitions is analysed to assess the potential for whether these definitions will contribute to a meaningful and impactful development of the concept. There is a need for more rigor, with the multiple definitions in the literature synthesised into a holistic problem management strategy: the Nature-based Approach. This hierarchical conceptual framework places natural capital and regulating ecosystem services at the core of the Nature-based Approach. An implementation resulting from the Nature-based Approach is Nature-based Management; a management plan utilising the flows of regulatory ecosystem services to manage societal challenges. A Nature-based Solution then results only from Nature-based Management that is successful in meeting predefined targets. Terminology which lends greater clarity to the science-policy and transdisciplinary interfaces is suggested. Here, we unequivocally suggest that NbS need to be more rigorously defined, and should be a component of the more holistic problem management strategy, the Nature-based Approach. We suggest reconceptualising NbS and highlight critical gaps in our knowledge of which both scientists and policymakers should be aware. These changes must be made rapidly if NbS are to be impactful and meaningful in their implementation.

Keywords: Nature-based Solutions; green infrastructure; language; conceptual framework; ecosystem services; ecosystem function; natural capital

Sustainable Infrastructure

Identification and Mapping of Water-related Infrastructure in Ireland

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Much of Ireland's water-related research and monitoring facilities are operated on a stand-alone model, neither connected to other pieces of infrastructure, nor available to other research activity. There is currently no registry of water-related infrastructure in Ireland; researchers, industry and the public find it difficult to gather information and know what is available for use. To address this issue, this research aims to identify and map the location of all relevant water-research and monitoring infrastructure in Ireland, which will be made available to the public through an online interactive map of the database.

The project is building a database of water-research infrastructure around Ireland, including Northern Ireland, and information listing all relevant operational details. This database is then translated into an online catalogue. The platform will build on the Environmental Protection Agency's (EPA) DROPLET website, which is an easy-to-use interactive web application for exploring information about funded projects on water research in Ireland. To develop the online catalogue, a design workshop was organised with potential users of the platform, from universities, research institutes and state bodies. The workshop engaged in tasks to: define what key information users would look for; gather user needs to inform features to be incorporated in the software; understand how users will interact with the online tool through a Customer Journey Map; and discuss the future development of water research infrastructure in Ireland.

This online database will raise the profile of current research infrastructure, making researchers and the public more aware of available facilities and platforms and provide better access for upcoming projects. Looking forward, the mapping of research infrastructure and surveying the research community will enable the development of a strategic roadmap on how best to advance water research infrastructure in Ireland.

Keywords: Water Research Infrastructure, Online Catalogue, DROPLET, Design Thinking.

Smart Technology for the Environment

Development of a lab-on-chip electrochemical immunosensor for detection of Polycyclic Aromatic Hydrocarbons (PAH) in environmental water

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Polycyclic Aromatic Hydrocarbons (PAHs) refer to a large family of organic compounds consisting of carbon and hydrogen atoms, which present an important threat as environmental pollutants. PAH contamination has been reported to increase cancer risk in humans. Unfortunately, current methods used to measure PAHs in water require a complex analysis for these pollutants.

This research has focused on the integration of electrochemical techniques with an immunoassay method to develop a real time portable and accurate solution for detection of PAH in water.

Our integrative approach facilitates a real-time detection of this family of organic compounds, by reducing the time of analysis to less than one hour. Additionally, the use of a lab-on-a-chip platform delivers a portable solution that could be used for in situ monitoring.

By optimizing an indirect displacement immunoassay that investigates presence and concentrations of Benzo[a]pyrene, we have obtained, thanks to the miniaturization of the platform compared to standard ELISA plates, a highly accurate system that provides fast results. The limits of detection are comparable to those of available state-of-the-art tools. It also presents a linear range that is practical in the application of PAHs in water in accordance with the European Drinking Water Directive (DWD) ((98/83/EC), 0.01ng/ml is the limit for BaP in drinking water.

The outcome of this work will provide a portable device for PAHs detection in water and an acceptable reproducibility and good stability. This is a potential solution for domestic testing that would allow consumers to control the quality of their drinkable water, independently of any specialized laboratory, therefore reducing costs and efficiency in testing.

Keywords: Polycyclic aromatic hydrocarbons (PAHs), a lab-on-chip electrochemical immunosensor, environmental water

Separation of Organophosphate Nerve Agents by Capillary Electrophoresis and Microchip Capillary Electrophoresis

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The objective within this study is to develop miniaturised chemical analysis devices for chemical agents' detection. Organophosphate (OP) compounds, which commonly used as chemical warfare agents and pesticides, are chosen as analytes, due to their toxicity and requirements of rapid warning and field deployment. Capillary electrophoresis (CE) is one of the most powerful techniques and frequently used in different applications. In this study, Agilent CE 7100 (with UV detection), Shimadzu microchip CE 2010 (with UV detection), and a custom-made box (with contactless conductivity detection) were used. Short-end injection was used in Agilent CE, so that the separation was achieved in an 8.5 cm capillary. In Shimadzu microchip CE and custom-made box, glass chip with 2.5 cm separation channel and PDMS chip with 4.5 cm separation channel are used respectively. The effects of the SDS concentration, buffer pH, buffer type, separation voltage were investigated. Rapid separation was achieved by short-end injection in Agilent CE. The separation times of five organophosphate compounds in 8.5 cm capillary were 2.4 minutes with acetate buffer, 2.1 minutes with MES buffer and 3.3 minutes with MES/His buffer. Buffer pH from 4.0 to 7.0, SDS concentration from 0 mM to 15 mM, buffer concentration from 15 mM to 50 mM, and separation voltage from 15 kV to 25 kV were also optimised. A faster separation was performed by Shimadzu MCE within 45 seconds. 45 mM acetate buffer (pH 5.0) with 10 mM SDS and 1 kV separation voltage were used. The custom-made box was tested and successfully detected one organophosphate within 1.7 minutes. Future work will focuses on separation of these analytes on the miniaturised, portable, custom-made MCE device, to further reduce separation time and cost, and improve limit of detection.

Keywords: Pesticides, Capillary electrophoresis, Microchip Capillary Electrophoresis

A promising process to increase P recovery as mineral fertilizer from sewage sludge by bio-acidification

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The mineral fertilizer production as struvite (MgNH4PO4, 6H2O) or calcium phosphate is currently the most popular way to recycle P from wastewater as a valuable product. Several technologies are available on the market. They address the objective of recycling P combined with the aim of reducing the running costs of the WWTP by decreasing the amount of dissolved P returned to the WWTP after anaerobic sludge digestion. However, only 15-20 % of the total P entering the WWTP is dissolved after this step and can be recycled by these processes. The technology innovation proposed in the frame of the Phos4you project aims to dissolve P by 2 mechanisms:

- P release by the microorganisms which have accumulated the P during the wastewater treatment.
- Maintaining the P released by the bacteria in solution and dissolving the mineral P combined with cations by developing bacteria producing lactic acid in situ, decreasing the pH down to 4-5.

Both of these mechanisms were induced by adding an easily degradable carbohydrate source into the sludge in strict anaerobic conditions. Previous results have shown that up to 75% of the P in sludge can be dissolved by this biological acidification process at lab scale. To select the best place for P dissolving before recovery by the Struvia process, a test was performed to assess the bio-P dissolution potential at different sampling points in a large WWTP combining biological and chemical P removal with aluminum salts. Thickened biological sludge (BS), BS mixed with thickened primary sludge (MS) and digested MS (DMS) were tested. Between 30% and 70% of P were dissolved by the bio-acidification process depending on the sludge, the best result was obtained with the MS and the lowest P dissolution was obtained with DMS even with the addition of twice the amount of the easily degradable carbohydrate. Up to 77% of the calcium and 88% of the magnesium were also dissolved by the process. On the precipitation and final recovery product side, the molar ratio tends to be in favor of the calcium phosphate route (Ca/P=1.94) rather than struvite precipitation (Mg/P=0.42), whatever the sludge tested. However, even if the N/P molar ratio is higher than 1 (N/P=1.35), and struvite is the desired product, the use of partial mix with digested sludge will lead to a more suitable N/P ratio.

Keywords: P recycling, struvite, sewage sludge, bio-acidification

Associations between mutations responsible for Citrullinemia, Jersey Haplotype 1, Congenital Muscular Dystonia 1 and udder health in dairy cattle

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The maintenance of carriers of lethal recessive genes which are associated with other more positive impacts on production traits could justify maintenance of carriers and improve profitability on farm. The purpose of this study was to ascertain if carriers of lethal recessive genetic disorders: Citrullinemia, Jersey haplotype 1 (JH1) and Congenital Muscular Dystonia 1 (CMD1) were associated with effects on carcass traits and somatic cell count. Genotypes for Citrullinemia, JH1 and CMD1 of 10,707 dairy cattle were acquired in addition to the phenotypes, in the form of predicted transmitting abilities (PTAs) for carcass and udder health related traits, from the Irish Cattle Breeding Federation. The PTAs were deregressed and an association between these and each SNP was analysed in ASReml using a weighted mixed animal model. The adjusted reliability cut-off was set at >10%. No significant association ($p>0.05$) between polymorphisms responsible for Citrullinemia, JH1 or CMD1 was observed on the carcass traits examined which included carcass weight (n=3194), carcass confirmation (n=518), carcass fat (n=360) and culled cow weight (n=1374) in the sample set analysed. Somatic Cell Score (SCS) was also investigated in order to determine if there was an association between the examined lethal recessive genes, and an increase or decrease in the SCS in the sample set (n=5747) analysed. No significant association was found with Citrullinemia or CMD1 carriers, however, a tentative association ($p<0.1$) between JH1 and SCS (0.09, s.e. 0.048) was identified. These results suggest no significant benefits for maintenance of carriers of Citrullinemia and CMD1, however, further investigation into the association between JH1 and SCS is warranted which demonstrates the careful consideration needed to achieve optimum selective breeding goals and improvement of the genetic merit of the national herd.

Keywords: genetics, dairy cattle, lethal recessives

Waste Management 2

Cost assessment of different routes for phosphorus recovery from wastewater using data from pilot and production plants

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Phosphorus recovery from wastewater has considerable potential to supplement limited fossil phosphorus reserves. Reliable cost data are essential for investor and policymaker decisions. In the FP7-project P-REX, investment and operational costs for nine phosphorus (P) recovery processes were calculated from the investor's perspective, taking into account all relevant side effects on the sludge treatment or the wastewater treatment plant. The assessment was based on pilot and full-scale data which were thoroughly consolidated and standardized with technical and cost data from the German wastewater-sludge treatment train to enable direct comparison. The cost influence of precipitation processes on the current wastewater-sludge treatment train ranges from -0.14 (generating profit) to 0.23 EUR per population equivalent (PE) and year, while the cost influence of sludge leaching processes is around 2.50 EUR/(PE y). The cost influence of processes using dry sludge and mono-incineration ash varies between 0.33 and 3.13 EUR/(PE y), depending on existing disposal pathways, mono-incineration, co-incineration or agricultural use of sludge. The specific costs per kg phosphorus recovered (-4 to 10 EUR/kg P) are in general higher than conventional fertilizer production (1.6 EUR/kg P). However, annual costs per PE represent less than 3% of the total costs for wastewater disposal.
In the ongoing Interreg project Phos4You, 6 recovery processes will be demonstrated varying vastly in scale, from approximately 10 PE to 1 Mio PE. The LCC (and LCA) methodology will be a compromise between the case specificity and the need to generalize. On the one hand, local conditions decide which processes can be applied and the ranking of processes, making the results site specific. On the other hand, comparison and generalization can increase the transferability of the results.

Keywords: cost, LCC, phosphorus, recovery process, sewage sludge ash, wastewater

Waste Management 2

Biomethane potential assays to maximise biogas productivity by co-digestion of Grass silage (GS) and Chicken litter (CL)

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In the present study, co-digestion ratios of GS and CL have been investigated by performing biomethane potential assays to determine the ratio that yields highest biogas and methane volume.
CL is rich in organic matter (c. 50%) which translates to a theoretical yield of 200m3 of biogas per kg of CL. The main problem with its disposal is that it has high phosphorous and thus in compliance with EU regulations, it cannot be simply spread on land as this poses a risk of contamination. GS is a widely used animal feedstock in Ireland and is easily available throughout the country. To date, there is a lack of data on the co-digestion of these substrates and their methane production potential.
Biomethane potential (BMP) assays were conducted for a 30days in 125 ml serum bottles at 37°C. All assays contained 2g by volatile solids of the GS and CL respectively in nine different GS:CL ratios- 0:1, 1:0, 1:1, 1:2, 1:3, 2:3, 3:2, 3:1, and 2:1. All assays were done in triplicates and biogas samples collected were pooled in gas bags. These were later analysed for % CH4 content using GC-FID. Highest CH4 yields were recorded for ratios of 1:3 and 1:1 of GS: CL, 137 ml CH4 /g VS and 135 ml CH4 /g VS respectively. These values represent increases of CH4 volumes recorded for either of the substrates compared to when digested individually, GS - 79 ml CH4 /g VS and CL - 124 ml CH4 /g VS. The co-digestion ratio of 1:3 will be used future studies as it not only gives highest methane yields but also because it uses 3 parts of CL which is a problem waste and only 1 part of GS which is a valuable animal feedstock.

Keywords: Co-digestion, biogas, biomethane potential, organic matter

Waste Management 2

Food Waste in the Irish Commercial Food Industry

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Food waste is widely recognised as a significant environmental, economic and social problem. In industrialised countries, the commercial sector (e.g. food retail and food service) has been identified as part of the food system with some of the greatest possibility for food waste reduction. While there is some data on overall quantities of food waste nationally, there is currently a lack of qualitative and sectoral-based data on commercial food waste in Ireland. It is broadly estimated that 200,000 tonne of food waste is generated by the Irish commercial sector. This study examines the quantities, types, and reasons for food waste in Irish food retail and food service. Primary data collection is through on-site waste composition analysis, involving the separation, grouping and weighing of food waste. The waste is grouped according to food type, waste type (e.g. preparation waste, unserved food, plate waste) and serving method. Through this, detailed qualitative and quantitative data on food waste within Irish businesses is being gathered. This data is used to generate preliminary, sectoral benchmark values on food waste generation. These benchmark values are in turn used to improve overall estimates of commercially generated food waste. They can also inform individual businesses of their performance, in terms of food waste, relative to others in the same sector. In addition, relevant food waste prevention practices are being identified to inform future, sector-specific best practice. The results of this work are relevant for businesses and sectoral organisations, as well as for policy makers.

Keywords: food waste, waste composition analysis, waste prevention, food service, food retail

Air Quality & Urban Development 2

Assessing the impact of emissions from diesel vehicles on air quality by using micro-simulation studies

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Diesel particulate matter (DPM) has been classified as "reasonably carcinogenic" by the U.S. Department of Health and Human Services. Moreover, the World Health Organization classifies it as "carcinogenic to humans". Due to the carcinogenic content of particulate matter the emission from diesel vehicles can result in air toxicity. This study focuses on the assessment of impact of PM2.5 emitted from diesel vehicles on the urban road network in Dublin. Verkehr In Stadten–SIMulations model (VISSIM) has been used to generate micro simulations at a local scale for analysis in the study area. An area extending to 0.30 sq. km near Dublin City Centre (7.26 km of road network) has been selected for the purpose of this study. The micro simulation takes into account the various types of vehicle categories that are observed in the study area. A base simulation was developed initially on the study area road network with the generic composition of the traffic volume, and the model was calibrated by using the observed traffic count information obtained from Dublin City Council. Three different future scenario representation of forecasted vehicle volume were identified to obtain the potential impact of diesel vehicle emissions in the future. The PM2.5 emission was modelled from the simulated activity data of the vehicles under different scenarios. Further, by accounting for the emission percentage of each type of vehicle operating on road, the cumulative rate of emission is obtained from this simulation study. Current research focuses on observing the impact of modernizing the vehicle fleet on the basis of the forecasted results obtained from the model. The policy measures can be proposed in terms of improvement of emission standards, restriction in speed limit in Dublin City, pedestrianisation of streets, scrappage of older vehicles, introduction of electric vehicles, projected growth in vehicle numbers & mileage rates.

Keywords: PM2.5, VISSIM, Micro-simulation, Dublin City Centre

Air Quality & Urban Development 2

AmmoniaN2K: Monitoring ambient ammonia concentrations on Natura 2000 sites in Ireland

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Ammonia is one of the five air pollutants set under the National Emissions Ceilings Directive which targets emission reductions for 2020 and 2030. In Ireland, there are over 100 Kilotonnes of ammonia emitted annually, of which agriculture is responsible for 98%. Ammonia can negatively impact the environment through both eutrophication and acidification. Critical levels have been set internationally for lichens and mosses (1µg/m3) and higher plants (3µg/m3). A critical level refers to a concentration in the air above which negative impacts are likely to be observed. Sensitive areas such as Natura 2000 sites can be particularly at risk from elevated ammonia concentration levels. This project is currently monitoring 13 Natura 2000 sites within the Republic of Ireland. An additional site in Northern Ireland (Lough Navar) is being monitored for cross calibration with the monitoring network in the United Kingdom. Concentrations are recorded using ALPHA (Adapted Low-cost Passive High Absorption) samplers which are prepared monthly in UCD and posted out to National Parks and Wildlife Services (NPWS) staff who exchange the samplers on site. These are then returned to UCD every month for analysis. This research is taking place over a 12 month period with six months of provisional results available to date; these have shown that upland sites appear to have negligible ammonia concentration levels, while midland bogs regularly exceed the critical levels. The influence of slurry spreading is also particularly obvious on certain sites, with very high concentrations observed periodically. In this study, sites were selected based on availability of NPWS staff to deploy ALPHA samplers monthly. If a sustainable future is to be achieved as highlighted in the conference theme, this practice must be significantly expanded to cover a broader diversity of sites for a more comprehensive monitoring programme.

Key words: Ammonia, Natura 2000, ALPHA sampler, Air pollution, Biodiversity, Air quality, Ireland

Institutional properties in Cork county borough

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The institutional property represents an integral element of society and social organisation. This 'sociofact' is positioned at the core of the systemic reference and by definition, is susceptible to volatile social, economic and cultural trends. While such trends can enhance the proficiency of such entities, they can equally impede their work and even threaten their continuance.

Acknowledging the fundamental role of institutional properties and the need to address the pronounced gap in the knowledge base detailing the causal and trendal factors impacting upon such institutions, the methodological framework employed to support this research is four fold. First, the research aims encompass profiling the historical development of the institutions to evaluating their potential for space re-use, with objectives activating documentary analysis and investigative techniques. Exploration of primary and secondary sources constitute the second concentration, with sample selection spanning medical, religious and educational genres in Cork county borough representing the third. Finally, data evaluation utilises humanistic constructs through the medium of Nvivo.

The findings of the research demonstrate that medical, religious and educational institutions in Cork county borough are in a state of flux. The factors generating this uncertainty emanate from matters attributed to social, economic and cultural change. They are manifesting themselves in declining staffing and clientele profiles and the new reality sees a shift in space use patterns. The opportunity provided by this shift is such that adaptations and re-use can be explored. In many instances, such re-use has yielded the incorporation of unique and innovative uses into such spaces. The resulting rejuvenation has been propagated in keeping with the charism of these institutions and in so doing, has secured the future of these institutional spaces in Cork for generations to come.

Keywords: Institutional property; Medical; Religious; Educational

The Human Built Environment

A comparative analysis of simulated and measured overheating patterns in an NZEB dwelling using Passivhaus standard protocols

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Since the recast of the European Performance of Buildings Directive in 2011, achieving Nearly Zero Energy Buildings (NZEB) becomes a mandatory standard for new dwellings constructed from 2020. Article 4 of the EPBD outlines that due consideration should be given to maintaining general indoor climate conditions to avoid negative effects, including overheating. State level legislation across Europe addresses the EPBD's requirements in terms of reduced energy consumption, however guidance does not address the requirements of article 4, in addressing overheating as a consequence of better insulated and air tight dwellings. An increase in the number of certified Passivhaus (PH) designers in Ireland in recent years has seen an increase in the implementation of PH standards and Passive House Planning Package (PHPP), which incorporates the requirements of DIN1946-2 in assessing the probability of annual overheating.

This research assesses the annual overheating patterns for an NZEB dwelling. The test dwelling is in Douglas, Co. Cork. PHPP demonstrates that the dwelling has a space heat demand of 14.5kWh/m2/yr. The overheating assessment requires that the mean indoor temperature does not exceed 25□C for more than 10% of a typical year. Temperature sensors measure overheating zonally within the test dwelling, with each habitable space representing a zone.

The simulated overheating percentage for a typical year is 0%, while the measured temperature taken as a volume weighted mean, indicates an overheating percentage of 1.25%. The significance of this 1.25% is not apparent when represented as a percentage of a year, as it would be representative of 4.56 days per year. The actual number of days where the mean temperature exceeds 25□C is 14 days, representing a significant difference from the representative 4.56 days. When the zonal temperature readings are analysed there is a clear variation in overheating using the zonal method and the dwelling mean temperature. One particular zone experiences overheating on 69 individual days of the year, highlighting an inaccuracy in the use of a dwelling mean temperature to predict or measure overheating.

Keywords: Overheating; Passivhaus; NZEB; EPBD

Social Sustainability in the management of Irish construction projects

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The rationale for this research is to identify and assess the application of social sustainability in the management of Irish construction projects. The definition of sustainability in the built environment that has the widest acceptance is the 'Triple bottom line' concept, which emerged from the UNs 'Brundtland Report' in 1985. This concept characterises sustainability as having environmental, economic and social components. The majority of research and commentary to date is very much focused on the environmental component.

This research attempts to identify and measure social sustainability within the Irish Regulatory Framework (IRF), and best practice voluntary systems, as applied to the management of Irish construction projects. In order to achieve this aim, social sustainability has to be adequately defined, isolated from the other two components, be identified within the management instruments used on construction projects, and have its application (or lack of) assessed.

The methodology adopted to achieve this aim, involves mapping the IRF and voluntary systems used on Irish construction projects against the management section of an International best practice sustainability measurement system, BREEAM International 2013. In addition to this principal mapping exercise, the social sustainability credentials of BREEAMs management section are verified by mapping them against the Berkeley research groups 'Creating successful places', social sustainability framework.

The application of social sustainability is then assessed using primary data derived from semi-structured interviews applied to three case studies of construction projects of varying monetary values and complexities.

The ultimate output of the research is focused on producing an interactive framework for identifying and assessing social sustainability on Irish construction projects, based on the mapping exercise and the primary data from the case studies.

Keywords. Social Sustainability, Irish Regulatory Framework, BREEAM (Building Research Establishment Environmental Assessment Method)

The Human Built Environment

Catering for the human (user) experience within the built environment in the age of information technology

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The 20th and the 21st century have seen the built environment evolve, expand and technically advance. Together architects and engineers are pushing the boundaries of environmental strategies, smart schemes, all of which aim to contribute to improving the standard of living within the built environment. In this age of rapidly advancing technological systems, are we asking the right questions? Have we taken time to assess how this approach toward designing the built environment, may impact the human (user) experience?
Winston Churchill said "we shape our buildings; thereafter they shape us", and so the question emerges, how are these smart, environmentally focused buildings affecting the human (user) experience? Also, are the architects and engineers responsible for these designs able to assess and answer these questions?
Intelligent advancements are a daily occurrence in today's society but are the people who occupy society keeping pace? Are smart technology's outsmarting their designers, and what measures are being put in place to ensure the human (user) experience remains on the hierarchy?
It is important to remain grounded. Every advanced product, every sustainable strategy implemented and every smart building erected is essentially to be used by people. Why aspire to sustain the environment through smart technologies if we do not sustain our people.
Recent research suggests there is a Gap in Knowledge in both industry and education. Validation through the visual aesthetic being one of the major concerns in industry, which may be due to a lack of necessary knowledge. Are we educating our architects and engineers to cater for the human (user) experience in a technology dominated society?

Keywords: user-experience, information age, smart building

The Human Built Environment

Co-Design for Energy Efficient Buildings

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The EU H2020 project, NewTREND, seeks to improve the energy efficiency of the existing building stock and improve the renovation rate by developing a new participatory integrated design methodology. The main aim of this research is to consider a collaborative approach for engaging with building users and occupants during the design process and develop an approach to occupant and user engagement that utilises co-design principles. Co-design is a family of approaches, with roots in participatory, community and user-let design. It has evolved across fields such as information technology, urban planning, architecture and consumer goods, aiming to widen participation and integrate end users in the design process.

Co-design has implications in terms of the changing roles of stakeholders. It requires the active involvement of the typically more passive or overlooked stakeholders such as building users, employees, customers or community members, not normally central to the design process. The role of the designer shifts towards being a facilitator, helping occupants and users realise their aims and ideas for the building. As part of the NewTREND project, UCC, assisted by its project partners, is undertaking a series of stakeholder engagement activities with the objective of eliciting attitudes and opinions, as well as trialling methodologies and documenting behaviours. Where participation is invited, it is often limited to consultation after the majority of the design process is already complete. The NewTREND approach will include six levels of engagement in order to address this, (ranging from the least preferable to the most preferable); informing, consultation, dialogue, collaboration, delegated power and co-design. This paper relates to the activities undertaken at three case study retrofitting projects in Sant Cugat (Spain), Seinajoki, (Finland), and Budapest (Hungary).

Keywords: Co-design, Building occupants, Building users, Participatory, Collaborative, Engagement

Climate Change

Developing a Collective Vision for Community Led Energy Transition

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The Irish Government has pledged to transition to a low-carbon society by 2050, yet it is widely acknowledged that Ireland will fail to meet its EU 2020 GHG emission reduction targets. This failure will lead to greater challenges in meeting future targets. Literature increasingly points towards the importance of local level action in meeting long-term sustainability goals and climate change action. Developing a sustainable vision for the future requires finding solutions involving collective effort from all levels of society.

Building on previous work examining motivations and barriers to action experienced by voluntary sustainable action community groups, this study applies a participatory backcasting scenario approach to construct the necessary steps to achieve transformative societal change. Using participative processes designed to involve stakeholders in visionary and problem-solving activities; participants go beyond 'usual' thinking and instead consider requirements for improved processes for building both awareness and capacity in developing local level climate change solutions. Results form the basis for reasoned policy recommendations primarily focused on sectors (i) within the control of communities, and (ii) significant in climate protection policy, thereby providing a link between international and national targets on one side and a range of local actions and options on the other.

The consequences of failure to meet EU 2020 targets will result in a situation where Ireland will need to borrow to pay fines and as yet unknown damage to the economy and international reputation. In addition, damage to infrastructure, coastal and river defences, business, agriculture, and society are uncertain. Many climate change studies address action at global and national levels, with limited potential for community involvement. Transitioning to greater sustainability requires appropriate participatory governance in planning and decision-making processes. This study contributes in aligning long-term climate change policy to the preferred future vision of communities in bringing about such a transition.

Keywords: Participatory governance, scenario analysis, backcasting, community, climate action

Climate Change

Social Acceptance of Renewable Energy: Exploring a Citizen Centric Paradigm

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The energy landscape in Ireland is facing significant transformation. This research examines public attitudes towards renewable energy (RE) and climate change in Ireland, and investigates the significance of the 'energy citizen' neologism in Irish political dialect.

An exploratory concurrent mixed methods research design has been utilised. Qualitative research involves semi-structured interviews with seven industry thought leaders. A bespoke online survey provides both quantitative and qualitative data, from a non-probability, self-selection sample of 455 participants. Social media research uses social listening techniques to monitor public discourse through the lens of the microblogging site Twitter®. The three-pronged study combines different strands of primary research, utilising triangulation to validate findings.

The multi-dimensional method provides a plethora of new findings. 75% of survey participants agree with the notion of hosting a RE development in their community. Strong support for RE technologies was also evident, for example, 90% of respondents indicate support for solar energy. Over 52% of participants show interest in investing in a local RE development. Over 70% of survey respondents react positively to the concept of the 'energy citizen' in the context of energy policy discourse and almost 90% of participants agree that "as citizens we must do more to combat climate change". In contrast, qualitative findings recognise the significant social acceptance challenges that must be overcome at a community level to implement RE technologies.

This study presents a familiar dichotomy; public acceptance of renewable energy at a socio-political level contrasts with social opposition in a local context. Arriving at a sustainable future will require a paradigm shift to positively engage citizens. From an energy policy perspective, the broadly positive sentiment towards the 'energy citizen' is encouraging. The research findings provide new information related to RE and climate change that can inform the development of energy policy.

Keywords: Climate change, renewable energy, citizen engagement, Irish Policy

Climate Change

The potential and limitations of negative emissions technologies at a small nation scale

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Negative emission technologies (NETs) are any activity that removes carbon from the atmosphere. Examples include bioenergy with carbon capture and storage (BECCS), direct air carbon capture and storage (DACCS), soil carbon management, afforestation and biochar. Each option typically involves the biological or technological capturing of carbon dioxide from the atmosphere and storing the resultant carbon in the biosphere (e.g. In biomass or soil carbon) or geosphere (e.g. In depleted oil gas reservoirs). NETs may have the potential to contribute significantly towards achieving the Paris Agreement temperature goals.

A preliminarily assessment of the indigenous NETs carbon removal capacity of Ireland is carried out using a simple model constrained by land area availability. The results find that, under relatively conservative land area availability, there may be significant carbon removal potential across a number of NET options. The highest potential cumulative carbon removal capacities for Ireland are from BECCS and DACCS, neither of which are currently deployment-ready. Lower potential capacities were found for NETs that are deployment-ready in Ireland: afforestation, biochar, and organic soil carbon management. These could provide immediate but saturation-limited and non-permanent carbon removal and storage. We present all these options for Ireland under the categories of relative carbon removal capacity, readiness, cost, vulnerability to re-release of captured carbon, vulnerability to future climate change, biodiversity risk, energy penalty and land pressure. Our findings show NETs deployment may have potential to moderate Irish nett emissions somewhat in the future, however this potential currently remains speculative and uncertain. Hence, near-term emissions reductions must still be prioritised.

Future national research priorities were identified, particularly in relation soil carbon saturation deficits, bioenergy productivity and geological carbon storage potential. Future work will consider the yield potential for two bioenergy crops, Miscanthus and willow, under current and possible future Irish climate scenarios using the crop productivity model BioCro.

Keywords: Negative emissions technology, Carbon dioxide removal, bioenergy crops, carbon capture and storage

Climate Change

Estimating National Carbon Quotas and Modelling Compatible Emission Pathways at a Small Nation Scale

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In light of the Paris Agreement to limit global warming to 'well below 2 °C', a key question is how to achieve fair allocation of the remaining global carbon budget and responsibility for negative emissions among UNFCCC Parties. To inform nation-scale modelling of rapid escalation of CO2 removal through negative emissions technologies (NETs) and to progress the practical pursuit of mitigation actions in line with the Paris Agreement, we present a case study estimating the remaining national carbon quota for Ireland. We explore the implications of these CO2 quota estimates for current and future Irish emission pathways, which potentially already include tacit obligations for deployment of NETs – at early and significant scale – to achieve land-based sequestration and geological carbon storage.

We consider five carbon quota allocation rules from the existing literature with differing weightings of inertia and equity. As of the end of 2017, a remaining "pure-inertia" CO□ quota for Ireland (assuming commensurate action on non-CO2 forcings) is estimated at about 900 MtCO2. A "pure-equity" quota is estimated at about 500 MtCO2. Fully allowing for historical responsibility and relative capacity would arguably constrain the quota still further. As of 2016, Ireland reported annual territorial emissions of approximately 40 MtCO2 (~8.4 tCO2 per capita) in addition to nett land use emissions of ~3.7 MtCO2. Meeting the inertia and equity quotas would already require sustained reduction rates (of nett CO2 emissions) in excess of 4% yr-1 or 8% yr-1 respectively.

Finally, we model, investigate and critically assess a number of alternative pathway combinations of gross emissions and removals aligned with the estimated Irish nett CO2 quotas.

Keywords: Paris Agreement, climate change, negative emissions technology, carbon dioxide removal, Ireland, national carbon quota, equity.

Climate Change

ECCO Creating new Energy Community COoperations – An overview

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The paper describes the aims and objectives a recently approved project under the Interreg North-West Europe (NWE) Programme entitled ECCO, Creating new Energy Community COoperations.
The NWE region is faced with a significant challenge to unlock new renewable energy sources to meet its Green House Gas (GHG) emissions targets and improve energy security. This energy transformation process demands not only the substitution of fossil sources with renewable ones, but also a change in how the whole energy production & distribution system is organised. Rural areas have a significant potential for the harvesting of renewable energy, using different resources such as solid biomass, solar, hydro and wind. However, due to lack of finances and coherent policies, and often a strong resistance from local communities, these are still underexploited.
There is a growing recognition that a key element in overcoming these barriers and helping the NWE region to achieve its GHG reduction targets is to ensure that rural communities and citizens become fully involved in the renewable energy business through enabling rural communities to implement their own renewable energy projects. Cooperatives have historically played an important role in developing local rural economies. In both Germany and the Netherlands, the community cooperative model has been employed successfully in expanding renewable energy production.
This project builds further on already existing rural energy community cooperatives (ECCO's), their good practices but especially focussing on the challenges they face to develop into fully fledged 'agents of change' in a future low carbon energy policy that can compete with the traditional solely profit-driven energy industry. It replaces the current 'ad hoc' development process with a proven and transferable methodological framework that takes into account key issues to enable ECCO's to emerge and develop into viable and reliable stakeholders in the low carbon energy field of the future.

Keywords: Community Energy Cooperative, GHG

Environmental Sciences Association of Ireland

CORK INSTITUTE OF TECHNOLOGY
INSTITIÚID TEICNEOLAÍOCHTA CHORCAÍ

Environ 2018

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Arriving at a Sustainable Future
28th Irish Environmental Research Colloquium

POSTER PRESENTATION ABSTRACTS
(Listed by Theme)

Marine & Coastal (MC)
Ecotoxicology & Invasive Species (EI)
Energy (EN)
Environmental Management (EM)
Water Quality & Resources (WQ)
Human Health (HH)
Sustainable Land Use & Agriculture (SL)
Environmental Policy & Communication (EP)
Nanotechnology & the Environment (NE)
Waste Management (WM)
Air Quality & Urban Development (AQ)
Sustainable Infrastructure (SI)
Smart Technology for the Environment (ST)
The Human Built Environment (HB)
Climate Change (CC)

MC1. Developing Leave No Trace Ireland Skills and Ethics for the Coastal Environment

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The coast provides a multitude of resources and is home to many species of flora and fauna that are specially adapted to living in this harsh environment. It is also a popular destination for tourism and recreation. In recent years, partly due to the success of schemes such as the Wild Atlantic Way, the number of visitors to the Irish coastline for outdoor recreation and tourism has dramatically increased. Increased visitation provides many benefits, socially and economically but also has adverse impacts on the natural environment. The aim of this study was to consider the need for, and to create a "Leave No Trace Ireland" Skills and Ethics programme tailored to the coastal environment. This was achieved through a desk study and field work. A case study assessing the impacts of the designation of the Wild Atlantic Way in County Mayo was undertaken and the research team sought the opinions of the local community along the WAW on the impacts of recreation on the coast. The results show that coastal recreation is increasing in Ireland, particularly along its west coast and that impacts from recreation are already evident. There is currently no information to inform individuals and groups on best practices with respect to coastal recreation, demonstrating the need for guidance to be established. The minimum impact practices of "Leave No Trace" and public education and awareness, can help to significantly reduce environmental damage in the coastal zone. To address the current lack of guidance available, a "Leave No Trace Ireland" Skills and Ethics document for the coast was developed.

Keywords: Coastal recreation, minimum impact, best practice, Wild Atlantic Way

MC2. Comparison of LiDAR and UAV-based data for 3D modelling of a coastal dune complex

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Three-dimensional topographical models of coastal areas are critical for the development of targeted land management actions to reduce the influence of environmental issues. LiDAR and photogrammetric solutions using Unmanned Aerial Vehicle (UAV) platforms are useful methods to generate three-dimensional topographical models for target areas around 50-100 hectares. LiDAR data is often available from National Mapping Agencies (NMAs), such as Ordnance Surveying Ireland (OSi) who charge □€250 per square kilometre for such data. OSi quote a spatial resolution and vertical accuracy in rural areas of 0.5m and 0.5m respectively. LiDAR data can be used to generate both Digital Terrain Models (DTM) and Digital Surface Models (DSM). UAV-based photogrammetry is a more recent on-site surveying technology and can gather modelling data with controllable resolution. This research compared these two methods by modelling the Buckroney dune complex in Co. Wicklow using both LiDAR data and three related datasets collected using a UAV. It is suggested the comparison of this LiDAR and UAV gathered data undertaken in this research could provide reference information for others to select suitable methods for topographic modelling of similar environments. LiDAR data of the study site, dating to 2011, was acquired from OSi and was processed to produce a DSM. A Trimble eBee UAV with an 18mp camera was used to collect imagery for the 60 ha site. Total flight time was 60 minutes. The results of the UAV survey was a point cloud, orthophotos and a DEM of the study site. The spatial resolution of the point cloud was 0.125m with a Root-Mean-Square error of 0.050m against ground control. Distance comparison was conducted between the LiDAR point cloud and the point cloud from the UAV collected datasets. The mean separation was 0.44m. This research concluded that LiDAR and UAV collected datasets were both suitable choices to create three-dimensional topographical models for target areas around 50-100 hectares. LiDAR data can save on data acquisition time if it is available. Whereas, UAV technology enables more up-to-date, more accurate and higher resolution mapping data to be gathered.

MC3. The cultivable surface microbiota of decaying Ascophyllum nodosum as a source of algal cell wall degrading enzymes with potential utility in enzyme-assisted extraction technologies.

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Seaweeds are of interest to the food, pharmaceutical and agricultural industries due to their high nutritional content and the prevalence of bioactive compounds with beneficial health effects. Current extraction methods of macroalgal-derived metabolites are problematic due to the complexity of the algal cell wall. The use of advanced extraction methods such as enzyme-assisted extraction (EAE) are becoming more popular as they allow the development of more efficient and eco-friendly processes than current methods. Seaweed-associated bacteria are likely to produce cell wall polysaccharidases as a mechanism to mobilize polymers for nutritional purposes when growing in a nutrient limited state, such as growth on decaying algae. Ascophyllum nodosum samples were collected from Irish coast and incubated in artificial seawater for six weeks at three different temperatures (18°C, 25°C and 30°C) to induce decay. Microbial communities associated with the intact and decaying macroalga were examined using Illumina Miseq sequencing and culture-dependent approachesThe bacterial populations associated with the seaweed were observed to change markedly upon decay with a substantial decrease in the relative abundances of certain phyla including Planctomycetes, Verrucomicrobia, Cyanobacteria and Actinobacteria observed during the decay period. Distinct trends were observed between temperature and the relative abundances of some of the phyla present. A total of over 800 bacterial isolates were cultured from the macroalga including a range of species from the phylum Bacteroidetes together with a number of Vibrio species which displayed multiple hydrolytic enzyme activities including agarase, amylase, alginate degradation, carrageenase and pectinase activities. Extracts from these enzyme active bacterial isolates were shown to be as efficient as commercial enzymes

Keywords: Ascophyllum nodosum, algal cell wall degrading enzymes, enzyme-assisted extraction, iChip

MC4. High-speed Gulf VII plankton sampler effectively captures gelatinous zooplankton assemblages

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Despite a surge in gelatinous zooplankton ecology research over the past twenty years, many offshore species have remained understudied due to their small size and difficulty to sample effectively. To date, the only extensive plankton monitoring scheme in place in Irish & UK waters is the Continuous Plankton Recorder Survey, which preferentially samples non-gelatinous plankton. One untapped source of extensive plankton data is from annual fish egg surveys which use a high-speed GULF VII sampler to collect plankton samples across Western European shelf waters. However, to-date, no study has evaluated the efficacy of the GULF VII for quantifying gelatinous zooplankton. This study collected plankton samples using both the GULF VII sampler and a standard 1 m vertical ring net at 14 locations along the shelf edge of the northern coast of Ireland during July 2017. It was found that there was no overall difference in total mean diversity of taxa found between the two sampling devices (Gulf=15.21, Ring net=15.36) or mean abundance of gelatinous organisms collected ($F_{1,4}=0.167$ $P>0.05$, Gulf=139.48, ring net=155.49). Considering the lack of gelatinous zooplankton data from oceanic areas, fisheries' institutes should consider these findings and use the Gulf VII as a new source of much needed information on the diversity and trends of gelatinous zooplankton.

Keywords: Gelatinous, Zooplankton, Jellyfish, Gulf VII, Ring net, Method comparison

MC5. Drones and seaweed: Mapping the intertidal brown seaweed Ascophyllum nodosum in Ireland

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Drones, seaweed, intertidal, reflectance, spectra, mapping, Ireland

The mapping of seaweed populations is important from both an ecological and economic perspective. This research aims to develop an innovative and multi-disciplinary approach to assess the distribution and biomass of the intertidal brown fucoid, Ascophyllum nodosum. This common species often dominates the mid-littoral zone along sheltered, rocky coastlines. Two locations in Co. Galway, western Ireland, were chosen where drone-based remote sensing surveys were conducted. Drones have received recent attention as platforms for Earth observation as they provide greater levels of spatial resolution and flexibility than planes and satellites.

The first site in Kilkieran Bay was surveyed in August 2017 using a DJI-Matrice 600 PRO mounted with an OCITM-F Ultra Compact Hyperspectral Imager. A DJI-Inspire 1 was also used to capture RGB imagery and multispectral data using a Parrot Sequoia. Ground control points were gathered using a Trimble R8. Supporting field data on site biomass and percent cover was collected. On the day of the survey a TriOS RAMSES Hyperspectral Radiance/Irradiance Radiometer was used to collect pure spectra from intertidal seaweeds and rocky/muddy substrata to support the classification of the hyperspectral data. Two transects were defined consisting of continuous quadrats, from upper to lower shore, which were clearly visible during the drone flights. Data were collected on species composition and percentage cover from each quadrat in both transects. Samples from selected quadrats were measured with the radiometer, removed from the site and analysed for pigments to facilitate the establishment of correlations between the drivers of spectral response in the visible region of the spectrum. Spectral Derivative Analysis (SDA) is used to identify characteristic spectral features for species to assess their spectral separability.

MC6. Determining the nitrate contamination in water using Raman Spectroscopy

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Nitrogen is a vital chemical element in the proteins and DNA of all living things. However, excess of nitrogen in water in the form of nitrate-nitrogen and nitrite-nitrogen can be harmful for human consumption as they affect the ability of red blood cells to transport oxygen. Moreover, it is difficult to detect the nitrogen contaminants in water as they are colorless, odorless, and tasteless. Therefore, we propose an optical method based on Raman spectroscopy to detect nitrate contamination well below the EPA recommended levels of 10mg/L. This optical method enables us to continuously monitor the water quality at the water body site in real time, unlike the traditional chemical based tests that require the periodic collection of water samples and storage facilities. Moreover, the optical method requires no consumables making it an attractive solution for long term use. Our initial results of nitrate detection in water are obtained using a commercial bench top Raman system, which is bulky and thus challenging to use near water body sites. Therefore, we are developing a customized Raman spectroscope that is particularly suitable to be deployable at water bodies.

Keywords: Water quality, raman spectroscopy, nitrate, nitrogen

Ecotoxicology & Invasive Species

EI1. The use of nematodes as environmental indicators for assessing the effects of Microplastics pollutants

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Microplastics, plastics debris with particle diameter less than 5mm, have become a global issue in the aquatic environment. The majority of microplastics research has focused on the marine environment while relatively little research has been undertaken in freshwater. Recently, microplastics contamination has been observed in drinking water. The effects of these materials include adsorption of persistent organic pollutants such as polychlorinated biphenyls (PCBs), dichlorodiphenyltrichloroethanes (DDTs), and nonylphenols; bioaccumulation; and bacteria transfer media. Therefore the aim of this project will be based on the understanding of microplastics properties and effects in the environment.

Attenuated total reflection Fourier transform infrared spectroscopy (ATR-FTIR) was conducted to analyse the characteristics and polymer type of the commercial cosmetic products. The majority of microplastics recovered in such products are polyethylene. So far, ATR-FTIR analysis of microbeads exposed to various treatments used shows significant changes due to adsorption of chemicals and/or biofilm formation.

Since nematodes have characteristics that enable them to be good indicators of environmental change, in this work, the microbeads are tested on several nematode species (Caenorhabditis elegans, Steinernema feltiae 12 (1) and Steinernema carpocapsae) in order to observe their effects on these microinvertebrates. This will involve LD50 toxicity bioassays exposing nematodes to various treatment concentrations, in 96-well plates, over 24 h and 48 h. The standardised ISO 10872:2010 protocol has been employed specifically to C. elegans. This work is on-going and findings will aid understanding of the effects of microplastics on the biotic environment.

Keywords: Microplastics, detection, FTIR, toxicity, nematodes, environmental bioindicators.

EI2. Impacts of plastic microbeads on the physiology of Lemna minor

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The term 'microplastic' refers to a variety of microscopic plastic fragments or particles made of synthetic polymers and of different shapes. Microplastics are microscopic in size, ranging between 0.1 µm to 5 mm. Microplastics found in personal care products (PCPs) such as exfoliates or toothpastes are also known as plastic microbeads. Plastic microbeads found in PCPs such as scrubs or toothpastes are frequently made of the plastic polymer polyethylene (PE). It has been estimated that between 4594 and 94,500 plastic microbeads can enter the environment per single use of a facial scrub.

Monitoring studies have shown that microplastics are ubiquitous in the aquatic environment. Also, laboratory based tests indicate that plastic microbeads could pose a risk to aquatic animal organisms. However, these studies have had a predominant focus on the marine environment. Data on the presence of microplastics in the freshwater environment are scarce and effects on aquatic plant species are unknown.

The ecotoxicological impacts of PE microbeads on the physiology of the freshwater duckweed Lemna minor (L.) were investigated in this study. L. minor is a common species in Ireland that is also widely used as a model species in ecotoxicology studies. The assessment of L. minor growth exposed to PE microbeads was analysed using the following parameters: frond and colony number, root length, adsorption of beads, beads per frond area and root length, plant biomass and chlorophyll a fluorescence. The study shows that aquatic plants need to be considered when investigating the environmental impacts of microplastics.

Keywords: Microplastics, Polyethylene microbeads, Freshwater, Aquatic plants, Ecotoxicology, Effects, Chlorophyll a fluorescence

EI3. Enhancement of Anaerobic Digestion of Whiskey Distillery Waste

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The primary aim of this work is energy recovery from distillery co-products such as pot ale and draff. Due to the characteristics of the waste streams, the alcoholic beverage industry is a highly polluting industry, with approximately 3.4 million tonnes of solid wastes, known as draff, produced per year, in addition to the production of approximately 8-15 L liquid effluent generated per litre alcohol (40.4 billion litres/year). Draff is typically processed and used as animal feed due to its high nutrient content. However liquid waste streams can be a revenue sink for distilleries due to their high organic load and polluting characteristics – there is a high COD/BOD, and high levels of biodegradable organic material such as organic acids (leading to low pH conditions) and high levels of potassium, sulphate, phosphorus and nitrogen.

The optimisation of biogas generation and quality from whiskey distillery co-products was investigated in this work, by evaluating the impact of a combination of two pre-treatment strategies prior to anaerobic digestion. Mechanical pre-treatment (using a Hollander Beater) and chemical pre-treatment (alkaline conditions) were employed onto both draff & pot ale mix. The parameters for testing were examined as three factors at three levels according to Box Behnken design, which is one of Response Surface Methodology (RSM) designs developed for optimisation. The recorded responses were analysed via Design expert software V7. It was found that beating time, digestion temperature and sludge percentages were significant parameters on anaerobic co-digestion of pot ale and draff (5:1 ratio).

EI4. Bioinformatic classification of expanded bovine β-defensin protein family

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β-defensins are a group of host defence peptides (HDPs), which are essential effector molecules of the innate immune response, produced by immune and epithelial cells. As well as the direct killing of pathogenic bacteria, it is hypothesised that these molecules help control the interface between microbes in the intestinal tract and the host immune system. The bovine genome comprises of the only □-defensin subfamily of HDPs, which are expanded in this species to encompass 57 reported genes.

The aim of this project was to use bioinformatic analysis/online tools to classify the structural properties of the peptides encoded by these genes and to visualise their 3D structures. These properties are known to contribute to their efficacy against bacteria and viruses and peptide charge and hydrophobicity play a major role in determining the characteristics of their antimicrobial functions.

Bioinformatic analysis including unsupervised clustering using PCA will be carried out in R. In this project, various parameters of the 57 genes will be catalogued such as charge and hydrophilicity.

Four distinct chromosomal clusters have been found in the bovine and using SWISS-2DPAGE and ProtParam software tools. The final results will be presented.

Keywords: β-defensins, bovine genome, host-defense peptide, chromosomal clusters, ExpaSy

EI5. Effluent toxicity testing Ireland 2012-2018

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The EPA state that the acute toxicity of a final effluent must be determined by four aquatic species from four trophic levels. Once the most sensitive species have been determined, subsequent compliance toxicity monitoring of those species must be carried out.
City Analysts have been carrying out acute toxicity testing since it took over from Enterprise Ireland in 2014. Toxicity testing in the aquatic environment is essential to determine the effects effluents have on the marine and freshwater environment. To determine these effects, a wide range of organisms are used, as toxicity is both chemical and species specific.
Following on from previous studies carried out by Enterprise Ireland, the levels of effluent toxicity since 2012 have been determined. This can be established by using an internal classification for the toxicity of effluents. Industry trends in effluent discharge along with species specific sensitivity will be evaluated.

Keywords: Toxicity, toxic units, effluents, aquatic environment

EI6. An investigation into acoustic detection of Lagarosiphon major (Ridley) in an Irish lake

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Lagarosiphon major, curly-leaved waterweed, is a high impact invasive species in freshwater systems known to reduce aquatic ecosystem biodiversity. A relatively new invader to Ireland, it was initially discovered in Lough Corrib, Co. Galway in 2005. Various management techniques have been researched and utilised to control L.major since its initial discovery. Devising an effective detection method is necessary to monitor the success of the control programme and also to investigate any further spread within Lough Corrib. In lakes, detection methods typically consist of snorkel and SCUBA diving surveys, bathyscope observations, grapnel sampling and local knowledge. In this research, an innovative acoustic detection method was utilised. Trials were carried out in Lough Corrib to determine the effectiveness of this alternative detection method for L. major. A professional grade side scan sonar, the L-3 Klein hydroscan 3500, was deployed and acoustic imagery was recorded and processed using Sonarwiz software. SCUBA sampling verified the sonar imagery as L. major. The results presented show the potential for assessing recovery of the aquatic habitat by using side scan sonar in an enhanced ecosystem management programme. This can be achieved through accurate geo-referencing, increased speed of results and by the creation of a data base of imagery for future comparison purposes. In addition, combining the sonar imagery with ArcGIS mapping has enabled a new approach to management of this invader in Lough Corrib.

Keywords: Invasive species, Lagarosiphon major, invasive species management, side scan sonar technology

Energy

EN1. Influence of wind exposure and sheltering on wood drying for fuel use

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Previous research has investigated the role of airflow in wood drying in the context of drying in the forest and at low wind sites. This study, in particular, exposed measured wood batches to winds of up to 21 m/s on an elevated and exposed site. A series of eight stillages of Sitka Spruce were established with delivery of clearfelled samples by Coillte. Each stillage was weighed initially and the test site arranged with stillages ranging from locations most exposed to prevailing winds, to those most sheltered. Concurrently, wind monitoring equipment was installed at two points close to the stillages, and wind speed and direction was measured with 1 minute averages. The decrease in the weight of each stillage was recorded regularly during the test and the precipitation on the piles was estimated from the Met Eireann weather station at Dunsany. The variation in weight and the averaged wind speeds experienced are expressed on a weekly basis at the start of the drying trial, when most weight loss is experienced, and fortnightly toward the end of the trial, when precipitation and temperature effects inhibit evaporation. The greatest weight loss was experienced in the most exposed stillage decreasing 18.6% from the commencement of the experiment, which was expected, but the most sheltered stillage also lost 11% of its weight. This indicates that the overall drying regime is not directly related to wind exposure solely, but on other aspects such as solar, temperature and humidity.

Keywords: Biomass, wood energy, drying, wind

EN2. Comparison between numerical and experiential modelling of a UASB bioreactor

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A better understanding of the hydrodynamic behaviour of anaerobic wastewater treatment reactors can lead to improved designs and higher biogas yield and treatment efficiencies. In recent years, software aided project and optimization of bioreactors and bioprocesses has become a matter of interest, especially due to the advance in the state of the art of computational resources. This work aimed to model the flow inside an Upflow Anaerobic Sludge Blanket (UASB) reactor used for wastewater treatment and biogas production in order to understand its hydrodynamics. Computational fluid dynamics (CFD) was used to model the three phase flow (liquid, gas and solid) in a UASB reactor treating vinasse and the results were experimentally validated. The UASB reactor was designed and then the geometry and mesh were developed in the software ICEM CFD. The simulations were performed using the software Fluent and a mesh with 528.000 control volumes. An Eulerian-Eulerian approach was adopted, together with isothermal, transient and three-dimensional conditions. PIV (Particle Image Velocimetry) and shadowgraphy were used for the experimental validation. The numerical model validation showed maximum differences lower than 9% between experimental and computational results for the gas and liquid velocities. The velocity profiles for the liquid showed good agreement. Numerical results showed that the gas was the main responsible for the mixing quality within the reactor. Considering the results, the model was considered validated. Understanding the multiphase flow within this reactor will allow optimizations on the process as well as on the reactor, in order to seek an increased efficiency both in the effluent treatment and biogas production.

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

EN3. Enhancement of Anaerobic Digestion of Whiskey Distillery Waste

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The primary aim of this work is energy recovery from distillery co-products such as pot ale and draff. Due to the characteristics of the waste streams, the alcoholic beverage industry is a highly polluting industry, with approximately 3.4 million tonnes of solid wastes, known as draff, produced per year , in addition to the production of approximately 8-15 L liquid effluent generated per litre alcohol (40.4 billion litres/year). Draff is typically processed and used as animal feed due to its high nutrient content. However liquid waste streams can be a revenue sink for distilleries due to their high organic load and polluting characteristics – there is a high COD/BOD, and high levels of biodegradable organic material such as organic acids (leading to low pH conditions) and high levels of potassium, sulphate, phosphorus and nitrogen.
The optimisation of biogas generation and quality from whiskey distillery co-products was investigated in this work, by evaluating the impact of a combination of two pre-treatment strategies prior to anaerobic digestion. Mechanical pre-treatment (using a Hollander Beater) and chemical pre-treatment (alkaline conditions) were employed onto both draff & pot ale mix. The parameters for testing were examined as three factors at three levels according to Box Behnken design, which is one of Response Surface Methodology (RSM) designs developed for optimisation. The recorded responses were analysed via Design expert software V7. It was found that beating time, digestion temperature and sludge percentages were significant parameters on anaerobic co-digestion of pot ale and draff (5:1 ratio).

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EN4. An Open-Source Integrated Solar Resource Monitoring Station

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Modelling of solar photovoltaic installations relies on the availability of accurate and comprehensive data regarding the available solar resource. There are several government and commercial organisations that make this data available, but often this data is only historical, and usually does not have accurate information specific to the location of an intended installation.

When designing photovoltaic systems it is important to be able to quantify the local solar resource and its distribution between direct and diffuse irradiance. State-of-the-art instruments are usually employed, at significant cost, to determine the parameters of interest. Our group has been actively developing a low-cost alternative to monitoring the local solar resource to provide accurate and real-time information on the available resource. The advantage of such a system extends beyond design and planning to real time energy monitoring for brokering energy cost.

Our proposed system integrates three instruments, a pyranometer, pyranometer with a shadow-band and a pyrheliometer in a single platform that is controlled and supervised by a dedicated microcontroller. Temperature, humidity and barometric pressure are also recorded. Additionally the system provides geolocation and timestamping of the data as it is recorded. The integrated system is standalone with wireless datalogging over the internet to a dedicated database that captures all relevant parameters from the reported GPS location of the instrument. The system is designed to be portable, robust and self-powered. It can be mounted in-situ or used as a portable forecasting tool.

The intention is to make the software and hardware open-source to encourage citizen engagement in actively monitoring the solar resource in a distributed system, with each monitoring station behaving as a node on an Internet-of-things hosted database. The aggregated data from all participating sites will provide researchers with access to high quality localised data.

Keywords: solar resource monitoring, integrated instrument, internet-of-things, open-source

Energy

EN5. Potential Energy Recovery Using Micro-Hydropower Technology in Irrigation Networks: Real-World Case Studies in the South of Spain

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The agricultural sector is one of the most significant users of water resources worldwide, accounting for about 30% of the total amount of water consumed in Europe, reaching values close to 80% in Mediterranean countries such as Spain. Irrigation infrastructure has been modernized in recent years in several areas dedicated to agriculture, changing from traditional open channels to on-demand pressurized irrigation networks. Despite improvements in water efficiency, the modernization of these networks has led to increased energy demands of the irrigation sector. Several negative consequences have been linked to additional energy requirements of pressurized networks, such as the increase of associated CO2 emissions linked to irrigation activity or the rising cost of water associated with the energy used by the pumping stations.
Yet, in a pressurized network, excess pressure in some areas can occur. This paper studies the excess pressure in pressurized irrigation networks and the conversion of this excess to usable energy by means of small-scale hydropower turbines. Twelve irrigation networks located in the South of Spain have been modelled to quantify this excess pressure, and an economic and environmental impact assessment has been considered. The paper highlights the significant potential for small-scale hydropower generation in rural areas in Southern Spain. A total of 43 points, along the 12 irrigation networks, were found as suitable locations where micro-hydropower (MHP) turbines or pump-as-turbines (PATs) could be installed. The amount of power available in these networks was over 1 MW, being capable of generating over 1 GWh per annum.

Key words: Hydropower; irrigation networks; excess of pressure; turbines; energy recovery

EN6. Northwest Energy Communities Start-up (NECS)

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Northwest Energy Communities Start-up (NECS) was carried out by Institute of Technology Sligo, Contract Research Unit (CRU) and Good Energies Alliance Ireland (GEAI) in response to the Sustainable Energy Authority of Ireland (SEAI) call for Sustainable Energy RD&D projects.

The project is designed to support the DCENR White Paper on Energy (2015), and in particular, to directly facilitate the early stage transition from passive consumers to energy citizens on a targeted community scale. 6 rural communities were selected to be included in the study.

The 1st stage of the project involved the collection of data related to energy use, residential infrastructure and behaviours in the selected study communities. This data collection included direct 'door step' surveys and statistical data gathering. The statistical data utilised included CSO (Central Statistics Office) Small Area data, SEAI Resource Maps and Photovoltaic Geographical Information System. The 'door step' surveys also provided significant community engagement and awareness for the project.

The next stage involved the analyses of the data in order to estimate typical energy use, costs and CO2 emissions for households and private transport, and to present these figures at community energy workshops. GIS mapping was used as an engaging demonstration tool, and the workshops included 'World Café' discussions to provide more community feedback.

In the final stage of the project Community Transition Roadmaps were developed for each study community. The Roadmap took account of the data, analyses and feedback to present a Transition scenario to 2025. The Transitions were set out for Knowledge, Homes, Transport and Community and highlighted the potential benefits in terms of local economic investment, energy savings and CO2 reductions.

While the Transition Scenarios are intended to be realistic, it is recognised that they won't happen all at once. Some transitions can be implemented with little effort, but those requiring investment and support will take longer. The timelines presented take account of this and present the potential annual energy cost savings for each community. These costs savings will continue annually beyond 2025, supporting investment in new community sustainability targets.

Keywords: Energy, Community, Climate Change, Environmental Policy and Communication, Environmental Management, The Human Built Environment, Sustainable Infrastructure, Transition

EN7. Incorporating heat storage inside twin-walled evacuated tube solar collector

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Whilst decarbonisation of the heating system remains one of the greatest challenges the U.K. faces, the development of affordable and efficient thermal energy storage is the key factor in its transformation into renewable energy sources. Therefore, this research-project will focus on developing low cost thermal energy storage to be incorporated into evacuated tube solar collectors. The potential of selecting two different energy storing materials, Phase Change Materials (PCMs), will be investigated for the storage medium, which will be for colder climate applications e.g. Scotland. A real-world test site will be set up and laboratory studies will be conducted to investigate the effect of the storage materials' characterisation e.g. energy density, affordability, toxicity, corrosivity, chemical-compatibility, lifecycle etc. The processes of selecting the right materials will be tested under different operating conditions using temperatures of a maximum of 200 °C in order to investigate limiting the fault conditions. Making solar thermal panels cost effective for space heating requires larger arrays and additional thermal storages. Therefore, the optimum system design, which depends mutually on the correct material selection, will also be investigated. Combining solar energy storage with a solar thermal system could help in increasing the system's efficiency and allowing oversizing, thus contributing to space heating without increasing the hot water cylinder size. Furthermore, it can be used to preheat water going to a combi boiler, electric shower or electric boiler in properties without a hot water cylinder. Developing solar thermal, efficient and inexpensive energy storage is vitally important in areas like remote and off-grid communities where heat is essential and people are on low incomes.

Keywords: Heating solution; Energy efficiency; Thermal storage; Solar thermal; Renewable heat

EN8. Towards an Augmented Reality System for the Maintenance of Offshore Wind Turbines

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In offshore wind, the cost of energy is dominated by operation and maintenance costs. A significant proportion of this expense is in deploying and transporting maintenance crews to the remote, inaccessible locations of the offshore wind turbines. Therefore, it is important that maintenance operations are performed error free to avoid incurring the cost of additional callouts. Industry 4.0 may offer an opportunity to improve this kind of complex maintenance task. One of the key enabling technologies for Industry 4.0 is Augmented Reality – real-time 3D registration of virtual information in the real environment. Previous literature has suggested that Augmented Reality could be a promising new mode for delivering maintenance instructions in industrial scenarios, with the potential to reduce error rates even for novice operators. This may be particularly beneficial for unplanned maintenance and unusual faults, where the maintenance crew might be unfamiliar with the tasks they need to perform. However, significant barriers remain which prevent widespread adoption of this technology in industrial maintenance, such as: difficulty developing augmented instruction sequences from existing data collection methods; coping with unplanned and unexpected maintenance scenarios; and validation concerns surrounding implementation in high value industrial environments. These challenges will be explored in the work presented here, in order to expose opportunities for future research. The results of this research will ultimately form the basis for the development of a complete augmented reality system for the guidance of wind turbine maintenance operations.

This project is undertaken as part of the Renewable Engine INTERREG VA programme to encourage cross-border research in the field of Renewable Energy and Advanced Manufacturing. All work presented here is performed as a collaboration between the University of Strathclyde and the industrial partner, Booth Welsh.

Energy

EN9. Gravitational Potential Energy Storage and Synchronous Inertial Stability

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Despite the recent successes in grid-connected battery storage systems, further work is required to diversify the range of energy storage systems for renewable sourced electricity. The GENSSIS (Gravitational Potential Energy Storage and Synchronous Inertial Stability) project presents a novel development in energy storage. The GENSSIS concept, similar to pumped hydroelectric storage, involves the conversion of potential energy to electrical energy. This is achieved by dropping a suspended steel weight inside a drilled hole. The steel weight is returned to the surface of the wellbore when energy supply exceeds the demand of the local grid or National Grid. The electricity delivered to the grid is controlled through varying the depth and speed of the weight release.

The prototype design consists of a 1500m drilled hole, containing 456m of steel weights suspended in the wellbore through a specialized winch system. The full-scale GENSSIS storage system will consist of 36 drilled holes. A control system will be designed to position the weights in order to meet the requirements of ancillary and balancing services to the National Grid. The maximum power delivered to the grid will amount to 73.8 MW. The storage system will also have a sub second response time making it suitable for both enhanced frequency response (EFR) and short term operating reserve (STOR) services for National Grid Electricity Transmission.

A key feature of the GENSSIS storage system is the 50-year operational lifetime, making it a sustainable energy storage method. In comparison to grid-scale battery storage systems, the GENSSIS design holds numerous advantages. Unlike battery storage technologies, there is no requirement to recycle materials after use. Further concerns relating to lithium ion battery storage, such as resource availability, do not exist with the GENSSIS design.

Keywords: Energy Storage, Sustainable Energy, National Grid

EN10. Small-scale anaerobic digestion for biogas production

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Small-scale anaerobic digestion (SSAD) is an attractive technology for the treatment of livestock and organic fraction of municipal wastes. SSAD systems can transform organic matter into biogas (a mixture mainly composed of methane and carbon dioxide) making the technology suitable for a variety of applications in energy, agricultural and as a starting feedstock for emerging bio-products and processes. SSAD systems thus do not only provide the benefits of improvingon-site energy generation, upgrading and provision of a nutrient rich fertiliser from the digester effluents, reduction in pathogenic loads, and reductions in odour and greenhouse gas emissions as afforded by large scale systems, but could additionally provide economic benefits with its application with lesser organic loading sources and with regards to its portability and flexibility. SSAD is particularly applicable to the agriculture sector where the average Irish dairy herd size consists of approximately 80 cows in 2016. Despite the apparent benefits of SSAD the technology is still not well understood with much of the research previously conducted focused on large-scale systems. This work in progress seeks to explore the current status of SSAD technology identifying various systems, design and operational considerations, and to review the latest environment, energy and economic analysis. This comprehensive study will shed light on an area with limited research providing an overview of the technologies present status and potentially identifying areas of future study. The study which will be carried out under the EU INTERREG funded Renewable Engine Project will work with an industry partner Organic Power to investigate a practical SSAD system and to identify the challenges the technology faces today.

Keywords: small-scale, anaerobic digestion, biogas

EM1. Discussion on the Environment Access and its Evaluation of Technical System

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For a long time, China's economic development has been characterized by high input, high consumption, high emission and low efficiency, which maintained a rapid growth of GDP, but led to a series of issues such as environmental pollution, ecological damage, and resource shortages. In recent years, China has entered into a period of high environmental risk and pollution, the traditional environment management methods already can't adapt the current social and economic development. Therefore, the environment access, as one of the environment management methods, was introduced in the hope of solving pollution problems from the source. However, the environment access system was just put forward in recent years, and the related theories for it is not perfect yet, there are lots of issues, such as ambiguous definition, inconsistent evaluation index system, and immature evaluation methods, need to be improved and solved. Authors defined the environment access, means in order to prevent environmental pollution and ecological destruction, the government set thresholds which suit to local conditions in certain area for a variety of economic subject development and construction activities, so as to achieve the source control, reasonable layout, efficient utilization of resources, etc. Then analyzed the features, connotations and roles of the environment access, and formulated the conditions, principles, contents, procedures and requirements of the environment access, built a basic framework for the environment access, and put forward the comprehensive evaluation index system and technical process. The results can provide some references and supports for the environment management and project decisions.

Keywords: Environment access; Basic framework; Comprehensive evaluation; Index system; Technical process

EM2. The use of cutaway peat turned into biochar as an opportunity to reduce greenhouse gas emissions

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The Irish agriculture sector accounts for nearly 33% of the total national greenhouse gas (GHG) emissions in Ireland and is legally obliged by regulations to lower these emissions. The biggest part of these emissions is associated with Ireland's intensive dairy and beef production sector. It was found that biochar production has a significant influence on the regulation of GHG production by transforming biodegradable materials into a more stable form. The transformations can limit the release of GHG emissions of these materials by preventing aerobic digestion. At the same time biochar, applied to other materials such as soil or manure, abates GHG emissions out of these materials. Biochar is the product of the thermochemical conversion of biomass in a process called pyrolysis. While its production from many common sources is well understood there remains considerable uncertainty over the efficacy of biochar production from the residual peats of cutaway peatlands. This is particularly striking with regard to their GHG mitigating characteristics. At the moment peatlands cover approximately 12.5% of Ireland and when bogs used in peat extraction are taken out of production leaving cutaway peatlands the associated residual peat is often seen as having little commercial value. However, this residual peat can be used as a feedstock for biochar production before the peatlands are set aside or subject to regeneration as wetlands, lakes and grassland areas. This study will explore the profile and character of peat-based biochar and evaluate its potential to mediate reductions in GHG emissions from livestock management systems. In order to do so residual cutaway ombrortophic peatlands will be used as the biochar feedstock.

EM3. A qualitative biological hazard screening tool for AD digestate

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Anaerobic digestion (AD) has been widely used as a green technology to treat food and municipal waste, farmyard manure and slurry (FYM&S), and agriculture residues to generate biogas. FYM&S is a natural soil conditioner, providing valuable nutrients to plants; however, it may contain a high concentration of pathogens. The different AD conditions (mesophilic and thermophilic) and pasteurisation regimes (in accordance with EU and Irish legislation) can influence pathogen inactivation. In this study, a simple qualitative screening method was developed to identify pathogens of greatest potential human/animal health concern as a result of the AD process. One hundred potentially harmful pathogens were identified from the literature and a qualitative scoring system was used to categorise (i) inactivation status following heat treatment (score S1) (ii) hazard pathway (score S2) and (iii) severity (score S3). The S1 score was introduced to consider the effect of different time-temperature conditions for both the AD process conditions (37°C for 4 days, 55°C for 4 days) and possible pasteurisation regimes (60°C for 4 days, 70°C for 60 min, and 90°C for 60 min) on the relevant organisms. The S2 score focused on the number of potential pathways of transmission (e.g. bio-aerosols, water, soil, through food and zoonotic contact). The severity of potential illness was computed by the S3 score considering any previously reported outbreak and mortality data. The final Hazard Screening Score (S-Score) was computed as the product of the individual S1, S2 and S3 scores for the particular pathogen. The final S-Score can be used to scientifically rank potential biological hazards from the AD process which may be present in the resulting digestate and allowing for prioritisation and further detailed risk analysis of the hazards of potential health concern. This study presents the qualitative scoring system and resulting biological hazard ranking.

Keywords: Animal waste, Hazard identification, anaerobic digestion, pasteurisation, risk assessment

WQ1. Optimization of adsorption of sulfamethoxazole and ketoprofen onto low-cost activated carbon made from fruit industry waste

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Activated carbon (AC) is a highly porous material that can remove (through adsorption) many pollutants from the liquid and gas phase. Different lignocellulose waste materials, which are widely available, cheap and environmentally friendly, are gaining importance as precursors in the production of cheap ACs with specific structural and adsorbent properties. In this study, the main source of biomass for the production of AC was cherry kernels, a fruit industry waste. The use of this AC for the removal of pharmaceuticals from aqueous solutions was investigated. The pharmaceuticals sulfamethoxazole (SMX) and ketoprofen (KP) were studied in batch experiments using different: pH values (2-9), adsorbent doses (0.4-4 g/L), contact times (5-300 min), initial adsorbate concentrations (1-50 mg/L) and solution temperatures (22-42 °C). The experiments showed that the optimal operation conditions were at 22 °C, pH 6.0-7.0, an AC dosage of 1-2 mg/L, and a contact time of 60 min – this resulted in a removal efficiency of >95% for SMX and KP. The maximum adsorption capacity of the engineered AC for SMX and KP was 19.181 mg/g and 19.675 mg/g, respectively. The adsorption mechanism of two pharmaceutical compounds include electrostatic interactions, ϖ-ϖ bonds and hydrogen bonds. The mass transfer was governed by external diffusion in the initial phase, until after a certain time (30 min), intraparticle diffusion gradually assumes this role. Preliminary co-adsorption work showed that the adsorption of SMX and KP was not modified significantly by the presence of other pharmaceuticals (carbamazepine, naproxen, diclofenac and ibuprofen) and heavy metals (Pb2+, Cd2+ and Ni2+). Results show that this AC could be used as a low-cost adsorbent for the removal of SMX and KP from wastewater.

Keywords: low-cost activated carbon, fruit industry waste, pharmaceutical adsorption

WQ2. Concentrations of pharmaceutical compounds in the influent and effluent of three different Wastewater Treatment Plants (WWTPs), Riyadh city, Saudi Arabia

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There is increasing concern about contamination of the environment with pharmaceutical compounds. Some pharmaceutical compounds are known to be poorly removed by conventional wastewater treatment techniques, and to become persistent once the effluent is discharged to the environment.
Five pharmaceutical compounds are currently being studied in the influents and effluents of three wastewater treatment plants (WWTPs) in the capital city of Saudi Arabia. The five compounds were chosen because of the high possibility that they could occur in the environment at concentrations that could pose a risk for human health and the environment. In addition, some of these compounds had previously been detected in treated and untreated water, and in soil. In this study, Acetaminophen was found in higher concentration than others (Acetaminophen> Metformin> Cephalexin). The concentration of Baclofen was just below the Limit of Quantification (LOQ) which was 0.1 ng L-1. Similarly, Allopurinol was detected <LOQ (500 ng L-1). This is the first reported study of Baclofen in WWTP effluents.
The influent of the King Saud University (WWTP-KSU) was found to have higher concentrations of the five compounds than the other two WWTPs. A potential explanation is that wastewater is discharged directly to this plant from the King Khalid University Hospital (800 beds) without treatment, together with wastewater from the university campus and housing area. The removal rate of 99%, 96% and 82% for Acetaminophen, Cephalexin and Metformin respectively by WWTP-KSU, was slightly higher than the other WWTPs. This study has confirmed the efficiency of the WWTP-KSU in removing selected pharmaceutical residues from wastewaters.

Keywords: Pharmaceutical Compounds, Contamination, WWTP, Acetaminophen, Removal rate

WQ3. Potential pathways, trophic transfer and bioindicators of microplastics within freshwater systems

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Microplastic (MP) polymers, 1-5000 µm in size, are ubiquitous within aquatic environments. Such small MP particles pose great risk to freshwater organisms due to their potential ability to infiltrate and transfer within aquatic food webs. Though some existing laboratory studies can facilitate our understanding of species susceptibility, the lack of field data from freshwater environments means that the spatiotemporal patterns governing MP exposure, as well as their associated dynamics within the freshwater environment are not well understood. There is a need therefore to assess MP exposure in Irish waters to gain an understanding of the current level of interaction between MPs and freshwater biota. Researchers at Galway-Mayo Institute of Technology, in collaboration with University College Dublin and Wageningen University, the Netherlands, have set out to address these knowledge gaps as part of a three-year EPA funded research project 'Sources, pathways and environmental fate of freshwater microplastics'. Part of this research aims to 1) characterise and quantify polymer types present in an Irish freshwater system, and determine whether they vary longitudinally between habitats and regions; 2) identify the pathways of MP exposure through a comprehensive analysis of a freshwater food web; 3) evaluate the ecological implications of MP uptake under realistic exposure conditions (as far as possible), through laboratory trials and observation; and 4) explore the use of using bioindicator species, such as primary consumers and top level predators, for monitoring purposes, with a view to informing the EU Water Framework Directive (2000/60/EC) and Marine Strategy Framework Directive (2008/56/EC) on best practice guidelines for monitoring MPs in Irish waters.

Keywords: aquatic ecology, food webs, polymers, water quality, water pollution

WQ4. Investigation of the microbial ecology of laboratory-scale IASBR systems treating synthetic and industrial dairy processing wastewaters at 11°C

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The dairy processing industry generates significant volumes of high nutrient load wastewaters. These effluents require extensive on-site remediation prior to release into receiving water bodies to ensure minimal impacts on Environmental Quality Standards (EQS). Substantial capital investment is required to deliver effective wastewater management and there is considerable interest in developing efficient, sustainable, cost-effective strategies for the sector. Intermittently aerated sequencing batch reactors (IASBRs) represent a biological nutrient removal technology combining multiple anaerobic/aerobic operational cycles to achieve chemical oxygen demand (COD), nitrogen (N) and phosphorus (P) removals in a single reactor. This study reports the application of IASBR systems to the treatment of both synthetic and industrial dairy wastewaters with a focus on next generation sequencing (NGS) based investigations of the microbial population dynamics. In summary it is highlighted the stable dominance of the reactor systems by members of Comamonadaceae family (to a maximum relative abundance of 81%) during high nutrient removal from synthetic wastewaters (68.8% N and 71.3% P removal efficiencies, respectively). Previous work by the group has revealed that aeration rates play a crucial role in system stability and performance. In this study both reactors were operated under aeration rates of 0.6 Litres per minute. Lower relative abundance of Comamonadaceae (to a maximum relative abundance of 26.3%) and higher overall bacterial diversity were observed under the industrial trial. It is hypothesised that the lower abundance of Comamonadaceae under industrial dairy wastewater testing may be linked to lower influent concentrations of PO4-P and NH4-N.

Keywords: wastewater bioremediation, biological nutrient removal (BNR), Intermittently Aerated Sequencing Batch Reactor (IASBR), Comamonadaceae

WQ5. Sawdust: A potential bio-adsorbent for removal of antibiotics in contaminated water

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This study investigated the potential of sawdust as a bio-adsorbent for the removal of different classes of antibiotics. Representatives of carbapenems (i.e. meropenem) and fluoroquinolones (i.e. ofloxacin) antibiotics were selected for the study, based on a priority list recently compiled by the World Health Organisation. The levels of contamination similar to those reported for polluted sites were simulated by dispersing antibiotics in water at room temperature. UV/Vis spectroscopy was deployed to determine the concentration of antibiotics in water. Sawdust was washed, dried and conditioned, before undergoing physio-chemical pre-treatments with different aqueous solutions of inorganic salts, acids and base to produce a modified form. Batch experiments were set-up for the adsorption studies of the antibiotics using both unmodified and modified forms of sawdust. Parameters such as contact time of sawdust with adsorbates and pH level of adsorbate solutions were also investigated to optimise the water treatment processes. It was found that both unmodified and modified sawdust adsorbents are capable to reduce the concentration of the antibiotics dispersed in water by more than 30%. Modified sawdust was characterised by greater uptake of meropenem and ofloxacin than unmodified sawdust. This may be attributed to the improved accessibility of functional groups in modified sawdust. Sawdust pre-treated with an acid was the most effective in adsorbing both antibiotics. The optimum contact times between the adsorbent and adsorbates were found to be 18 hrs for meropenem and 6 hrs for ofloxacin. The adsorption of meropenem and ofloxacin was found to be favourable in acidic condition of adsorbates. The surface charge of the sawdust and the electrostatic force between the adsorbent and the antibiotics in acidic condition may be responsible for the adsorption efficiency. These preliminary results indicate that sawdust potentially can serve as an alternative bio-adsorbent suitable for removing different classes of antibiotics from contaminated water.

Keywords: Sawdust, bio-adsorbent, antibiotics, and wastewater treatment

WQ6. Grass Growth Trials for Recovered P Fertilizers

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The EU INTEREGG Phos4You project is investigating the recovery of phosphorus (P) from municipal wastewater streams with P return to land. The EU recognises that phosphorus is a finite element, that is vital to sustain all life. Mineral P is derived from P rich rock and is used as an artificial fertilizer. P fertilizer is vital to sustain modern farming practice.

This research aims to review Ireland's dependency on imported phosphorus fertilizers and establish a method to replace it with indigenous, recovered raw P from Irish wastewater treatment plants (WWTPs), closing the P cycle and also potentially reducing the eutrophication effects of wastewater effluents on receiving waters.

The research presented will involve growth trials. The recovered P compound fertilizer will be spread on a series of grass trial plots, in conjunction with commercial mineral P fertilizer also applied to trial plots. Three individual grass crops will be cut and measured through the growing season together with weekly dry matter production measurements, allowing comparison of the effectiveness of recovered P compared with commercial P application. The findings of this research will provide information which is important to creating a link between P recovery technologies and applications and the end user, thus contributing to the closing of the P-cycle.

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

WQ7. A survey of the presence of microsystins in water reservoirs in Singapore

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Microcystins (MC) are a group of toxins produced by harmful algal blooms. These toxins can cause serious poisoning in humans and animals and chronic exposure can cause liver cancer. Toxic cyanobacteria have been found in some of the freshwater reservoirs of Singapore so human exposure is a possibility. A survey of 17 reservoirs was undertaken where samples of surface water and algae were collected once a month over a 12 month period using reverse-phase liquid chromatography coupled to a triple quadrupole mass spectrometer. Six MC variants were tested using this method: MC-RR, MC-LW, MC-LF, MC-LR, MC-LY and MC-WR.

HH1. Sewage Epidemiology to Investigate the Impact of Environmental Phthalates on Human Health

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Phthalates are synthetic organic chemicals commonly used as plasticisers in polyvinylchloride and additives in personal care products. Over 213M kg of phthalates are produced globally each year with end use products including food packaging, flooring, paints, tubing and medical devices. Due to their high production volume and continuous release, phthalates are ubiquitous in the environment leading to widespread human exposure. Research has shown that exposure to phthalates has been associated with numerous adverse health effects including impaired reproductive health in males, decreased neurological development in children, cancer and obesity. As a result, some phthalates including DBP, BBP, and DEHP have been banned or limited in manufacturing. As new research emerges indicating that substitute plasticizers have similar effects, these restrictions are likely to increase.

This research constitutes the first application of sewage epidemiology to determine phthalate exposure in an Irish population. Phthalate levels in influent, effluent and sewage sludge will be monitored by GC-MS and LC-MS/MS analysis, tracking the cycle of phthalates throughout the wastewater system. Phthalate biomarkers will be analysed in influent to assess phthalate exposure through the use of mathematical and probabilistic models. A meta-analysis on odds ratio data serves to relate the level of exposure to an associated risk, providing the first step in phthalate risk assessment within the Irish environment, informing future environmental policies. Metabolites from the following phthalates are considered: benzylbutylphthalate, dibutylphthalate, diethylhexylphthalate, di-n-octylphthalate, diisononylphthalate, and diisodecylphthalate.

This study is part of a large-scale project representing an intentional collaboration between Dublin city University, Arizona State University and NIVA informing on phthalate safety and usage.

Keywords: Human Health, Wastewater Epidemiology, Wastewater Quality

HH2. Out of sight, out of mind?
Groundwater as a source and pathway for Antimicrobial-resistant infection in the Republic of Ireland

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Antimicrobial resistant (AMR) bacteria are acknowledged as significant emerging aquatic contaminants with potentially adverse human and ecological health impacts. This study represents the first to investigate the presence and magnitude of resistance among an Irish groundwater sampling cohort (n = 125), with sample-derived E. coli isolates examined against a panel of commonly prescribed human (n = 13) and veterinary (n = 8) therapeutic antibiotics. A Geostatistical analysis was employed to determine the causative factors of resistance. Resistance to the human panel of antibiotics was moderate (21.4%) with the most frequently occurring resistance phenotypes associated with 1st and 2nd generation broad spectrum antimicrobials. Highest levels of resistance were associated with the penicillins (e.g. ampicillin – 14.3%), while notable levels of resistance were also found among the fluoroquinolones, representing a concern, as this antibiotic class is frequently employed in the treatment of salmonellosis. In contrast with the human panel, extremely high levels of resistance to veterinary antibiotics were found; all isolates presented resistance to >1 veterinary antibiotic, with particularly high levels of resistance (93%) found among the aminoglycosides. Geostatistical modelling indicates a significant association between the presence of both human AR ($p = 0.011$) and MAR ($p = 0.002$) and DWWTS reliance, indicating that regions characterised by a higher density of on-site treatment systems are associated with the presence of antibiotic resistant E. coli. A significant association was found between households comprising children <5 years of age and the presence of both human AR ($p = 0.022$) and MAR ($p < 0.001$). Results also indicate a significant relationship ($p = <0.001$) between livestock density and the prevalence of veterinary MAR. This study presents evidence of the presence and extent of antibiotic resistance in the Irish groundwater environment, which represents the primary daily source of drinking water for ≈750,000 people. All isolates were sampled from groundwater sources for domestic human consumption, thus the significance of (multiple) antibiotic resistance, cannot be overstated.

SL1. Screening of environmental soil samples for mycobacteriophages against pathogenic Mycobacterium avium paratuberculosis

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Bacteriophages have been described as "the most abundant organisms on earth which play a significant role in maintaining the microbial balance throughout the planet". A bacteriophage is a type of virus that infects bacterial cells. Bacteriophages have been isolated from every environment in which bacteria exist contributing to biodiversity (approximately 1031 phage particles on the planet) (Keen, 2014). Since the discovery of bacteriophages in 1915, their environmental applications have been infinite including their ability to treat inherent bacterial diseases in humans, plants and animals and their use as bio control agents in water quality, agricultural land, the food industry and marine environments. A plethora of emphasis has been focused on the application of bacteriophages as an alternative to antibiotics, which are continuously overused and misused in diverse environments, particularly in agriculture and human health. One of the major concerns that exist at present is the threat of antibiotic resistant due to this misuse. The utilization of whole, partial or a cocktail of bacteriophages has proven to be effective against a variety of MDR-bacteria, which can be found from environmental sources such as soil, water, sand, grassland, wastewater etc. suggesting the immense potential of environmental bacteriophages. Environmental bacteriophages and their applications are extremely prosperous in maintaining a sustainable future. The purpose of this study is to screen environmental soil samples for mycobacteriophages against pathogenic Mycobacterium avium paratuberculosis. Soil samples are gathered from different areas in Ireland with various soil types including peaty, gley and brown soil. The soil samples are then processed and analysed using microbiological methods.

SL2. The remobilisation of redox-sensitive phosphorus in soil complexes

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There has been a move toward intensifying farmland in both the Republic of Ireland and New Zealand to meet new demands. However, at the same time, there has been increasing social and regulatory expectations to meet environmental sustainability standards. Therefore, the two goals of increased production and environmental health have become inextricably linked, and are driving the move to smarter farming using technology and science to inform sustainable production. Phosphorus (P) is a key nutrient in productive agriculture and is also a significant contributor to water quality degradation if it moves from land to waterways. One way to create an effective balance between P use and P loss using smarter farming is to fully describe and model the risk of P loss from different soils and land types. Previous work has been done to delineate the risk of P loss from hydrologically sensitive areas (HSAs) via runoff, and create descriptive models to predict hotspots and mitigate loss. However, soil biogeochemical reactions also need to be considered. A largely uninvestigated area is the potential for sorbed P to be lost from iron-oxide (Fe-oxide) complexes when soils become waterlogged, due to anaerobic conditions reducing and dissolving redox-sensitive iron complexes. Therefore, laboratory incubation experiments were conducted to quantify the potential reducible-P pool in different soil types from both Ireland and New Zealand to aid land use decisions; and field monitoring was carried out to establish the likelihood of this reduction reaction ('reductive dissolution') to release significant concentrations of P within a catchment, and therefore a key contributor to P loss and degrading water quality.

Keywords: Phosphorus, Reduction, redox, reductive dissolution, iron water quality

SL3. An investigation of sub-surface carbon fluxes in blanket peatlands

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Peatlands are recognised as both a sink and source of CO2, therefore understanding factors that influence either sequestration or emission of CO2 is important in the management of peatland areas. Although CO2 fluxes are recognised as occurring throughout the peat profile, national emission inventories guided by IPCC (1996) guidelines typically measure only the Net Ecosystem Exchange (NEE) which tends to reflect surface fluxes. However, using only surface fluxes excludes the rates of production and transport occurring in the lower peat profiles. This study proposes to explore the nature of sub-surface CO2 fluxes in selected blanket peatland sites in Ireland. This will involve the characterisation of the factors influencing CO2 production, including decomposition rates and nutrient status, and also include factors influencing transport such as diffusion, advection and pressure pumping. The existence thresholds, or tipping points, within the system will be monitored. The outputs of this study will be a mechanistic-based assessment of sub-surface CO2 dynamics within Irish blanket peatland systems. This will provide a direct input in peatland carbon flux determinations and facilitate the optimisation of land-use carbon sequestration capacity as required under the IPCC Good Practice Guidelines. It will also add to our knowledge and understanding of the sensitivity of this ecosystem type to the effects of climate change, environmental system stress and land-use adaptation.

Keywords: Peatlands, Carbon, Greenhouse Gas emissions, Land-use

SL4. The application of microbial consortium constructed by functional microbiome technology for preventing plant absorption of cadmium and promoting plant growth.

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Hazardous metals such as cadmium are extremely mobile in soil, and readily accumulate in crop plants. Downstream consumers are subsequently at risk of developing heavy metal associated renal and skeletal conditions. These detrimental health effects are well documented, as are simultaneous effects in terms of a reduction in crop quality. In recent years, microbial consortia have emerged as a potentially effective solution to this problem due to their versatility and ease of application.

Upwards of 90% of polluted Chinese arable land is designated for remediation by 2020 by order of recent government policies. In addition, studies supported by the EU commission have identified an area of 137,000 km2 within its borders that require treatment via bioremedial methods, a task that would require €17.3 billion via conventional means. Thus new, cost-effective remediation techniques have become highly desirable. Biostabilisation utilises microbial heavy metal sequestration to prevent cadmium uptake by crop plants. The economic viability of this technique holds promise theoretically, but must be experimentally validated prior to effective product development.

This collaborative Institute of Technology Carlow based study will determine the potential of selected microbial strains for cadmium immobilisation. Mechanisms of microbial cadmium resistance will be classified and their contribution to cadmium stabilisation determined. The synergistic or antagonistic effects of a range of chemical amendments will also be explored. The objective of this research is an affordable product that will ensure public safety and improve farm productivity effectively.

Keywords: Cadmium, Plants, Heavy metal uptake, Microbial cadmium resistance, Biostabilisation

SL5. Phos4You: Quality assessment of phosphorus fertilizers recycled from municipal wastewater

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According to Eurostat (Fertilizer Fact Sheet – 1985-2012), the phosphorus demand in North-West Europe is continuously decreasing. It has been estimated that 26% of phosphorus in North-West Europe could be recovered from municipal sewage water. Phos4You project has been established to decrease the demand for phosphorus by demonstrating innovative phosphorus recovery technologies and processing the phosphorus from municipal wastewater to valuable fertilizing products (phosphorus slag, phosphorus salts (struvites and di-calcium phosphates), microalgae, phosphoric acid and adsorbed granules). The project recognizes the rise in phosphorus technologies and demand for creation of standardized methodology for quality assessment of the new fertilizer products, undefined by current legislation. Phosphorus availability, presence of contaminants, ecotoxicity, as well as crop and soil specific response of new phosphorus fertilizers are being selected as product specific quality indicators. Chemical extraction techniques (national, EU, etc.), passive sampling techniques (DGT, Rhizon, ion-exchange resins), bioindicators (Omega-3 index, etc.) and pot/filed experiments are being compared to find the most efficient way of measuring the phosphorus availability. Both, organic (PAHs, PCBs, pharmaceuticals, hormones, etc.) and inorganic (heavy metals, etc.) contaminants are being closely followed. Safety is being determined by various ecotoxicity (microbial, aquatic and soil organisms) tests. Methods for quality assessment of new phosphorus fertilizers are being cross compared and harmonized. Importantly, fertilizer uptake of different plant species (mono-and di-cots) is being demonstrated on different scales (pot, plot, field) and on different phosphorus poor synthetic and real arable soil. Resulting standardized methodology (supporting work of WG-STRUBIAS in defining the EU standard) defines the quality and determines safety of the various products from different processes and locations, ensuring the applicability of the recycled material on the market. It asserts the requirements from all relevant stakeholders (e.g. industry, government, distributers, end users, etc.) within the concept of circular economy.

Keywords: recycled phosphorus fertilizers, municipal wastewater resources, quality assessment

SL6. Title: Food crops, nutrients and rhizobacteria: A promising long-term relationship

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As the global population continues to increase (albeit the rate of increase is slowing), the problems of starvation and malnutrition prevail. We need to meet the food demands of the predicted 9.8 billion people of 2050 while simultaneously trying to eradicate 'Hidden Hunger'. Biofortification of food crops is one approach for tackling malnutrition around the world. It can offer a sustainable way to enhance the nutritional content of food crops in areas where malnutrition is common.

My research focuses on the zinc and iron content of Solanum tuberosum and how rhizobacteria-mediated uptake can improve the levels of these micronutrients. The rhizobacteria used in this research were isolated from an organic potato farm in Co. Cork. Using microboxes as the growth vessels, S. tuberosum microplants were grown and inoculated with different species of bacteria in vitro. After 8 weeks of growth, the plants were analysed using a Varian SpectrAA 600 atomic absorption spectrophotometer to measure the levels of iron and zinc. The most beneficial bacterial species were selected based on results from various bacteriological plate assays, and these were sequenced. Using the results from BLAST and the zinc and iron analysis, we were able to determine that the Arthrobacter and Bacillus species performed best in terms of nutrient uptake in S. tuberosum. The application of this system in vivo is the next step towards creating a protocol for the improvement of nutrient acquisition in staple crops.

Keywords: Biofortification, plant biotechnology, micronutrients, rhizobacteria, nutrient acquisition, Solanum tuberosum

SL7. An application of the S-loop model to identify potential pathways towards sustainability in Irish land use

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Depending on the approach to land use and management, land use offers opportunities for the conservation and restoration of natural capital and the reduction of greenhouse gas emissions. In this project the S-loop model, which is a learning model for sustainability, was used. This model guides the integration of current knowledge on sustainability goals across sectors, the activities, which must change and the system within which the change has to occur. Using expert interviews, a complete description of factors influencing Irish land use was attempted as well as information on activities gathered. I will present this overview over the factors that affect land use in Ireland currently. The interviews revealed that there are two ways of framing the factors amongst experts: one of them is the 'landscape perspective', i.e. the perception of a spatial juxtaposition or overlap of different interests in terms of their claims to using land, the second one is the 'agricultural value chain' perspective, where it is essential that the different sectors develop in a coordinated manner. For the ongoing dialogue on how to best transform Irish land use towards sustainability, which includes the reduction of greenhouse gas emissions, it is important to recognize these different perspectives and assure that critical factors as identified in this project are not left out from any proposed solutions. Furthermore, the S-loop model was used to identify knowledge gaps and to produce research recommendations for the EPA's research programme.

Keywords: system perspective, integration amongst sectors, carbon neutrality, societal transformation

SL8. Assessment of Enhanced Vegetation Index (EVI) derived agro-system map of Ireland based on various partitioning cluster algorithms

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Agriculture is critically dependent on weather and climate for its production and performance. To compare farm system performance at national scale, it is necessary to group farms of similar biophysical characteristics. The objective of this study was to derive an agro-system cluster map of Ireland from the Enhanced Vegetation Index (EVI) of Moderate Resolution Imaging Spectroradiometer (MODIS- 1km) sensor time series data (2002-2014). Even in the absence of climate variables, the EVI effectively identifies the combined effect of agriculture management, soils and climate on the system. The EVI data for all farm locations as recorded in the consolidated National Farm Survey (NFS) from 1980 to 2014 were used. The monthly, seasonal and cumulative annual EVI, latitude and longitude, and elevation of all farms were analysed. Various partition-based clustering techniques such a K-Means, Partitioning Around Medoids (PAM) and Clustering Large Application (CLARA) were tested and K-Means clustering was found the most suitable for identifying the agro-system zones. Eight agro-system clusters with distinct farm types, management and biophysical setting were identified and correlated to farm system characteristics as derived from the Agricultural Census at electoral division level. The tillage areas were distinguished most effectively from other farm systems, but the intensity of different livestock systems could also be distinguished using this clustering algorithm. The derived agro-systems map can be fed as an input to Agro-Meteorological models to determine the impact of weather on crop yields and farm performance, while accounting for the variation due to farm system and climatic zone.

Keywords: Land use, agro-climatic zones, extreme weather, remote sensing

SL9. Estimation of the effects of a polymorphism in the DGAT1 gene with carcass traits in Holstein Friesian dairy cattle

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A desirable objective for Irish farmers is to utilise genetic information to increase productivity on farm. Increasing the frequency of alleles associated with increased milk production and composition traits can improve the overall genetic merit of the herd, while also aiding in applying sustainable agricultural practices. It is important, however, that no negative effects on other traits of importance result from the application of this objective. Genotypes for the diacylglycerol O-acyltransferase 1 (DGAT1) polymorphism (c.694GC>AA), which has previously been associated with increased milk production traits, were obtained from the Irish Cattle Breeding Federation (ICBF) for 10,707 cows. Phenotypes for carcass traits, expressed as predicted transmitting abilities (PTAs), were also obtained from the ICBF. Only animals with an adjusted reliability of >10% were included for analysis and this included n= 3194, 1374, 518 and 360 cows for carcass weight, culled cow weight, carcass conformation and carcass fat, respectively. Associations between each polymorphism and PTA were analysed in ASReml using a weighted mixed animal model. Tentative associations ($p<0.1$) were observed between this polymorphism and carcass weight (0.97 kg, s.e. 0.55) and carcass fat (0.10 kg, s.e. 0.06). A significant association ($p = 0.01$) was observed for carcass conformation (0.38, s.e. 0.15). These results suggest that increasing this desirable allele on farm and in the national herd may have an impact via carcass traits on carrier animals.

Keywords: Genetics, DGAT1, dairy cattle, carcass traits

SL10. No evidence of an association between DGAT1 and fertility traits in Holstein Friesian dairy cattle

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A polymorphism within the diacylglycerol O-acyltransferase 1 (DGAT1) gene, which leads to an alanine to lysine substitution at position 232 in the protein, has previously been associated with an increase in milk composition and production traits in cattle populations. Increasing this desirable allele in the Holstein Friesian cattle population may improve the overall genetic merit of the national herd which will aid in applying sustainable agricultural practises, however, it is necessary to ensure that there are no antagonistic effects on other traits of importance. Genotypes for the DGAT1 dinucleotide substitution polymorphism (c.694GC>AA) on 10,707 cows were obtained from the Irish Cattle Breeding Federation (ICBF). Phenotypes for fertility traits, expressed as predicted transmitting abilities (PTAs), were also obtained from the ICBF. Only animals with an adjusted reliability of >10% were included for analysis and this included n =1193, 264, 4566, 8564, 152 and 2380 for calving interval, survival, calving difficulty, gestation length, mortality and maternal calving difficulty, respectively. Associations between each polymorphism and PTA were analysed in ASReml using a weighted mixed animal model. No associations ($p>0.05$) between the DGAT1 polymorphism and any of the aforementioned fertility traits were observed in the sample set tested. These results suggest that increasing the frequency of the desirable allele contributing to increased milk composition and production would not have a significant negative effect with regards to the fertility traits analysed in this study.

Keywords: genetics, dairy cattle, DGAT1, fertility

SL11. Novel associations between MSTN mutations and fertility traits in Holstein Friesian dairy cattle

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DNA variants of the myostatin gene (MSTN) have been associated with a muscle hypertrophy phenotype in a number of international cattle beef breeds. The objective of this study was to estimate the effects of polymorphisms in MSTN on fertility traits (Calving Interval, Survival, Calving Difficulty, Gestation, Mortality and Maternal Calving Difficulty) in Holstein Friesian dairy cattle. MSTN genotypes (n=7) on 10,707 dairy cattle were obtained through the Irish Cattle Breeding Federation (ICBF), who also provided phenotypes expressed as predicted transmitting abilities (PTAs). Associations between each SNP and deregressed PTAs (adjusted reliability cut off >10%) were carried out in ASReml using a weighted mixed animal model. No observations ($P>0.05$) between MSTN and either calving internal (n=1193), survival (n=264), gestation (n=8564) or maternal calving difficulty (n=2380) were obtained in the sample set examined. Significant associations were detected between MSTN variants nt267 and calving difficulty (1.33, s.e. 0.51, $p<0.05$, n=4566) and nt374-50, nt414 and nt748-78 with calf mortality (2.48, s.e. 0.99, $p<0.05$, n=152). These results suggest that carriers of these mutations exhibit effects on calf mortality and calving difficulty in Holstein Friesian cattle. Validation of these observations are warranted in larger sample sizes especially in relation to calf mortality. The estimation of such effects can provide additional information on the value of carriers of MSTN mutations impacting profitability and sustainability of cattle enterprises.

Keywords: dairy cattle, myostatin, DNA mutations, association study

SL12. No evidence of an association between MSTN mutations and milk traits in Holstein Friesian dairy cattle

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Myostatin is a member of the transforming growth factor superfamily of secreted growth and differentiation factors which are required for the correct regulation of skeletal muscle. In cattle, DNA variants of the myostatin gene (MSTN) have been associated with a muscle hypertrophy phenotype and economically important traits in a number of beef cattle breeds. The objective of this study was to estimate the effects of alleles in the MSTN gene (n=7) contributing to muscle hypertrophy against conventional milk production traits (protein percentage, fat percentage, milk (kg), fat (kg) and protein (kg)) in Holstein Friesian dairy cows. MSTN genotypes on 10,707 dairy cattle were obtained through the Irish Cattle Breeding Federation (ICBF), who also provided phenotypes, expressed as predicted transmitting abilities (PTAs). Associations between each SNP and deregressed PTAs was carried out in ASReml using a weighted mixed animal model. Only cows with an adjusted reliability cut-off of >10% were included in the analysis and included n=6876 for milk yield and composition traits. No associations ($p>0.05$) were observed between the MSTN alleles examined and milk traits in this sample set of dairy cows. Results suggest the potential for increasing the frequency of this allele in the national herd without adverse effects in relation to milk production variables.

Keywords: dairy cattle, myostatin, milk production, association study

SL13. Farm-ECOS: Enhancing farmland biodiversity and the provisioning of ecosystem services through connectivity at the landscape scale

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The decline of European biodiversity is particularly apparent in agricultural ecosystems. Recent trends in agriculture have had deleterious and measurable effects on bird populations on a continental scale. As part of the Common Agricultural Policy (CAP), agri-environment schemes and more recently 'greening' have aimed to stem this biodiversity loss. However, biodiversity declines continue and it is clear that CAP measures need a stronger evidence base to enhance their cost effectiveness. FARM-ECOS is a 4 year project which aims to identify and develop an evidence base for novel and cost-effective measures to maintain and enhance the ecosystem services provided by Irish farmland, with particular focus on the role of improved ecological connectivity. This will include assessments of the benefits that improved connectivity can bring to ecosystem services in both tillage and grass-based systems, leading to the identification and development of improved agri-environment measures.

Two distinct and representative study regions have been chosen where a gradient of farming intensities and enterprises exist - north County Sligo and the Blackstairs region of Co. Carlow and Wexford. Using orthophotography, habitats and linear features have been identified. Landscape connectivity maps will be produced for each area, and the level of connectivity will be assessed using a number metrics of landscape structure and function (e.g. patch area, patch density, patch variability, edge metrics). In conjunction with assessment of connectivity, surveys will be undertaken on selected taxa (e.g. invertebrates and vegetation) associated with the primary connectivity features identified. Mapping and assessment of selected ecosystem services for each region will be undertaken using appropriate software (e.g. InVEST, AIRES). Finally, the relationship between biodiversity, ES and connectivity metrics will be explored to assist in the design of improved agri-environment measures. These can be incorporated into new results, hybrid or action based agri-environment payments for ecosystem services.

Keywords: Agricultural landscapes, Agri-environment schemes, Biodiversity, Ecosystem Services, Connectivity

SL14. Profiling β-Defensin Gene Expression in the Bovine Salivary Glands

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Antimicrobial peptides are effector molecules that link innate and adaptive immune response. Functional characterisation focused on antimicrobial functions but researches show immunomodulatory functions for these peptides, now referred as Host Defence Peptides (HDPs). They play a critical role in managing the interface between host and resident microbiome. Cattle produce ~100 litres of saliva per day but expression of HDP in salivary gland hasn't been investigated. This study aims to characterise expression of □-defensin genes in bovine salivary glands using quantitative polymerase chain reaction (qPCR). Samples were collected from parotid and mandibular salivary glands from healthy Holstein-Friesian cattle and cattle experimentally infected with Mycobacterium avium paratuberculosis, the causative agent of Johne's disease. Biopsies were taken post-mortem from the salivary glands and RNA was extracted using standard techniques (Qiagen). After primer design and cDNA synthesis, β-defensin expression was assessed for HDP genes including TAP, Cathelicidin 4, LAP, BBD112, BBD131, S100A8 and S100A12. Normalisation of gene expression was performed relative to expression of ACTB. Expression was identified in all genes with exception of BBD131 and Cathelicidin 4. Significant differences in expression was detected for BBD112, S100A8, S100A12, LAP and TAP between parotid and submandibular salivary glands in the MAP infected cattle only ($P<0.05$). Differences between groups didn't reach statistical significance (S100A12 and LAP had P values of 0.08 and 0.07). This study identified expression of bovine β-defensin genes in salivary gland for the first time. Results suggest that salivary gland expression of genes may form a component of the innate immune response in the oral cavity and digestive tract.

Keywords: β-defensin genes, parotid, mandibular, qPCR, MAP

Environmental Policy & Communication

EP1. Development of a method for the analysis of phthalates and their metabolites in environmental samples

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Phthalate esters are a group of synthetic organic chemicals that are most commonly used as plasticizers in polyvinyl chloride (PVC) materials. Common end uses for PVC, and therefore phthalates, include tubing, blood bags, medical devices, clothing, flooring, packaging, toys, automobile parts, flooring, and roofing. As phthalates are so commonly used, their impact on the environment and human health has been extensively studied. Phthalates have been found to be recalcitrant, ubiquitous within the environment, and in many cases, detrimental to human and animal health.

The phthalates included in this study are Benzylbutylphthalate (BBP), Dibutylphthalate (DBP), Dipentylphthalate (DPP), Diisopentylphthalate (DIPP), Diethylhexylphthalate (DEHP), Dihexylphthalate (DHP), Diisobutylphthalate (DIBP), Di-n-octylphthalate (DNOP), Diisononylphthalate (DINP), Diisodecylphthalate (DIDP) and Dimethylphthalate (DMP). Also included are five monoester metabolites of these compounds. Method development has been carried out on an Agilent 6470 triple quad mass spectrometer, with varying methods of sample preparation depending on matrix. Methods include solid phase extraction, soxhlet extraction and ultrasonic solvent extraction. This project aims to carry out a pilot study on occurrence of these compounds in a variety of environmental matrices and development of methods to support this aim. This research is timely as the extent of phthalate contamination within Ireland, and the impacts on human health, are unknown.

BE1. Monitoring of carbon dioxide fluxes in a temperate grassland using nonlinear signatures

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CO2 fluxes are being monitored using an eddy covariance (EC) system set in Irish temperate managed grassland. The data from EC are usually reported half-hourly with an objective to collect data 24h a day (365 days a year). The average data coverage over the year is approximately 65% due to system failures or data rejection through filtering. The EC method works best during windy periods; however, during calm climatic conditions measured fluxes may be underestimated as the fluctuations in the vertical wind speed are too small to be resolved by the sonic anemometer. Hence, it is more likely that the goodness of the daytime CO2 flux data will be better than the night time measurements. Similarly, the seasonal variation contributes to the goodness of the data. Hence, the pattern of behaviour of the CO2 flux signal needs to be studied. In that regard, the Delay Vector Variance (DVV) method was used to detect the presence of determinism and nonlinearity of the seasonal variation of the CO2 flux time series. The DVV method detected nonlinearity in the seasonal time series of the CO2 flux, related to the variations in underlying factors and processes (e.g. variation in momentum flux during the dry nights and net ecosystem exchange limits during the day). Though the majority of the methods used in the literature to identify nonlinearity in the time series deal only with large amount of data, DVV showed a consistent and moderately robust performance in detecting nonlinearity in a time series with a small number of measurements. This is particularly important for the night and winter CO2 flux time series. The information on the presence of nonlinearity in the time series of the CO2 flux can guide the choice of CO2 filters for day and night more appropriate for the conditions of the measurements.

Keywords: carbon dioxide flux, seasonal variation, delay vector variance method, grassland

BE2. Lough Arrow - Conservation Status Assessment and Collaborative Actions for the Natura Network

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The Collaborative Actions for the Natura Network (CANN) is an ambitious INTERREG VA project (2017-2022), which intends to improve the conservation condition of selected Special Areas of Conservation (SACs) within Border Regions of Ireland and in Western Scotland, under the European Union's Habitats Directive (92/43/EEC). This PhD research is part of the wider project activities focused at one of the CANN sites; Lough Arrow, Cos Sligo and Roscommon is a designated SAC, containing a representative example of the Annex I habitat "Hard oligo-mesotrophic waters with benthic vegetation of Chara spp." The current conservation status of this Annex I habitat is significantly impaired and deemed by the most recent Article 17 conservation assessment to have a "Bad" classification nationally. This classification is due to a number of pressures impacting the habitat at a national scale, most notably, the impacts from pollutants and invasive species which are compromising both habitat quality and availability.

This project will determine the current conservation condition of the Annex I habitat occurring in the Lough by utilising national and EU standards. During the CANN project, a number of novel in situ conservation measures will be undertaken to potentially improve the conservation condition of the habitat. Temporal changes in relation to habitat quality will be monitored throughout the duration of this PhD, to determine the significance of methods utilised by the CANN project. Furthermore, the use of certain biotic and abiotic variables will be investigated in relation to their contribution to habitat assessment. Correlations between assessment techniques used in the Habitats Directive (92/43/EEC) and the Water Framework Directive (20/60/EC) will also be investigated in order to determine their relationship and role in determining lake status for Lough Arrow.

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

BE3. Development and Testing of Molecular-Based Methodologies for Real-Time Profiling of Biological Communities in Freshwater Aquaculture

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The lack of expansion in the freshwater aquaculture sector as a whole has become an alarming concern over the past 20 years in Ireland. This is marked contrast with FoodWise2025 that seeks to increase food exports by €19bn by 2025. Impediments to traditional flow-through production process encompassing fatal disease outbreaks, issues with uncertainty over discharge licensing and a lack of understanding of the overall culture water dynamic have contributed to this stagnation. In order to address the intensive sustainability of Irelands' freshwater aquaculture sector and to inform these bottleneck concerns, it is important to develop an in-depth understanding of the dynamic mix of biological and physico-chemical parameters governing desirable rearing water as a baseline for successful operation.

This project focuses on development and testing of novel molecular diagnostic methods facilitating DNA profiling of predominant bacterial and algal communities in rearing water, with real-time detection of important fish pathogens. Gaining an understanding of target species that contribute to finfish disease outbreaks and poor water quality is essential for prevention and control of problematic species. Molecular-based techniques, such as real-time PCR, have many advantages over traditional plating methods in the identification of species present, as less than 1 % of microorganisms will grow via the latter method. The use of species-specific probes enables detection of problematic pathogens and therefore aids future characterisation of harmful bacteria and algae. Linking the biological profile with water quality parameters such as nitrates, nitrites and ammonia in a pill-pond farm when production is thriving will allow for the amendment of the process when production regresses or fails. It will also identify the potential to up-scale and replicate this type of fish farm in the culturing of a variety of freshwater species such as trout, therefore providing an opportunity to expand the industry. Findings from this project will inform innovation (including sensors) and policy.

Keywords: freshwater aquaculture industry, molecular-based techniques, community profiling, real-time PCR, biological parameters, physico-chemical parameters, bacteria, algae

BE4. A Study of Invertebrates species in different hedgerows/hedges of different flora characteristics surrounded by Semi-natural and Artificial habitats

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Hedgerows and hedges are important habitats for invertebrates. The hedgerows land coverage in Ireland is approximately 6.4 % or 450,000 hectares (1.1 million acres). Since Ireland has very little natural woodland, hedgerows have become a critical habitat for a wide variety of flora and fauna. Loss of biodiversity of hedgerows and hedges is increasingly under threat from human activity and pollution. Hedgerows supply important services to urban and rural areas such as providing habitats for pollinators and predators of pest species. Other ecosystem services of hedgerows and hedges include prevention of soil erosion, shelter, aid in carbon sequestering, water buffering and flood prevention. This project studied the invertebrates' biodiversity and abundance in selected hedgerows and hedges of different flora characteristics. The surrounding habitats, artificial and semi-natural were studied using Fossitts guide to habitats. Eleven sites in total were studied including semi-natural hedgerows surrounded by artificial and semi-natural habitats and artificial hedges surrounded by semi-natural and artificial habitats. The survey methodology utilised included pit traps and observation of flying invertebrates, and identification of flora aided by guidebooks. Quantitative analysis carried out including richness, Simpson diversity index, evenness and chi square test for association. This research showed the importance of appreciating artificial hedges and semi-natural hedgerows as habitats for invertebrates and both have a big role to play in areas such as pollination and soil formation. Slugs appear to be a species present in all sites and is possibly a keystone species. The importance of this project in terms of baseline studies and species abundance was demonstrated.

Keywords: Invertebrates, hedgerow/hedges, biodiversity

BE5. A Rapid Assessment Framework for Irish Habitats: A Case Study of Machair Habitat Quality.

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Existing habitat assessments in Ireland lack a standardised, quantitative methodology and are often beyond the time constraints of monitoring staff. There is thus a need to develop a framework that can rapidly assess habitats and provide a benchmark against which we can measure change. Based on a global review of existing habitat assessment schemes we developed a new rapid framework specific to Ireland. The new framework consists of a three-tiered approach incorporating 22 variables that encompass adjacent land uses, site management, and site-specific key indicators of habitat condition. First a pre-survey considers the site context within the wider environment. This is followed by a structured field survey that focuses on easily measured physical and biological variables minimising field time. Finally, a site overview considers overall site management conditions. We tested our framework against the current qualitative designations of habitat condition for Irish Machair. Machair was chosen as it is a globally rare habitat and particularly vulnerable to rapid changes from both anthropogenic and climatic sources. The new framework scores matched 70% of the current 'traffic light' designations established in the Habitats Directive, with remaining sites scoring near the boundaries of these designations. Two variables, 'ecological corridors' and 'connectivity' contributed over 40% of the total weighing of the final score. We envisage further development of this framework to cover all Annex I habitats in Ireland and for assessment of agri-environmental schemes. This new framework is a practical response to the lack of a unified approach to assessing and reporting habitat condition and will help Ireland to meet the monitoring requirements of the Habitats Directive to ensure that conservation efforts are having the desired effect.

NE1. Patterned Protein-Polysaccharide Thin Films Through Humidity Regulated Phase Separation

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Greater sustainability in mass manufacturing is essential to alleviating anthropogenic climate change. This requires fundamental changes to the materials and manufacturing processes used at every level of industry and society. It means high surface-area, micro- and nano-patterned films have, in the 21st century, become a fundamental material, crucial to a wide variety of industries and technologies. Typically, such patterned materials are produced using petrochemically derived polymers and top-down processes. As with any vital technology made from oil resources, there are growing concerns about disposability, lifecycles, threat to supply, and increased costs as supplies dwindle. A sustainable materials approach to these films, producing them from biopolymers in bottom-up processes, could allay these concerns. Biopolymers are abundant, renewable, low cost, easy to manufacture, and bottom-up processing hugely reduces the use of toxic solvents. This paper describes precisely such a process; a bottom-up production of patterned biopolymer surfaces. We detail the controlled phase separation of biopolymeric thin films into nanopatterns using easily transferable variables and methods. Similar morphologies to those commonly observed with synthetic block-copolymers, were achieved across a large range of feature sizes, from 200 nm to > 5 µm: Bicontinuous, porous, droplet-matrix, particulated and dimpled. Protein and polysaccharide type, protein to polysaccharide ratio, casting method and ambient humidity were primary conditions found to influence the pore morphology of the biofilms. High protein concentrations (HPC 4:1 and 2:1 blends) generally resulted in porous structures whereas high polysaccharide concentrations (1:2 and 1:4 blends) resulted in spherical structures. High humidity conditions (60% - 90% relative humidity) resulted in the growth of large protuberances up to 6 µm in diameter while lower humidity (10% - 30%) resulted in smaller discrete structures smaller than 200 nm.

NE2. Potential of using Nano-zeolite for Nitrogen and Phosphorus immobilisation in dairy wastewater

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This study examines the feasibility of using coal fly ash to synthesize Nano-zeolite, and the nitrogen and phosphorus adsorption efficiencies of the nanomaterial in dairy wastewater.

Chemical treatment of coal fly ash wasconducted and corresponding changes in its property were followed. s. The sample treated with NaOH showed an increased cation exchange capacity and P sorption index in comparison of the initial fly ash due to particle modification from smooth surface to plate- and rod-shape crystals which were attributed to the Nano-zeolite.

Batch experiments were conducted by mixing coal fly ash and the Nano-zeolite with wastewater to study the effect of sorption time, pH values, dosage of Nano-zeolite on nitrogen and phosphorus removal efficiency. The adsorption process reached equilibrium in a very short time (less than 60min), which suggests that there is potential for fast immobilisation of nutrients. The concentration of ammonia decreased from 118 to 35 mg/L (71% removal) while the concentration of phosphate decreased from 52 to 45 mg/L. Specifically, ammonia removal efficiency ia is estimated to be 36.6, 51.8 and 70.9(%) at pH 3, 7 and 10, respectively. The phosphate removal efficiency of increased dramatically with the decrease of the slurries' pH values, with removal rates of 92.1, 47.3, 12.3(%) at pH 3, 7 and 10, respectively. Nano-zeolite could be a potential absorbent for fast immobilisation of ammonia but not phosphate. Surface modification of Nano-zeolite could be introduced in order to enhance the pollutants removal efficiency.

Keywords: Nano-zeolite, Nitrogen and Phosphorus immobilisation, dairy wastewater

WM1. Dairy processing wastewater as a feedstock for microbial bioplastic production

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Over the last few years the Irish dairy sector grew steadily to an annual milk production volume of over 7 billion litres. Dairy processing adds further value to the milk, but at the same time generates up to 10 litres wastewater (WW) per litre processed. This WW contains a high concentration of organic pollutants that need to be removed before discharge. Our approach aims to exploit this waste stream as a feedstock for polyhydroxyalkanoates (PHA), a polymer with similar properties to petroleum based plastics. The storage molecule PHA is widely used by bacteria, to withstand prolonged starvation periods. The adaption of biomass towards PHA accumulation is driven by an aerobic dynamic feeding regime. Bacteria capable of PHA storage are selected, due to their increased survivability during the starvation periods. Over time the mixed microbial system is therefore optimised for PHA accumulation. A parallel process involves a pre-digestion of the dairy processing WW, in an anaerobic, hydrolytic reactor. Here, acidogenic bacteria metabolise the organic fraction of the WW to form volatile fatty acids, the building blocks of PHA. In a final production step, the adapted WW and biomass is combined in a fed-batch system, to produce the end product PHA. Once PHA has accumulated in the cells, they are harvested and the end product is purified in the downstream process. This approach combines the valorisation of dairy processing WW, alongside a sustainable material production of a bio-based, degradable plastic. Herein we present an overview of the system setup and optimisation to date.

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

WM2. The growth of Lemna minor on dairy processing wastewater under laboratory conditions

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The growth of Lemna minor plants on dairy processing waste (the waste formed in the processing of raw milk for products such as cheese, cream and dried milk powder) was optimised in this research. These experiments are part of the larger Newtrients project that will determine the potential of using L. minor to recycle dairy processing waste, as a part of a circular economy approach that will recover plant nutrients from waste. The aquatic plant L. minor can take environmentally damaging compounds from waste, such as nitrogen and phosphorous, and then can be harvested and used as a high-protein agricultural feed. L. minor growth is determined by the availability of essential nutrients in the waste. Conversely, high amounts of certain nutrients may cause toxicity. In lab-based experiments L. minor plants were grown on 'synthetic' dairy processing wastewater which mirrors the real waste of the dairy processing industry, but has the advantage of enhanced reproducibility. Use of the synthetic dairy waste also allowed concentrations of specific compounds to be changed, to determine effects on L. minor growth. The dairy processing waste contained all the required nutrients for L. minor growth. Nevertheless, L. minor grew sub-optimally or frequently died on synthetic dairy waste. It was tested whether this was due to sub, or super-optimal concentrations of nutrients. Concentrations of a number of nutrients (nitrogen, phosphorous, iron, chloride, sodium, manganese, calcium, magnesium) were changed to see how that affected the health and growth of the L. minor plants. L. minor tolerated a broad range of nutrient concentrations with limited impact on growth. Yet, it was found that the ratio of calcium to magnesium in the waste had a profound impact on the growth of L. minor. A ratio in favour of magnesium (1:9 – calcium:magnesium) in the synthetic dairy waste led to L. minor death. While a ratio in favour of calcium (2:1 – calcium:magnesium) resulted in growth. Other compounds such as chloride, manganese and sodium had a modest negative impact on plant growth. It is concluded that with minor modifications, synthetic dairy industry waste is a suitable substrate for growth of L. minor, and this will enable recovery of nutrients as part of a circular economy approach.

Keywords: wastewater, recycling, circular economy, sustainability, duckweed

WM3. The Microbial and Physicochemical Treatment of Irish Landfill Leachate

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The waste management industry within Ireland has undergone a dramatic change due to the implementation of the Landfill Directive (1999/31/EC) and the Waste Management legislation 2009. A major reduction in the number of municipal solid waste landfills has subsequently occurred. One major concern of municipal solid waste disposal is the production of landfill leachate. This chemical cocktail can continue to be produced for centuries after a landfill is decommissioned. The management of leachate is essential for the protection of the surrounding environments specifically ground and surface water.

Many methods are used to treat leachate. Most are adapted from wastewater treatment methods and usually involve the effective combination of both biological and physicochemical methods. It can be difficult to obtain satisfactory results with just one method due to the variety of composition between different leachates. In Ireland, leachate is either discharged directly into sewerage mains (≤ 51%), treated in increasingly overloaded regional wastewater treatment plants (≤ 48%) or treated onsite (≤ 1%). Of these options treatment in wastewater treatment plants is costly and often inadequate, with 30% fewer wastewater treatment plants accepting leachate (2010-14) due to stringent discharge limits set by the EPA.

The current research has developed a pilot system that can successfully treat leachate to discharge limits through the use of bacteria along with pumice stone and oyster shells. A total removal rate of ≥91% was achieved for BOD, COD, ammonia, phosphate and nitrates with these compounds being treated to discharge limits for wastewater. The next step for this research is to scale up the pilot study and begin treating leachate in-situ while monitoring seasonal variation and determining how effective this treatment can be over a longer time frame.

Keywords: Landfill leachate, Waste-management, Novel treatment bioremediation, Adsorption

WM4. Laboratory scale conditioning of synthetic dairy processing wastewater as a feedstock for Lemna minor production

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National production of milk was approximately 7 billion litres in 2017, with an estimated value to the economy of €1781 million. Raw milk is processed into a variety of products, the majority of which are destined for export. The production process can generate high volumes of wastewater, up to 10L per litre of milk processed. Theses wastewaters carry high loads of chemical oxygen demand (COD), nitrogen (N) and phosphorus (P), ranging from; 1,150 – 68,814 mg/L COD, 14 – 1,462 mg/L N, and 7.2 – 650 mg/L P. Environmental Protection Agency (EPA) regulations allow for no more than 50mg/L COD, 10mg/L N and 5mg/L P in effluent discharged to water bodies. As a result, there is considerable pressure on dairy processing industries to apply comprehensive, costly treatments to remediate these waste streams. However, in line with the emerging national focus on sustainability and circular economy principles, the potential to utilise dairy processing wastewater as a feedstock for value added products is gaining interest. One possibility involves the cultivation of high protein content plants for potential use as feed for dairy herds during the off-peak season. Lemna minor (duckweed) is one such plant that has been reportedly used in bioremediation and wastewater treatment, offering rapid growth and high protein contents. This study aims to condition dairy processing wastewater for Lemna minor production using various wastewater treatment technologies. Herein we discuss the proposed strategies and preliminary findings to date.

Keywords: Dairy Processing Wastewater, duckweed, Lemna

AQ1. Real-time Monitoring of Biological Airborne Particles in the Hospital Environment (ReM-BAPHE)

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Conventional sampling methods for airborne bacteria and fungi in hospitals are limited due to short sampling times of the conventional sampling devices used (minutes to hours on appropriate media). Subsequent culturing restricts the detectable organisms and only allows retrospective analysis (days). These problems restrict their efficacy in quantifying the role of airborne transmission in healthcare infection. It also does not help develop standard settings for the treatment of indoor hospital air. In contrast, continuous bioaerosol sampling is being increasingly used to characterise outdoor air. The techniques combine laser particle size and shape detection with fluorescence signals from viable organism containing amino acids and NAD(P)H. Hence, portable instruments such as the Waveband Integrated Bioaerosol Sensor (WIBS) are now often used to count airborne pollen, fungal spores and bacteria in real-time. Such an instrument was deployed to monitor bioaerosols in hospital wards. Therefore, changes over time could be measured and so empirical interventions currently used to increase air quality could be evaluated. Data were obtained from a continuous multi-day WIBS monitoring campaign of a 4-bedded bay on a ward using a HEPA-filtered heating, ventilation, and air-conditioning (HVAC) system. ~10% of total particles less than 20 microns in diameter were found to be fluorescent at wavelengths typical of biomolecules. Twenty-fold spikes in particle numbers were measured on occasion on a minute to minute resolution. Hourly-averaged particle numbers showed regular diurnal fluctuations with four major peaks and one minor peak per day. These were recorded at times of day with maximum footfall and coincide with various ward activities. In summary, WIBS continuous, real-time monitoring of the hospital environment reveals airborne particle bursts of probable bacterial or fungal origin in much larger numbers than reported by conventional culture-based sampling. Cumulative multiday monitoring reveals these bursts are associated with movement or occupancy and regular ward activities.

Keywords: Bioaerosol, Real-time analysis, Indoor air quality, WIBS

AQ2. Behavior of pressure field extension for specified granular fill materials for radon mitigation by soil depressurisation systems

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Design of bearing layers (granular fill materials) is important for a house with a soil depressurisation (SD) system for indoor radon mitigation. These layers should not only satisfy the bearing capacity and serviceability criteria but should also provide a sufficient degree of the air permeability for the system. Previous studies have shown that a critical issue of a SD system is the pressure field extension in the bearing layers, but this issue has not been systematically investigated. This study conducted a series of two-dimensional computational fluid dynamic simulations to investigate the behaviour of the pressure field extension. The granular fill materials investigated in this study are the T1 Struc and T2 Perm. Different conditions, which might encounter in a practical situation, were investigated. The results show that the air permeability and thickness of the granular fill materials are the two key factors which affect the pressure field extension significantly. Therefore, these factors should be considered sufficiently in design. Finally, a significant improvement of the pressure field extension can be achieved by designing a proper air tightness of the slab.

Keywords: radon; soil depressurisation systems; granular fill materials; computational fluid dynamic

AQ3. Molecular Characterisation of Organic Aerosols from Coal, Peat and Wood Burning

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Domestic solid fuel (DSF) burning is one of the primary contributors to air pollution, particularly in residential areas. The pollutants produced by DSF burning include volatile organic compounds (VOCs), nitrogen oxides, sulphur dioxide and particulates (PM), mainly in the sub-micron range (PM1). Although it is known that PM1 from solid fuel burning contains a very large amount of organic carbon, there is little detailed information on the molecular composition of the particles. The aim of this work is to characterise the molecular species in particles produced by the burning of a variety of solid fuels including wood, peat briquettes, turf, coal and smokeless coal.

PM produced by burning the solid fuels in a modern stove were collected on 150 mm quartz fibre filters, which were pre-baked at 600°C for 6 hours to remove any contaminants. The PM was extracted from the filters using methanol and filtered to remove large particles. The extracts were subsequently analysed using an ultra-high resolution mass spectrometer (Orbitrap Velos), which measures the mass of chemical species with an accuracy of five decimal places, thus allowing the identification of chemical formulae with a high level of precision. In each of the samples, several thousand individual chemical species were identified. Statistical analysis procedures enabled the compounds to be grouped into several different types including condensed aromatics and lignin-type compounds. All of the samples also contained several oxygenated nitroaromatics, which are known to be produced from the combustion of solid fuels. Analysis is ongoing in order to determine if unique marker compounds are present in PM produced by coal, peat and wood burning. The results from these fuel-burning experiments will be compared to those obtained from analysis of field samples collected in the towns of Killarney, Enniscorthy and Birr as part of the SAPPHIRE project.

Keywords: Air Quality, Particulate Matter, Solid Fuel Burning, Mass Spectrometry

AQ4. Characterisation and Source Apportionment of Carbonaceous Aerosols in Ireland

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Carbonaceous aerosol accounts for a large portion of the ambient aerosol across Europe. Its sources can be both natural and anthropogenic; the latter increasing dramatically in recent years with economic and industrial growth, along with the ever escalating global population. Carbonaceous aerosols impact the atmospheric radiative balance, climate change and regional air quality while also adversely affecting human health. It is, therefore, key to determine the relative contribution of combustion sources; making use of either fossil fuels, such as road traffic, or biomass burning, such as domestic solid fuel and wood burning. By identifying and quantifying such sources, steps can be taken towards heightening public awareness of air-quality related issues and developing efficient abatement strategies.

Online and offline measurements were made in four locations in Ireland; Mace Head, Co. Galway, Malin Head, Co. Donegal, UCD Belfield Campus, Dublin 4 and Carnsore Point, Co. Wexford, in an effort to identify and quantify the sources of ambient aerosols. The range of instruments included a high volume air sampler (Digitel High Volume Air Sampler), a sequential air sampler (Partisol Sequential Air Sampler) and a multi-wavelength aethalometer (Model AE33, Magee Scientific).

The PM samples obtained in this campaign were subject to a variety of chemical analyses, such as the determination of organic carbon (OC) and elemental carbon (EC) fractions of ambient carbonaceous aerosol, analysed according to the EUSAAR-2 protocol (Cavalli et al., 2010), and gas chromatography-mass spectrometry (GC-MS) focusing on the wood burning tracer levoglucosan and its isomers; mannosan and galactosan. The online measurements were used to characterise the fine carbonaceous aerosol and deduce source contribution estimates for fine particulate matter (PM2.5) in the four locations, based on the multi-wavelength aethalometer approach for determining biomass burning and traffic contributions in combination with filter based-measurements of the biomass burning tracer levoglucosan and elemental carbon (EC).

Keywords: Carbonaceous aerosol, organic carbon, elemental carbon

Sustainable Infrastructure

SI1. A Transnational Assessment of the Potential For Micro-Hydropower Energy Recovery in Water Pipe Networks: Mapping Existing Resource Potential in the Atlantic Area Of Europe

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The inefficient consumption of energy in water distribution networks is a well-known problem and one that has been addressed by numerous researchers to date. There are known locations in water distribution networks (WDNs) with excess pressures, where energy is purposely dissipated by using special infrastructure such as break pressure tanks (BPTs) or pressure reducing valves (PRVs), in order to prevent pipes bursting and reduce water leakage losses. One of the solutions to reducing the energy dependency of WDNs is by recovering a portion of this dissipated energy wasted at locations of excess pressure, through the implementation of micro hydropower technology (MHP).
While the potential of MHP energy recovery in WDNs is a suitable solution to improve the energy efficiency of the water sector, it has seen limited exploitation in practice due to a number of technical and non-technical issues. These non-technical issues include a lack of awareness about the scale of the existing resource available in water pipe networks and its corresponding environmental and economic impact. This paper describes a methodology, and its application, for the development of a transnational assessment of MHP potential in the existing water networks in parts of France, Ireland, the United Kingdom, Spain and Portugal. The work includes discussion on spatial and temporal extrapolation of existing resource assessment to wider geographical coverage and longer time scales. A mapping of potential wasted energy resources on such a large scale has not been conducted to date. Preliminary estimates of the potential for energy recovery in drinking water networks in Europe arising from this work estimate a potential for 1900 GWh of savings per annum. The potential for energy recovery in private industrial networks and the potential for future growth of the existing resources remain to be quantified.

Keywords: Micro-hydropower; drinking water distribution networks; energy recovery; resource mapping

SI2. "Development of an industrial scale pyrolysis system to bring about the rapid delamination of End-Of-Life Photovoltaics"

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As of 2014, Photovoltaic (PV) modules were added to the EU's Waste Electrical and Electronic Equipment (WEEE) directive making it law; that manufacturers and suppliers are responsible for their end-of-life management. This, alongside the amount of rare and precious metals these modules contain, provides added incentive, both environmentally and economically, to recycle these panels. Between 80-90% of the current PV market share is dominated by first generation PV known as crystalline silicon. These panels are comprised of the following layers that form a thin laminated structure: glass, two encapsulant layers (top and bottom of cells), crystalline cells, back sheet, junction box and frame. The silicon within the panel is at a premium value in the wafer state, as opposed to the raw material, due to the high temperatures and energy used in original wafer production. With silicon being the main semi-conductor used in electronics as well as PV, the expansion of both industries means the ever-growing demand for silicon has never been as high. It has been proven that the encapsulant, which bonds the layers together, can be broken down in order to delaminate the entire structure using chemical or thermal methods. The proposal for this project is to use pyrolysis as a thermal method to delaminate the panel, with an emphasis on recovering the silicon wafer to provide economic benefit and contribute positively towards a circular economy. The optimum process parameters will be determined for various atmospheres. The syngas from the process will be recycled, and the heat recovered will be used to heat the delamination stage and help make the process self-sustainable. From the planned small-scale pyrolysis experiments, the results will be further extrapolated using predictive modelling software to determine the exact characteristics of the pyrolysis process that would occur at industrial scale.

Keywords: PV Recycling, Pyrolysis, EoL, Circular economy, industrial scale pyrolysis, Photovoltaic delaminate

SI3. Bridge management and climate change

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Bridge management requires a multidisciplinary approach (structural, hydraulic and geotechnical engineering, hydrology, materials and transport management). A significant amount of bridges over rivers face scour (removal of river bed material around bridge structure and foundations due to the effects of the flowing water) during their lifespan. Studies indicate that of all hazards, the hydraulic hazard (scour) is the main cause of bridge failures (partial or complete failure of bridge structure) worldwide. Existing bridge and transport infrastructure will be affected by hydraulic hazards (flooding and scour) even more so in coming years. In order to adapt to effects of climate change it is possible to establish a monitoring and forecasting network at bridges. Based on the physics of atmosphere, river geometry and land characteristics (land cover, soil) of a river runoff area (river catchment), engineers can predict water levels and runoff at the bridges with considerable lag time prior of the flooding occurs. This paper presents an operational flood forecasting system for Bandon River in Co. Cork, Ireland and its role in a Bridge Management System.

Keywords: Bridge management, Bridge scour, Flood Early Warning System

ST1. Candidate method identification for lead and arsenic detection and quanitification in water using optochemical detection systems

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Heavy metal contamination of drinking water is a serious global issue. Chronic exposure to heavy metals such as lead and arsenic can cause serious health problems. Because of the high toxicity of lead and arsenic, the EU has set a standard limit of 10 µg ml-1 for both of these metals in drinking water.

In order to effectively monitor heavy metal concentration in water, highly sensitive and selective monitoring methods are needed. Standard laboratory techniques such as atomic absorption spectroscopy, mass spectroscopy and ion chromatography are the most commonly used methods for heavy metal determination in water. Although these methods are sensitive and selective, they are not cost-effective and thus unsuitable for in situ monitoring purposes.

Autonomous microfluidic detection systems could serve as an alternative environmental monitoring option. The small size of these systems gives many advantages such as low cost, ease of use, and reduced chemical consumption. Microfluidic detection systems have been developed and successfully used for nutrients (N- and P-based) and pH monitoring in water.

The aim of this research is to identify and assess candidate optochemical detection methods for lead and arsenic detection in water. Extensive literature analysis and a selection process using UV vis spectroscopy was carried out. For arsenic detection, a colorimetric method using leuco malachite green dye was selected and optimised. Preliminary assessment of the method's performance in microfluidic detection systems was carried out. A colorimetric method based on 2, 5-dimercapto-1, 3, 4-thiodiazole dye was selected for lead analysis and optimised for microfluidic detection.

Keywords: heavy metals, colorimetric methods, microfluidics

ST2. Predicting annual electricity consumption on Irish pasture-based dairy farms using a Support Vector Machine model

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This study analysed the previously developed support vector machine (SVM) model for predicting the annual electricity consumption of 20 Irish commercial dairy farms, data from which was not included in the development of the model. Model input variables include easily-attainable variables related to milk production, stock numbers, infrastructural equipment and managerial procedures. This allows predictions to be made on a large scale without the use of specialised equipment. Previous research found the SVM model was capable of predicting monthly electricity consumption to a relative prediction error (RPE) of 12%, representing a 54% improvement over a standard multiple linear regression approach. However, this research did not analyse the prediction performance of this machine-learning algorithm for predicting annual electricity consumption. The SVM model may achieve further improvements when predicting annual consumption as areas of model over-prediction may be balanced by contrasting areas of under-prediction. This annual accuracy metric may be useful for stakeholders wishing to calculate the impact of dairy farming on electricity resources in Ireland on an annual basis per farm. Results showed the SVM model was capable of predicting annual electricity consumption of the top 90% of dairy farms to within 9% (RPE) of actual annual electricity consumption, thus improving its utility as a prediction tool over monthly prediction. The two least-accurate farms (bottom 10%) were found to represent a minute proportion of the Irish dairy farm demographic with average herd sizes in excess of 190 cows and annual milk production greater than one million litres. This study showed the prediction accuracy of the SVM model improved when predicting electricity consumption on an annual basis. This model may be utilised to provide accurate decision-support information to both dairy farmers and policy makers or as a tool for conducting macro- scale environmental analysis for marketing Irish dairy products abroad.

Keywords: Energy Modelling; Machine Learning; Dairy Sustainability Monitoring; Dairy modelling

ST3. Techno-Economic Analysis of Decentralized Sustainable Energy Systems Installation and Market Potential at the Sector and System Level

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In a world where natural resources are endangered in the face of the massive consumption of industries and population, professionals in the energy sector need to fully comprehend the framework within which sustainability has to be approached. As developed countries try to implement a transition from current fossil-based energy systems to green-powered energy solutions, both the energy providers and the consumers are required to take economic, environmental and social considerations into account and accordingly invest in the optimal technology. The complex task of choosing between green technologies, due to the wide range of variables, parameters and constraints involved, makes it difficult and time consuming to make decisions based on simple human analysis.

This project aims to enhance decision-making in industrial applications of energy-efficient systems. It will benefit both new and existing applications, with a parallel elimination of human intervention. The economic aspect and carbon emissions of different technologies will be evaluated, to determine the strategy that best combines both. The existing literature adequately covers the high-level design of sustainable technologies; their smart operation though remains a challenge. In order to enable the stakeholders to quickly identify the optimal techno-economic pathways for different geographic regions and economic sectors, a single database and single assessment methodology to compare them across a common basis are required. The ultimate aim is to develop a user-friendly application, using that database, which will analyse the user's unique requirements compiled from their varied input points and export recommendations accordingly. The work is at the initial stage, however it is expected that the insight gained will enhance the industrial selection, feasibility of application and optimisation when making decisions to install renewable energy systems within key sectors in the UK, in order for them to become widely adopted for decentralized heat and power supply.

Keywords: Decentralized Energy Systems, Low-carbon Technologies, Decision-making Software, Techno-economic Feasibility, Operation Strategy

ST4. No evidence of an association between lethal recessives Citrullinemia, Jersey Haplotype 1, Congenital Muscular Dystonia 1 and milk production and composition in Irish dairy cattle

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If lethal recessive alleles are also associated with economically important production traits, then it could be justified to maintain the lethal alleles in a breeding population. Justification for maintaining these alleles through mating strategies would be aided by identifying and assessing how animals that are carriers for these alleles are performing, enabling better, more informed choices.

The purpose of this study was to ascertain if carriers of lethal recessive genetic disorders: Citrullinemia, Jersey Haplotype 1 (JH1) and Congenital Muscular Dystonia 1 (CMD 1) were associated with positive or negative effects on milk production traits.

Genotypes for Citrullinemia, JH1 and CMD1 from 10,707 dairy cattle and phenotypes, in the form of predicted transmitting abilities (PTAs), for milk related traits were obtained from the Irish Cattle Breeding Federation.

The PTAs were deregressed and an association between these and each SNP was analysed in ASReml using a weighted mixed animal model. The adjusted reliability cut-off was set at >10%.

No association ($p>0.05$) between polymorphisms responsible for Citrullinemia, JH1 or CMD1 was observed on the milk traits examined which included milk protein percentage, milk fat percentage, milk yield, milk fat yield and milk protein yield in the sample set (n=6876) analysed.

There was no evidence of an advantage to maintain or strategically mate animals carrying these lethal recessive mutations, which supports that the exclusion of these carriers from the population will not reduce the genetic merit on farm for the traits examined.

Keywords: genetics, dairy cattle, lethal recessives

ST5. Geobotanical Prospecting for Lithium

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Lithium (Li) is a rare metal that is in high demand because of its use in Li-ion batteries. The arrival of the electric vehicle industry is increasing this demand even more. Li is becoming very popular and sought after. This demand for Li is ensuring that a key priority for mining companies is prospecting for Li mineral deposits. One method of prospecting uses plants.

Geobotanical prospecting interprets the presence of certain plants as an indication of a specific metal in the soil. Hundreds of known metal-indicator plants have been experimentally confirmed for a wide range of metals. Plant indicators for copper include the Silene suecica and Ocimum centraliafricanum plants. Astragalus plants can indicate uranium and the Equisetum arvense plant can indicate the presence of gold. Geobotanical prospecting has been used both historically and recently to prospect for metals and led to the discovery of lead in Norway and copper in the US to name two.

There is a known deposit of Li in the South East of Ireland in the Carlow area. This work posed the question: "Can two common hedgerow plants (Fraxinus excelsior and Hedera hibernica) be used to prospect for Li?". The different root systems of these plants allowed us to access the organic and topsoil layers. Li is thought to be absorbed passively by most plants because of its similarity to K+ and Na+ so it was not unreasonable to assume that these two plants could be good Li-indicators. We have sampled the soil and the leaves of both plants at 118 different sampling sites along five sampling transects at four separate times from Spring to Autumn covering the Carlow area. Using flame photometry, we have determined the Li concentrations in these samples and present our findings here.

Climate Change

CC1. Resolving the links between nutrient and carbon budgets in the Burrishoole catchment.

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Lake ecosystems are sensitive indicators of catchment modification. Owing to increased anthropogenic pressures and variations in climatic conditions, there is a need to understand and detect these changes by monitoring susceptible parameters at appropriate timescales. The Burrishoole Ecosystem Observatory Network 2020 (BEYOND 2020) is a multi-institute research cluster that is working to build on the existing biological and sensor monitoring programme in the Burrishoole catchment in Country Mayo, Ireland.
The proposed work programme focuses on the elucidation of biogeochemical and biological pathways using sensors, metagenomics, and biosensor development. As part of the Beyond 2020 cluster this project aims to address the current gap in monitoring in the Burrishoole catchment by quantifying and investigating nutrient (nitrogen N, and phosphorus, P) cycling to gain a fuller understanding of the drivers of productivity. The project will leverage the many data streams currently being collected in the area to link carbon budgets to macronutrient fluxes through the utilisation of high frequency monitoring and the measurement of seasonal and trophic dynamics of the main carbon and nutrient pools in addition to the microbial, zooplankton and phytoplankton populations. A new in-situ nitrate sensor will be deployed at the main inflow to augment current infrastructure in the catchment which, in addition to weekly/fortnightly grab samples, will be used to quantify in-streams and in-lake nutrient concentrations and loadings. Isotopic and stoichiometric analysis will be carried out to determine the reliance of the ecosystem on allochthonous carbon and to determine the nutritional quality and potential implications for consumer production and internal nutrient cycling within the system.

Keywords: Lake Biogeochemistry - High Frequency Monitoring - Macro-nutrient Budgets - Ecological Stoichiometry - Zooplankton Allochthony

CC2. An Atlas of Extreme Weather Events in Ireland post-1946

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Warming of the Earth's atmosphere associated with the anthropogenic climate change may lead to an increase in the frequency and magnitude of weather extremes. As a warmer atmosphere can hold more moisture, its potential for violent weather events is greater.

Due to its exposed geographical location on the fringe of the Atlantic, Ireland is no stranger to severe weather. Atlantic storms and heavy rainfall events resulting in flooding are the most typical weather extremes in Ireland and millions of euros are spent every year on repairs of infrastructure and clean-up operations in their aftermath.

A further increase in the frequency and the intensity of extreme weather episodes would have serious socio-economic implications for the country and put a greater number of its residents at risk. More research such as attribution studies of individual extreme weather events is needed to put the implications of climate change for Ireland in country-specific context.

This study aims to provide a historical context for extreme weather events in Ireland by compiling a mapped and dated atlas of such events that took place between 1947 and the present day; significant events occurring in the course of this study may also be included.

Several databases of extreme weather in Europe and Ireland already exist (i.e. European Severe Weather Database, Mét Eireann's Major Weather Events, OPW's Flood Maps), however, they either focus on a particular type of event or analyse only one of its aspects. Hence there is potential for this research to provide a more comprehensive event portraits by including their meteorological profiles as well as summarise their socioeconomic impacts and map their spatial extents.

Instrumental weather data collected by Mét Eireann covers a period long enough to perform an analysis of the meteorological signals and understand climatic drivers behind most selected events. Historical sources, press archives and other publications supply information on the basis of which the events' economic tolls can be estimated and their societal impacts scrutinized. In addition, spatial footprints and relevant meteorological variables will be represented graphically using GIS methods.

Keywords: severe weather, storm, hurricane, flooding, climate change, Ireland

CC3. Temporal variation of soil carbon stock and its controlling factors over the last two decades on the southern Song-nen Plain, Heilongjiang Province

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Against the current background of global climate change, the study of variations in the soil carbon pool and its controlling factors may aid in the evaluation of soil's role in the mitigation or enhancement of greenhouse gas. This paper studies spatial and temporal variation in the soil carbon pool and their controlling factors in the southern Song-nen Plain in Heilongjiang Province, using soil data collected over two distinct periods by the Multi-purpose Regional Geochemical Survey in 2005e2007, and another soil survey conducted in 1982 and (??)1990. The study area is a carbon source of 1479 t/km2 and in the past 20 years, from the 1980s until 2005, the practical carbon emission from the soil was 0.12 Gt. Temperature, which has been found to be linearly correlated to soil organic carbon, is the dominant climatologic factor controlling soil organic carbon contents. Our study shows that in the relevant area and time period the potential loss of soil organic carbon caused by rising temperatures was 0.10 Gt, the potential soil carbon emission resulting from land-use change was 0.09 Gt, and the combined potential loss of soil carbon (0.19 Gt) caused by warming and land-use change is comparable to that of fossil fuel combustion (0.21 Gt). Due to the time delay in soil carbon pool variation, there is still 0.07 Gt in the potential emission caused by warming and land-use change that will be gradually released in the future.

Keywords: Song-nen plain; Soil carbon pool; Spatial and temporal variation; influencing factors

CC4. A comparison of hydrological models: between a complex distributed model (GEOtop) and a simple lumped model (PDM)

Parvaneh Nowbakht, Research focus: hydrological modelling

School of Engineering & Environmental Research Institute, University College Cork.

Several hydrological models have been developed to analyse the rainfall-runoff relationship and complete water cycle in rural catchments. The aim of this study is to compare the complex fully distributed model GEOtop and the lumped model PDM (Probability Distributed Model).
GEOtop is a physically-based distributed hydrological model suitable for rural catchments. In GEOtop, Digital Elevation Models (DEMs) with complex topographies are used. GEOtop divides the catchment into cells according to the topographical characteristics of the basin (elevation, slope, aspect, shadow, sky view factor). The soil thermal and hydraulic characteristics, vegetation and soil cover features are given as inputs in the form of maps. The meteorological data (rainfall, radiation, temperature) from one or more points in the catchment are spatially distributed to each cell, then the model calculates both the energy and mass balance in the catchment by numerically solving the 3D Richards' equation.
PDM is a conceptual model suitable for a variety of catchments, and has minimal data and computational requirements – much less than GEOtop. Rainfall and potential evaporation data are used as inputs to produce runoff at any point of the catchment which is controlled by the absorption capacity (of the canopy, surface and soil), described by a Pareto distribution. The PDM transfers rainfall to two parallel flows, direct runoff or fast flow and recharge or slow flow by recursive solution of the Horton-Izzard equation.
Acknowledgement
This material is based upon research supported by the Irish Environment Protection Agency (Grant Award No. 2016-W-MS-23), for the project Tools for Climate Change Attribution of Extreme Weather Events in Ireland (ClimAtt, http://climatt.ucc.ie/). The author thanks Jeroen Pullens and Ciaran Lewis for their assistance with GEOtop.

Keywords: Flooding; Peatlands; Hydrology; Rainfall-Runoff Model

Environmental Sciences Association of Ireland

ESAI ANNUAL REVIEW 2017

ESAI Chairpersons Address from Dr. Frances Lucy

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

- Environ 2017 – 27th Irish Environmental Researchers Colloquium hosted by Athlone Institute of Technology, 10-12th April
- ESAI Postgraduate Researcher of the Year Award
- ESAI Graduate awards at Universities and Institutes of Technology throughout Ireland
- ESAI Grassroots Workshop competition
- Where there is No Engineer' – National Finals, Supported by ESAI

We had a large attendance at Environ 2017 and this is reported separately. I would like to acknowledge Dr. Andy Fogarty and Dr. Sile O'Flaherty and their team of staff and students for hosting Environ 2017 at Athlone IT. The colloquium in Athlone was a huge success and extremely well organised from the welcoming committee directing car parking to the seamless management of the presentation sessions. The theme for 2017 was 'Putting the Eco in the Economy'. Congratulations to all the winners in the ESAI Student Presentation competition which featured nine awards this year with a special mention to Aoife Hayes, Winner of the Best Oral Presentation at Environ 2018'.

Congratulations to Philip Shine, the winner of the 'ESAI Postgraduate of the Year Award'. He is a postgraduate student at Cork Institute of Technology in the final year of his studies. Philip's entry based on his PhD research project on 'Electricity and direct water consumption on Irish dairy farms' was of exceptional high calibre. Philip's cutting edge research informs the dairy sector on how Increasing milk production must be met with the sustainable consumption of on-farm electricity and water resources to ensure sustainable growth. Thank you to all the entrants for the 'ESAI 2017 Postgraduate of the Year Award' – all of the entrants were of a very high standard. Thanks also to ESAI council members Drs. Liam McCarton and Niamh Power for co-ordinating the judging. We encourage MSC and PhD researchers, in the final year of their research study, to apply for the ESAI Postgraduate Award in 2018. Please come along to see Philip present his research at the ESAI AGM on March 27th at 5.30pm in Tourism & Catering Building, Room T106.

One of our major initiatives in the past few years is to reach out to colleges more than we have done in the past. As part of this, we are fortunate to have an ESAI Liaison in each college. These staff members act as a contact point for ESAI activities and information flow. We are also offering free membership to all undergraduates in relevant courses in each college. The list of third level environmental education programmes on our web site has been updated as part of this process. This year we have recruited 135 new undergraduate members. We see this is a good sign of increased interest in early stage researchers and the growth of the ESAI.

In 2017, for the first time, we provided an undergraduate research award to the best graduates in many Environmental programmes in Irish HEIs. This was carried out with the help of the college liaisons who worked with their colleagues to identify the best students within their own environmental courses. Many students throughout Ireland were delighted to get their certificate and prize of ESAI membership. They looked great in their graduation photos holding their awards on the ESAI Twitter feed!

We would also like you to consider the ESAI Grassroots workshop scheme. The Grassroots Workshop Support Scheme was established in 2016 to assist researchers, particularly postgrads and postdocs at hosting specialist workshops. We are grateful to the EPA for providing funds for four more workshops in 2017-2018. This is a great opportunity to organise an event independent of your postgrad research project, which adds to your knowledge, networking and competence in project management.

Another recent development is that we have signed up to the voluntary Code of Governance. We see this as an important self-assessment of how we carry out our role as an Association, with oversight and fair process.

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

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

On the ESAI Council front, we are actively seeking new members for the council to get involved in a range of new and existing activities. This is a great experience for both early stage [PhD and Post Doc] and more mature researchers and also research supervisors. Please attend the ESAI AGM on March 27th at 5.30pm in Room T106. at 5.30pm if you wish to become involved.

On behalf of the ESAI, I wish to say a sincere thanks to all members of the ESAI Council who are always enthusiastic and willing to get involved in council tasks. I particularly want to thank those who are stepping down from their roles. I would also like to thank my predecessor Dr. Tom Curran formerchair of the ESAI council for his continued guidance. Thanks to the ESAI college liaisons who play a pivotal role in promoting Environ and in other activities.

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

Best wishes to all for research in the year ahead.

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

ESAI Goals and Objectives 2017

Benefits of Membership

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

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

Raise your Profile

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

Keeping you informed

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

We circulate a quarterly newsletter summarising our work throughout the year. We also coordinate an email Listserver, which facilitates a community in excess of 2,600 subscribers to exchange information about environmental events and career opportunities in Ireland. To sign up to these services, please visit our website. We are also very active on a number of social media platforms including Facebook, Twitter and LinkedIn.


http://twitter.com/esai_environ


http://www.facebook.com/esaiweb


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

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2017 Events

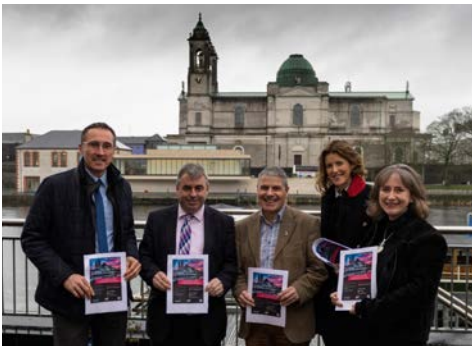
Date	Event
Jan 1st	**ESAI Grassroots Workshop Support Scheme** Sponsored by EPA – Rolling Call
February 28th	**ESAI Grassroots Workshop Support Scheme** Sponsored by EPA – Rolling Call
March	ESAI Environews Spring Edition available online www.esaiweb.org
April 10th-12th	**Annual Conference** Environ 2017 co-hosted by Athlone Institute of Technology 27th Annual Irish Environmental Researchers Colloquium, Athlone Institute of Technology, Athlone, Co. Westmeath
April 10th	**Workshop @ Environ 2017** 14:00-17:00 Field Trip to Clara Bog Clara Bog
April 10th	**Workshop @ Environ 2017** 14:00-17:00 Maximising and Assessing Research Impact Athlone Institute of Technology
April 10th	**Workshop @ Environ 2017** 14:00-17:00 Where Next? Career Opportunities after Completing a PhD Athlone Institute of Technology
April 10th	**Workshop @ Environ 2017** 14:00-17:00 Where Next? Career Opportunities after Completing a PhD Athlone Institute of Technology
April 10th	**Launch** ESAI Postgraduate Researcher of the Year Award Launch
April 11th	**ESAI AGM** 7:30-18:00, Athlone Institute of Technology All members welcome
April 12th	**ESAI Student Competition Prize Giving Ceremony**
April 30th	**Undergraduate Membership Offer** Free Membership for all Undergraduate Members Scheme Rolled Out
May 17th	**Talk: Evaluating Food Chair Sustainability Using Carbon and Water Footprint Toos – Supported by ESAI** 16:00-17:00, Room G08, UCD Agriculture and Food Science Centre, UCD, Belfield, Dublin 4
June 31st	**'Where there is No Engineer' – National Finals, Supported by ESAI** 10:00-16:00, Radisson Blue Royal Hotel, Golden Lane, Dublin 8
July 31st	**ESAI Undergraduate of the Year Award Nominations Closes**
August 31st	**ESAI Grassroots Workshop Support Scheme for Postgraduate and Postdoctoral Researchers** Sponsored by EPA – Rolling Call
September 31st	**Undergraduate Membership Offer** Free Membership for all Undergraduate Members Scheme Rolled Out

2017 Events

Date	Event
October 31st	**ESAI Grassroots Workshop Support Scheme for Postgraduate and Postdoctoral Researchers** Sponsored by EPA – Rolling Call
October / November	**ESAI HEI Nominated Undergraduate of the Year Award Winners Graduate** Presentations taking place at HEI's nationwide
December	**ESAI Postgraduate Researcher of Year Award Winner Announced**
December 4th	**Environ 2018 co-hosted by Cork Institute of Technology 28th Annual Irish Environmental Researchers Colloquium** Call for Papers Opens – Register on www.environ2018.org
December 30th	**Free Membership for Undergraduate Members Offer Closes**
December 31st	**ESAI Grassroots Workshop Support Scheme for Postgraduate and Postdoctoral Researchers** Sponsored by EPA – Rolling Call

Environ 2017

Environ 2017



Launch of Environ in Feb 2017: Cllr. Aengus O Rourke, Deputy Kevin Moran, TD, Dr. Andy Fogarty, Ms. Marese Ward Shine, Dr. Sile O Flaherty.

Two hundred and eighty five delegate registered for the hugely successful three day 27th Irish Environmental Researchers Colloquium, Environ 2017 in Athlone Institute of Technology which was organised by Dr. Andy Fogarty and Dr. Sile O'Flaherty (Conference Joint Convenors), Marese Ward Shine (Conference Coordinator), Sinead Macken (Environmental Sciences Association of Ireland – ESAI Liaison) and ESAI council members. The theme of the conference was "Putting the Eco in the Economy".

Over 100 oral papers and sixty poster were presented at the conference which was divided into sixteen themes:- Biodiversity and Ecosystem Services, Nanotechnology and the Environment, Environmental Socioeconomics, Air Quality, Urban Development, Water Quality and Resources, Invasive Species, Ecotoxicology, Sustainable Land Use and Agriculture, Waste Management, Environmental Management, Environmental Policy and Communications, Marine and Coastal, Environment and Human Health, Energy and Climate Change.

Delegates from USA, Germany, UK, Northern Ireland and Ireland attended the conference. The overwhelming success of the conference was largely due to the amazing student volunteers, AIT staff and the ESAI.

Highlights of the conference included a public engagement debate entitled "Draining the Shannon-Flood Mitigation" which was attended by 240 people and was addressed by two ministers, Minister Denis Naughten (Department of Communications, Climate Change and Environment) and Minister Sean Canney (Department of Office of Public Works and Flood relief) This debate was reported on the RTE 9 pm News and was also featured on Newstalk radio as well as all the local radio stations. The conference trended twice on Twitter which is unusual for academic conferences.

Environ 2017

Professor Ciaran O Cathan and Dr. Don Faller in front of the chocolate centrepiece which was specially commissioned for Environ 2017.

A unique feature of Environ 2017 was the production of an edible art centrepiece which was made entirely from chocolate. The art piece depicted a steel and concrete base, propping up a tree and entangled around the world to represent the intersection between ecology, the environment and the economy. The theme of the conference was "Putting the Eco in the Economy".

The conference began on the afternoon of Monday 10th April with four education and training workshops on offer to delegates: 'Field Trip to Clara Bog' (Dr Sile O'Flaherty, AIT), 'Maximising and Assessing Research Impact' (Dr Fintan Bracken, University of Limerick), 'What Next? Career Opportunities after completing a PhD' (Dr Yvonne Lang, IT Sligo) and 'Nature Based Solutions for Health and Mental Health' (Dr Tadhg MacIntyre, University of Limerick).

Above: Dr. Andy Fogarty, Mr. Ciaran Mullooly, RTE and Dr. Sile O Flaherty

On Monday evening proceedings followed with Minister Denis Naughten planted a native oak tree in the president's garden to commemorate the special occasion of AIT hosting Environ.

This was followed by a cheese and wine reception in the fountain area of the canteen. All of the invited speakers for the evening which included Minister Denis Naughten, Minister Sean Canney (OPW and Flood Relief), Dr. Ciaran Byrne (CEO Inland Fisheries Ireland), Ms. Anja Murray (RTE), Mr. Éanna Rowe (Waterways Ireland), Mr. Michael Silke (IFA Spokesperson), Mr. Ciaran Mullooly RTE (Chairman) were presented with a beautiful piece of bog oak from the Celtic Roots studio in Ballinahown, Co. Offaly.

Environ 2017

Ms. Kathleen Cleary, Flood victim making her point to Minister Sean Canney at the public engagement debate

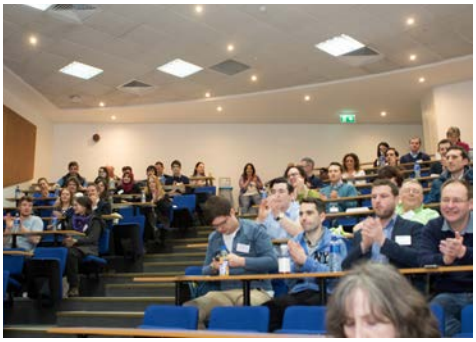
Minister Naughten delivered his keynote address on the theme of Ireland's Climate Change Policy which was followed by the much anticipated public engagement debate entitled "Draining the Shannon – Flood Mitigation. This was always going to be an interesting event and didn't disappoint on the night. All of the six invited speakers were given seven minutes to outline their position. The contentious debate was very skilfully managed by the Chairperson, Mr. Ciaran Mullooly (RTE). It was then thrown open to the audience for questions. The Douglas Hyde auditorium was full to capacity and a lively debate ensued with lots of audience interaction. The evening finished up a little later than anticipated at 10.30pm due to the interest in the debate and the number of question fielded from the audience.

Dr. Andy Fogarty, Professor Ciaran O Cathain and Dr. Pat Gallagher, Chief Executive, Westmeath County Council at the official opening ceremony of Environ 2017

At 9.15 am Tuesday 11th April, the conference was officially opened with a ceremony held in the Douglas Hyde Lecture Theatre. The speakers included:
AIT President Professor Ciarán Ó Catháin, Dr. Andy Fogarty - Conference Co-Convenor, Professor Frances Lucy, ESAI Chairperson and Dr. Pat Gallagher, Westmeath County Council.

Over the course of the next two day over 100 oral papers were presented in four parallel sessions. Sixty academic poster were exhibited upstairs in the B rooms. This worked particularly well as it allowed delegates to mingle with exhibitors/sponsors and to view the posters on display.

Environ 2017



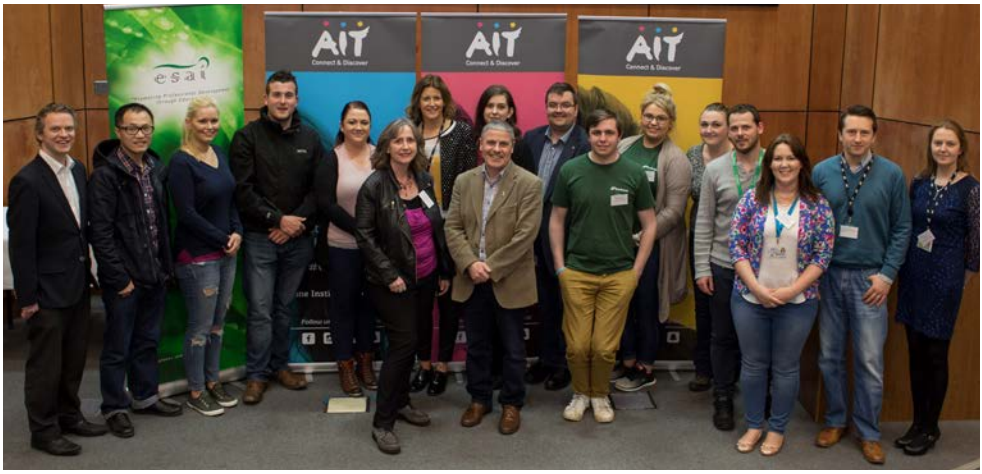
Environ delegates at poster session

The college hosted the Environmental Science Association of Ireland AGM on Tuesday evening which was attended by over 40 people which is a record for the ESAI.

Proceedings then moved to the Sheraton Hotel Athlone for the Environ 2017 conference dinner. The evening began with a drinks reception in the Seige Suite with entertainment from AIT's very talented Professor Clem Higginbotham (AIT) and Ms. Aine O'Reagan. A buffet dinner was then served in the Hoey Suite with music afterwards from Small Deal.

Wednesday began with registration open at 9.00am. The conference then continued with oral presentation taking place throughout the morning alongside the poster presentations.

This was followed by lunch and then the important business of the day, the Environ 2017 prize giving.



Just some of the AIT staff and student volunteers who made Environ 2017 possible

A huge thank you to all the students and staff who are too numerous to mention who made the conference such a success.

ESAI INCOME AND EXPENDITURE ACCOUNT 2017

ESAI INCOME AND EXPENDITURE ACCOUNT		
For the year ended 31 December 2017		
	€	€
Opening balance as 01/01/17		11,871.02
Income		
Membership	2,830.76	
Environ 2016 - Delegate Fee	1000.00	
Environ 2017 - Delegate Fee	27,384.58	
Sponsorship	21,205.00	
Environ 2017 Prizes	1,750.00	
Workshop Sponsorship	3,000.00	
Rebate	62.50	
Total Income	**58,727.84**	
Expenditure		
Environ 2017 (inc prizes)	31,149.70	
Environ 2018	1,268.44	
Environ 2017 Refunds	458.54	

ESAI INCOME AND EXPENDITURE ACCOUNT 2017

Website	2,349.14	
Administration	9,087.50	
Travel	819.49	
Postage/Stationary	67.42	
Bank Charges (inc. Merchant banking)	1,269.00	
Insurance	1,047.50	
Workshop Grassroots	2,446.74	
Donation	100.00	
Postgrad Prize	500.00	
Admin	118.98	
Total Expenditure	**50,682.45**	
Excess Income over Expenditure		8,045.39
Closing Balance per Bank @ 31/12/17		**19,916.41**

ESAI Council Members 2017

Chairperson	**Regular Members**
Dr Frances Lucy	
Email: chairperson@esaiweb.org	Dr Thomas Curran
Honorary Secretary	Dr Dorothy Stewart
Dr Kevin Ryan	
Email: secretary@esaiweb.org	Mr Declan Feeney
Honorary Treasurer	Ms Caroline Wynne
Mr Liam McCarton	
Email: treasurer@esaiweb.org	**Membership Officer**
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Dr Thomae Kakouli-Duarte	
Email: thomae.kakouli@itcarlow.ie	
Conference Coordinators 2018	
Dr Joe Harrington & Dr Niamh Power	
Email: conference@esaiweb.org	
Conference Coordinator 2017	
Dr Andy Fogarty	
Email: afogarty@ait.ie	

ESAI Student Competition 2018

The ESAI will be judging all student oral and poster presentations for consideration in this years student competition. Winners will be invited to submit an article on their research project to the ESAI Website and the ESAI E-Zine 'Environews. Along with their certificate and award each winner will receive a 12 month subscription to the Royal Irish Academy journal 'Biology and Environment'. Results will be announced at the prize giving ceremony at the close of conference at lunch time on Wednesday 28th March at 13:30pm.

The prizes and categories this year are:

- ESAI Best Oral Presentation (€500) sponsored by Environmental Sciences Association of Ireland (ESAI)
- ESAI Best Poster Presentation (€250) sponsored by Environmental Sciences Association of Ireland (ESAI)
- Best Soils Presentation (€250) sponsored by Soil Sciences Society of Ireland (SSSI)
- Best Water Related Presentation (€250) sponsored by the Chartered Institution for Water and Environmental Management (CIWEM)
- Best Biodiversity Related Presentation (€250) sponsored by the Chartered Institution for Ecology and Environmental Management (CIEEM)
- Best Waste and Resources Management Presentation (€250) and 12 months student membership to CIWM sponsored by the Chartered Institution of Wastes Management (CIWM)
- Best Air Quality Presentation (€250) sponsored by Department of Communications, Climate Action and Environment
- Best Climate Change Presentation (€250) sponsored by Department of Communications, Climate Action and Environment
- Richard Fitzgerald Poster Prize for Best Aquatic Environment Presentation (€250) sponsored by AquaTT
- Best Plant Biology Poster Prize (€250) sponsored by International Association for Plant Biotechnology

Dr. Richard D. Fitzgerald

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

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

ESAI Postgraduate Researcher of the Year 2018

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

Winner receives €500
Closing date is Sept 30th, 2018.

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

esai
Environmental Sciences Association of Ireland

Grassroots Workshop Support Scheme

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

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