Environ 2016

Ecosystem Services for a Sustainable Future

26th Irish Environmental Research Colloquium

University of Limerick, March 22nd - 24th

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Contents

Welcome to ENVIRON 2016

Dear Delegate,

The ENVIRON 2016 organising committee welcomes you to the 26th Irish Environmental Researchers Colloquium (ENVIRON 2016) at the University of Limerick. ENVIRON has previously been hosted at UL in 1997 and 2003 and we are delighted to host ENIVRON again.

The ENVIRON colloquium is the largest annual gathering of environmental researchers in Ireland with over 200 researchers attending this year. The event continues to provide an excellent platform for postgraduate students and postdoctoral researchers to present their research to a wide audience. Since its establishment, one of the main strengths of the colloquium has been that it attracts delegates from a wide variety of disciplines providing a unique opportunity for specialist researchers to learn what is happening outside their own research area. ENVIRON 2016 provides a great opportunity to network with your fellow researchers, and with industry, agencies and policy makers. This will inspire you to think 'outside the box', to explore global research trends and technologies in search of a cross disciplinary vision.

The conference will begin on Tuesday March 22nd with three workshops on: 'Introduction of the use of R in Environmental Statistics' (Dr Cóilín Minto, GMIT), 'Maximising and Assessing Research Impact' (Dr Fintan Bracken, UL) and 'The UL Green Campus Journey' (Dr Colin Fitzpatrick, UL Green Campus Committee). ENVIRON 2016 will host a public lecture on the evening of Tuesday March 22nd with author and journalist Paddy Woodworth entitled 'Pricing the Planet: The economic and environmental benefits of accounting for natural capital and ecosystem services'. The talk will be chaired by Dr France Lucy of IT, Sligo.

The colloquium will be formally opened on Wednesday morning by Professor Don Barry, President of UL followed by four keynote speakers: Prof John O'Halloran (University College Cork), Ms Katy Tsesmelis (Manager of the International Aluminium Institute), Prof Dave Goulson (University of Sussex) and Mr Damien Clancy (Chairman of Rusal Aughinish). Four concurrent sessions will follow lasting one and half days and spanning a broad range of topics and disciplines. These sessions will showcase the state of the art in Irish environmental research.

We hope that you will find ENVIRON 2016 stimulating for your own research and that you will also enjoy the various social activities you undertake around our beautiful campus.

Dr Ronan Courtney, Dr Ken Byrne and Dr Audrey O'Grady

ENVIRON 2016 Colloquium Convenors

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ESAI Welcome to ENVIRON 2016 Delegates

On behalf of the Environmental Sciences Association of Ireland (ESAI), the ESAI Council extends to you a warm welcome to the 26th Irish Environmental Researchers Colloquium (ENVIRON) at University of Limerick (UL).

We are delighted that the ENVIRON Colloquium should be held again in UL; it was previously held here in 1997 and 2004. It also coincides with some significant recent achievements at UL such as the Athena SWAN Institution Award and the Green Flag. It is great to see that University of Limerick is showing leadership in these important areas. Indeed, the Green Campus Journey at UL is featured among the excellent workshops being held during our 3-day event.

ENVIRON provides a platform for researchers to present to a wide audience and also gives an opportunity to engage with the general public. We continue our policy this year in reaching out to a wider audience with a public lecture "Pricing the Planet" by author and journalist Paddy Woodworth.

I would like to highlight some other initiatives that we have developed in the ESAI in the past year or so for the benefit of our members. We now have an ESAI Liaison in each college, who provides a conduit between the ESAI and the academic community. We have rolled out free membership to all undergraduates in relevant courses, which are listed on our web site. 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. Please keep up to date by checking our web site www.esaiweb.org and connecting with our growing network on social media (Facebook, Twitter and LinkedIn). Last year, this event was trending on Twitter, so let's try to achieve the same outcome this year using the hashtag **#environ2016**.

The ESAI wishes to sincerely thank Dr Ronan Courtney, Dr Ken Byrne, Dr Audrey O'Grady and the UL committee for hosting ENVIRON and for assembling a very comprehensive programme. As I sign off as outgoing Chair of the Environmental Sciences Association of Ireland, I would like to acknowledge the excellent contribution of Ms Sinead Macken (ESAI Administrator) and all members of the Council who continue to work to make the ESAI an organisation of which we can proud.

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

Dr Tom Curran

ESAI Chairperson

ENVIRON 2016 ORGANISING COMMITTEE

Conference Convenors

Dr Ronan Courtney, Dr Ken Byrne and Dr Audrey O' Grady

University of Limerick Planning Committee

Ms Ber Norris
Dr Teresa Curtin
Dr Stephen Dooley
Bastian Egeter
Dr Colin Fitzpatrick
Dr Tom Harrington
Mr John Murnane
Dr Jean O'Dwyer
Dr Tom O'Dwyer
Dr Bernadette O'Regan
Dr Emmet O'Reilly
Ms Samantha Prior
Dr Achim Schmalenberger
Ms Aisling Walsh

Environmental Sciences Assocation of Ireland (ESAI)

Ms Sinead Macken	ESAI Administrator
Dr Tom Curran	ESAI Chairperson

ESAI Council

On the ground assistance at University of Limerick

A special thank you to Faculty Postgraduate Research Students and Undergraduate Students
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Information Technology Division
UL Catering

Thanks to the ENVIRON 2016 Sponsors and Exhibitors

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RUSAL Aughinish

New Boliden

Marine Institute
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DELEGATE INFORMATION

Registration

The ENVIRON 2016 Registration Desk will be open at the following times

Tuesday March 22nd	12:30 – 17:00	EGO10
	19:00 – 20:00	Analog Devices Building
Wednesday March 23rd	08:00 – 18:00	EGO10
Thursday March 24th	08:30 – 13:00	EGO10

DELEGATE BADGES

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

Locations

Registration	as above
Public lecture	Analog Devices Building
Plenary sessions	Jean Monnet Theatre
Conference sessions	CI063, CI062, CI061, CI060
Poster sessions and exhibitors	EGO10
Tea/ Coffee/ Lunch	EGO10
Introduction to R Workshop	A1089
Maximising and Assessing Research Impact	Training room (Library)
UL Green Campus Journey Meeting Point	EGO-10
ESAI AGM	C1058

Delegates giving oral presentations

After registering for the colloquium, delegates giving oral presentations should upload their presentation at the content management desk (located beside 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 located in EGO10. When you arrive at the registration desk please indicate that you have a poster for presentation and we will direct you to the poster area.
Posters can be erected on Tuesday March 22nd (13:00 – 17:00) or on Wednesday morning March 23rd (08:00 – 10:30). All posters should be in place by 10:30 on Wednesday, March 23rd. Please do not remove posters until the end of the final poster session on Thursday 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

The University of Limerick has Eduroam for those from other campuses. There is also free wifi available (ulwireless)

Tea/ Coffee/ Lunch

Teas/ coffees at all breaks and lunch on Wednesday and Thursday will be available in EGO10. On Thursday, a brown-bag lunch will be available for all, which you can eat in University of Limerick or later when travelling.

ATM

There is a Bank of Ireland and ATM on campus located in the courtyard area (Number 16 on campus map)

Parking

Please refer to campus map. Free parking is available in carpark. There are also two pay carparks in P2 and P17.

Local Transport

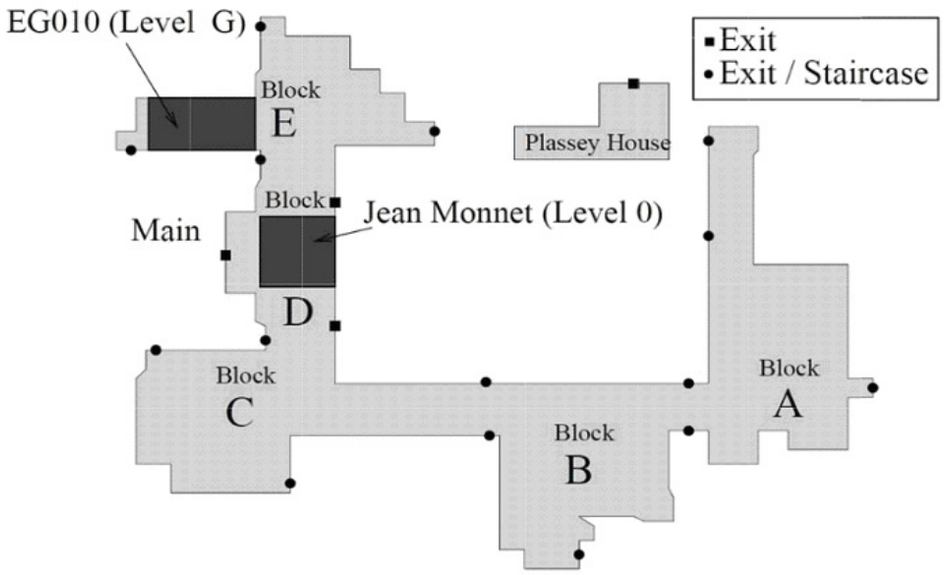
There is a bus service to Limerick city centre every 15 mins from 07:00 to 18:15. Services are then every 30 mins until 23:45.

Taxi services include

All Route Taxis	061 311111
Ballinacurra Taxi Service	061 301333
Castletroy and City Taxis	061 332266
Delaney Richard, Mini Bus Hire	087 2724462
Economy Cabs	061 411422
Fixed Price Taxis	061 313131
Plassey Cabs	061 336336

See also http://www.limerick.ie/visiting/visitorinformation/gettingaround/taxi

Building Map



	Environ 2016 Programme, Tuesday March 22nd
12:30 - 17:00	**Registration** – EGO10 Main Building University of Limerick
	Workshops
14:00 - 17:00	**Introduction to the use of R in Environmental Statistics.** Facilitator: Dr. Coilin Mento, GMIT (A1089)
14:00 - 17:00	**Maximising and Assessing Research Impact** Facilitator: Dr. Fintan Bracken University of Limerick (Training Room (Library))
14:00 - 17:00	**The UL Green Campus Journey** Facilitators: UL Green Campus Committee (EGO-10)
19:00 - 20:00	**Reception – Analog Devices Building**
20:00 - 21:30	**Public lecture** **Pricing the Planet: The economic and environmental benefits of accounting for natural capital and ecosystem services** Author and Journalist Paddy Woodworth Chair: Dr Frances Lucy, IT Sligo

	Environ 2016 Programme, Wednesday 23rd
8:00	**Registration** – EGO10 University of Limerick Main Building
9:00 - 9:20	**Opening of Environ 2016.** UL President Prof Don Barry, UL Committee, and Dr. Tom Curran, ESAI Chairperson.
09:20 - 10:50	**Plenary Session & Keynote Presentations 1** **Speakers:** Prof John O'Halloran – University College Cork; Katy Tsesmelis - International Aluminium Institute
10:50 - 11:30	**Coffee; Poster Session 1 & Meet the Exhibitors (EGO-10)**
11:30 - 13:00	**Plenary Session & Keynote Presentations 2** **Speakers:** Prof Dave Goulson - University of Sussex; Damien Clancy- Rusal Aughinish.
13:00 - 14:00	**Lunch (EGO10)**

14:00 - 15:25/15:40*	**Session 1 (C1060)** Waste Management	**Session 2 (C1061)** Water quality and Resources 1*	**Session 3 (C1062)** Marine and Coastal 1	**Session 4 (C1063)** Environment and Human Health 1
15:25 - 16:05	**Coffee; Poster: Session 2 & Meet the Exhibitors (EGO10)**			
16:05 - 17:45	**Session 5 (C1060)** Energy	**Session 6 (C1061)** Invasive Species and Environmental Management	**Session 7 (C1062)** Climate Change	**Session 8 (C1063)** Sustainable Land use 1
17.45	**ESAI AGM (C1-058)**			
19.30	**Drinks Reception: Castletroy Park Hotel**			
20.30	**Conference Dinner and Entertainment: Castletroy Park Hotel**			

	Environ 2016 Programme, Thursday 24th March			
9:00 - 10:40	**Session 9 (C1060)** Waste Management 2	**Session 10 (C1061)** Water quality and Resources 2	**Session 11 (C1062)** Marine and Coastal 2	**Session 12 (C1063)** Environment and Human Health 2
10:40 - 11:20	**Coffee; Poster Session 3 & Meet the Exhibitors (EGO10)**			
11:20 – 13:00	**Session 13 (C1060)** Biodiversity and Ecosystem Services	**Session 14 (C1061)** Sustainable Land use 2	**Session 15 (C1062)** Environmental policy and communication; socioeconomics	**Session 16 (C1063)** Novel applications in sustainability and research innovation
13:00 - 14:00	**Lunch, Prize Giving & Close of Environ 2016 (EGO10)**			

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BIOGRAPHIES

Workshop Sessions

R: Facilitating reproducible statistical analysis in the Environmental Sciences

Dr Cóilín Minto is a senior researcher in quantitative ecology and biostatistics at the Marine and Freshwater Research Centre at the Galway-Mayo Institute of Technology (GMIT). His research focuses on the development and application of statistical methodologies to dynamics at individual, population and community levels. Cóilín studied both biology and statistics at undergraduate and graduate levels and received his PhD from Dalhousie University, Halifax, Nova Scotia. His statistical research interests cover foundational and novel approaches, including: probability theory, likelihood and Bayesian hierarchical analysis, longitudinal analysis and dynamic time series analysis, particularly state space modelling. Implementation is facilitated by extensive programming experience in R/S-plus, WinBUGS, and AD-Model Builder coupled with high-performance/parallel computing. Published articles include analyses of life history dynamics, community dynamics, conservation status and population recovery including analyses in Science and Nature. Current research includes: bioeconomic modelling; multivariate time series analysis; development of statistical methodologies for the assessment of data-poor populations; and the development of analytical techniques for monitoring harbour seal abundance. Cóilín is a full member of the International Biometric Society and a founding developer of the RAM Legacy Stock Assessment Database

Maximising and Assessing Research Impact

Dr. Fintan Bracken currently works in the University of Limerick as the Research Services and Bibliometrics Librarian. In this role, Fintan is responsible for providing services to researchers in many aspects of the research process including reference management, publication strategy, bibliometrics, open access and maximising research impact. Prior to joining UL in October 2013, Fintan worked for IRIS Electronic Information Services Ltd. which manages IReL, the Irish Research eLibrary. He has also previously worked in the Marine Institute's research library. Before he completed his MLIS in 2011, Fintan worked in environmental consultancy. He conducted and published research on bird biodiversity in various farmland, woodland and peatland habitats during his PhD and post-doctoral studies in University College Dublin. His current research interests include usability studies and bibliometrics.

The UL Green Campus Journey

Dr. Colin Fitzpatrick is a Senior Lecturer in the Department of Electronic and Computer Engineering at the University of Limerick, Ireland. His research centres on sustainable lifecycle engineering with an emphasis on electrical and electronic equipment. This has seen him work on several industry, national and EU projects related to Eco-Design, Product Lifetime Extension, Reuse, Conflict Minerals, Circular Economy, WEEE and Electricity Demand Management. He served as Co-ordinator of the StEP Task Force on Reuse from 2009 until 2014 and is currently a member of the UNIDO supported Ethiopian E-Waste Management Advisory Group. He is also a member of the Electronics Goes Green, International Symposium on Sustainable Systems and Technology and Care Innovation Program Committees. He will be the local host for the StEP E-Waste Academy for Scientists (EWAS) which will be held in Limerick in August 2016. He has chaired the UL Environmental Committee from 2006 until present and has overseen such initiatives as the UL Community Roofgarden, the UL Farmers Market, and the multi-disciplinary module on Sustainable Development offered by UL. He holds a B.Eng in Electronic Engineering and Ph.D. in Environmental Engineering from the University of Limerick.

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Keynote Session

Session Chair:

Dr. Frances Lucy is Director of the Centre for Environmental Research Innovation and Sustainability (CERIS) at the Institute of Technology, Sligo. Her main research areas are in aquatic invasive species, biodiversity and water quality with national and international programmes and initiatives targeting this research. Frances is a Board member of Inland Fisheries Ireland.

Keynote Speaker:

Paddy Woodworth (Ireland, 1951). Journalist, author, lecturer, tour guide. Former Arts Editor and Foreign Desk Editor at The Irish Times. Also published in International Herald Tribune, Sunday Times (London), El Pais, Vanity Fair, Annals of the New York Academy of Sciences etc. Broadcaster with Irish National Radio & TV, BBC, US and Spanish networks. Author of three books, most recently 'Our Once and Future Planet: Restoring the World in the Climate Change Century' (Chicago, 2013). Research Associate, Missouri Botanic Garden; Adjunct Senior Lecturer, University College,
Dublin.

Plenary Session

Environmental Sciences Association of Ireland Chairpersons Welcome:

Dr. Tom Curran is a graduate of UCD's Engineering programme, holding a BE (Ag & Food), MEngSc (Environmental Engineering) and a PhD in Biosystems Engineering. He has worked in production and environmental management in the food industry for a number of years before returning to UCD as a staff member in the Biosystems Engineering discipline.
His main research interests are in the measurement, abatement and dispersion modelling of odour and other gases from the agrifood and waste management industries. His work also incorporates sustainable water management and ozone technology. Dr. Curran co-ordinates the MSc Environmental Technology degree programme at UCD.

Plenary Panel

Professor John O'Halloran holds the Chair of Zoology at University College Cork. John was awarded a PhD for his research in 1987 and a DSc for his published works in 2009 by the National University of Ireland. He has published more than 200 research papers, 16 book chapters and a number of books, the most recent being 'Bird Habitats in Ireland'. He has presented over 150 research presentations nationally and internationally and published one monograph and a number refereed technical reports for translation of research to industry and other stakeholders. He is Vice-President of the British Trust for Ornithology, Chair or Ireland's Countryside Bird Survey Steering Committee, a Board Member of BirdWatch Ireland and a Council Member of the European Ornithologists' Union.
John is an ornithologist whose research interests include forest ecology and management, freshwater ecology and ecotoxicology. John has a particular interest in the ecology of both swans and dipper, having carried out extensive research on both species over the last 30 years. He has published extensively on birds and their

the last 30 years. He has published extensively on birds and their habitats and on the response of biodiversity, particularly birds, to habitat management. His interest in forest ecology centres on the impacts of planted forests and forest management on plant and animal communities. John's research has addressed questions ranging from ecosystem processes and biodiversity assessment, through to conservation and sustainability issues to individual species and genetic studies. John is dedicated to transferring research from the field, laboratory and bench to class, industry and policy development. John has been awarded over €10 million for research, teaching and conferences, and during his career has supervised 31 Masters research projects and 41 PhD projects to completion.

Katy Tsesmelis is Manager – Mining & Refining at the International Aluminium Institute. She is responsible for bauxite and alumina activities, and is strongly involved in the IAI communications programme. She joined the IAI in 2007 after graduating with a BSc in Geology from Imperial College, London. She is currently undertaking an MSc at Cranfield University in Environmental Informatics.

The International Aluminium Institute is the global forum of the world's aluminium producers. Through the Institute, the aluminium industry aims to promote a wider understanding of its activities and demonstrate its responsibility in relation to all key sustainability issues - environmental, health, safety and recycling.

Professor Dave Goulson was brought up in rural Shropshire, where he developed an early obsession with wildlife. He received his bachelor's degree in biology from Oxford University, followed by a doctorate on butterfly ecology at Oxford Brookes University. Subsequently, he lectured in biology for 11 years at the University of Southampton, and it was here that he began to study bumblebees in earnest. He subsequently moved to Stirling University in 2006, and then to Sussex in 2013. He has published more than 240 scientific articles on the ecology and conservation of bumblebees and other insects. He is the author of Bumblebees; Their Behaviour, Ecology and Conservation, published in 2010 by Oxford University Press, and of the *Sunday Times* bestseller *A Sting in the Tale*, a popular science book about bumble bees, published in 2013 by Jonathan Cape, and now translated into

German, Dutch, Swedish, Korean, Chinese and Danish. This was followed by *A Buzz in the Meadow* in 2014. Goulson founded the Bumblebee Conservation Trust in 2006, a charity which has grown to 8,000 members. He was the Biotechnology and Biological Sciences Research Council's Social Innovator of the Year in 2010, was given the Zoological Society of London's Marsh Award for Conservation Biology in 2013, was elected a Fellow of the Royal Society of Edinburgh in 2013, and given the British Ecological Society Public Engagement Award in 2014. In 2015 he was named number 8 in BBC Wildlife Magazine's list of the top 50 most influential people in conservation. He lives in East Sussex with his wife and their three boys.

Damien Clancy is Chairman of Rusal Aughinish and an International Consultant for the UC RUSAL Group. Rusal Aughinish is the largest alumina refinery in Europe and North America. The refinery is located on the Shannon estuary in the West of Ireland. Rusal Aughinish is the largest overseas subsidiary of the Russian based company UC RUSAL, the world's largest producer of aluminium and alumina.

Damien joined the company in 1979 and held many roles ranging from R & D to Manufacturing to HR. He spent seven years in Canada, on two different work assignments – one in the main operating complex and the other in the Head Office in Montreal. He was Managing Director of Rusal Aughinish for 12 years until December 2014. His period as Managing Director involved many diverse challenges such as ownership changes, major refinery reorganization, building the R&D capability and reputation plus implementing various critical survival strategies due to the impact of the 2009 world recession. Success was such that, today, in spite of no "strategic" advantages, Rusal Aughinish is widely recognized in the alumina industry as the world benchmark refinery.

His career and role as an International Consultant has involved extensive travel on business related matters working in countries and cultures as diverse as Canada, US, The Netherlands, England, Switzerland, Jamaica, Guinea, Brazil, Guyana, Australia, India, China, Ukraine and many parts of Russia.

He received a mathematics (B.A.) and engineering degree (B.A.I.) from Trinity College Dublin, Ireland in 1979. He holds a M.Sc. in Quality and Change Management from the University of Limerick, Ireland (1993) and a M.Sc. in Business and Executive Coaching from National University of Ireland (UCD Smurfit Business School) (2013). In 2013 the University of Limerick appointed him as Adjunct Professor in Relationships in Multi-National Companies for the Faculty of Science and Engineering and the Faculty of Business (Kemmy Business School).

He is a Chartered Engineer (C. Eng.), a Chartered member of the Institute of Personnel & Development (MCIPD) and a Member of the Institute of Directors in Ireland (M Inst D).

He is a former member of University of Limerick Governing Authority. He previously held a number of roles in the Irish Business Employers Confederation (IBEC) - President of IBEC Mid-West, member of IBEC National Executive Committee and Director of IBEC.

Damien was born in Dublin but moved to Limerick at an early age. He attended Ard Scoil Ris and is married to Sheila, with two adult children, David and Rachel.

Environ 2014 Best Oral Presentation Winner

Fergus Mc Auliffe is a PhD researcher in the School of Biological, Earth and Environmental Sciences, UCC. His researches focuses on the use of willow (*Salix viminalis* L.) for zero-discharge domestic wastewater treatment. His work has examined the effect of different design modifications to the traditional zero-discharge system, and the impact of varying soil types and coppice management regimes on evapotranspiration rates, plant growth and nutrient uptake. In addition he has also examined the potential for the development of a willow-selected mycorrhizal inoculum, for use in the zero-discharge setting to increase plant establishment and growth. Alongside this research, Fergus is also Education, Public Engagement and Communications Manager at iCRAG – the Irish Centre for Research in Applied Geosciences. This is an SFI funded research centre which aims to transform applied geoscience research in Ireland. Specifically, the centre aims to de-risk energy and mineral exploration, secure and safeguard groundwater supplies and to engage with the public to explain the nature of applied geoscience activities.

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ORAL AND POSTER PRESENTATION SCHEDULE

Oral Presentations Sessions (1-4): Wednesday 23rd March, 14:00 -15:25/15:40

	Session 1 Waste Management 1 (Room C1060)	**Session 2 Water Quality and Resources 1 (Room C1061)**	**Session 3 Marine and Coastal 1 (Room C1062)**	**Session 4 Environment and Human Health 1 (Room C1063)**
14:00 - 14:10	*Opening Chair Address* Margaret Murphy Regional Resource Efficiency Officer Southern Waste Region	*Chair Dr. Tom O'Dwyer (UL)*	*Opening Chair Address* Dr. Ciarán Kelly (Marine Institute)	*Chair Dr. Andy Fogarty (AIT)*
14:10	Thermodynamic Evaluation of Anaerobic Digestion and Integrated Gasification for Waste Management and Energy Production within Wastewater Treatment Plants **K. Dussan NUIG**	2014 best oral presentation winner Invited Speaker **F. McAuliffee**	Quantification and characterisation of nitrogenous components of three native Irish seaweeds **P. Tobin UL**	A geo-statistical investigation of agricultural and infrastructural risk factors associated with primary (sporadic and index) verotoxigenic E. coli infection in the Republic of Ireland, 2008–2013. **J. O'Dwyer UL**
14:25	Use of IASBR to treat dairy processing wastewater: A laboratory scale study **E. Tarpey NUIG**	Successful Resource Benchmarking: Banding Irish Wastewater Treatment Plants Using Discharge Licence Data **E. Doherty NUIG**	Valuing Ireland's Blue Ecosystem Services (VIBES) **D. Norton NUIG**	GO GREEN EX Going Outdoors: Gathering Research Evidence on ENvironment and EXercise in a Community Based Interdisciplinary Intervention **N. O'Sullivan UL**
14:40	Phycoremediation potential of indigenous microalgae in landfill leachate treatment **A. Paskuliakova IT Sligo**	Atmospheric Cold Plasma treatment of microbiological and organic pollutants in wastewater **A. Patange DIT**	Reducing the impact of pathogens and disease in the Irish Pacific oyster Crassostrea gigas by understanding Environment: Host: Pathogen interaction **B. Booklelaar UCC**	Perceived versus actual air quality and how this impacts on levels of green exercise in communities **A. Donnelly TCD**

15:10	The use of Bauxite Residue for Phosphorus recovery in wastewater **P. Cusack UL**	Modelling the Sources of Nutrients in Irish Catchments **E. Mockler UCD**	Serum Amyloid A as a Biomarker for Stress in Fish **S. Bohan IT Carlow**	Investigation of the elemental content of Fucus serratus seaweed bathwater **T. Westby IT Sligo**
15:25		Comparisons of intermittently loaded laboratory filter systems to treat dairy soiled wastewater **J. Murnane UL / NUIG**		

Oral Presentations Sessions (5-8): Wednesday 23rd March, 16:05 -17:45

	Session 5 Energy (Room C1060)	**Session 6 Invasive Species and Environmental Management (Room C1061)**	**Session 7 Climate Change (Room C1062)**	**Session 8 Sustainable Land use 1 (Room C1063)**
16:05 - 16:15	Chair Dr. Colin Fitzpatrick (UL)	**Chair Address**	*Opening Chair Address* Prof. Frank McDermott (UCD Earth Institute)	**Chair Address**
16:15	Potential energy generation from the anaerobic digestion of domestic household and garden wastes **D. Brady Cork IT**	Turning the tide on invasive species: Testing multiple methods of control on the invasive sea-squirt *Didemnum vexillum* **M. O'Brien UCD**	Temporal patterns of soil respiration across a Sitka spruce chronosequence on blanket peat **A. Jovani Sancho UL**	Economic sustainability of Short Rotation Forestry in Ireland: a market survey **A. de Miguel Munoz Waterford IT**
16:30	Developing a participatory integrated design process involving occupants and users in the design process of energy retrofit **J. McRae UCC**	The invasive macrophyte *Lagarosiphon major*, its management and the importance of native seed banks: implications for future control **E. Keenan UCD**	Effect of early life dietary intervention with linseed oil on the ruminal bacterial community structure of lambs **T. Lyons UCD**	Nutrient cycling in conifer forests in Ireland and implications of management and disturbance on their sustainability **J. Johnson UCD**
16:45	Incentivising Energy-Efficient Building: A Framework for Developing New Business Models **P. O'Connor UCC**	*Diversity* and detections of *Phytophthora* species from trade and non-trade environments in Ireland **R. O'Hanlon DAFM**	After Paris: A critique from the perspectives of new institutionalism and neo-functionalism in international relations **S. O'Neill UCD**	Temporal variation in heterotrophic respiration in afforested organo-mineral soils **R. Lane UL**
17:00	Development of a *Talaromyces emersonii* 'Molecular toolkit', enabling the efficient expression of designer enzymes/ enzyme cocktails for industrial applications **R. O'Donnell IT Sligo**	Campaign to Control/Eradicate terrestrial Invasive species in Achill Island , Co Mayo **T. McLoughlin EPA**	The impact of the Irish dairy processing industry on climate change **W. Finnegan NUIG**	Nutrient exchanges under increased forest biomass harvesting **T. Cummins UCD**

17:15	Is the development of Net Zero Energy agricultural dairy farms possible in Ireland? **W. Keane Cork IT**	Sustainability Impact Assessment of the Cascade use of Harvested Wood Products **J. O'Dwyer UL**	A Question of Quality: Soil Carbon sequestration in deep horizons of Irish Grasslands **G. Torres-Sallan Teagasc**	Influence of different rates of inorganic Phosphorus fertilizer on soil biological properties in a soil-biota system **I. Ikoyi UL**
17:30	Examining the New Energy Paradigm: Ireland, the Energy Transition and the wider European Experience **B. Lennon UCC**	Counting the cost of floodplain development in Ireland **J. Creavin NUIG**	Assessing organic carbon in Irish afforested mineral soils by soil-type, horizon, and depth **A. Premrov UCD**	Taping into phosphorus reserves in Irish grassland soils **J. Graca Teagasc**

Oral Presentations Sessions (9-12): Thursday 24th March, 9:00 - 10:40

	Session 9 Waste Management 2 (Room C1060)	**Session 10 Water Quality and Resources 2 (Room C1061)**	**Session 11 Marine and Coastal 2 (Room C1062)**	**Session 12 Environment and Human Health 2 (Room C1063)**
09:00 - 09:10	**Chair Address**	**Chair Address**	**Chair Address**	**Chair Address**
09:10	Review of Fat, Oil and Grease (Fog) waste utilisation trends **T. Wallace UCD**	Tertiary treatment technologies for water reuse and rainwater harvesting in the Irish dairy industry **K. Fitzhenry NUIG**	Exploring the culture of cooperation in Indo-Sri Lankan shared waters **S. Twomey UCC**	The effect of different resting water depths on schmutzdecke development and treatment performance in biosand filters **G. Beechinor UCC**
09:25	Using the red mud by-product as a source of critical raw materials **E. Ujaczki UL**	Comparison of the contribution of carbon from aquatic buffer zones of alternative vegetation types to the diet of selected macroinvertebrate feeding groups **C. McConigley UCD**	Bioremediation of tributyltin: Isolate screening and gas chromatography-mass spectrometric method development **C. Finnegan IT Carlow**	Plasmid mediated colistin resistance encoding gene *mcr-1* not detected In Irish E. *coli* **D. Morris NUIG**
09:40	Biogas from slaughterhouse waste in Ireland: Assessment of potential energy recovery pathways **A. Ware Cork IT**	Nitrogen and phosphorus removal in modified pyrite-based autotrophic denitrification biofilters **Y. Yang GMIT**	Impact of intertidal oyster trestle cultivation on the ecological status of benthic habitats **J. Forde RPS Group**	A Monte Carlo simulation model to evaluate emerging risks from spreading biosolids on agricultural land **R. Clarke UCD**
09:55	Pathogen survival in farm-based anaerobic digestion **S. Nolan NUIG**	The Quantitative Analysis of Lithium in Ground and Surface Water of Co. Carlow Ireland **A. Lloyd IT Carlow**	Commercial and experimental scale IMTA research **D. Gunning UCC**	An initial investigation of environmental factors affecting neighbourhood health in Ireland **D. Norton NUIG**

10:10	Are building contractors paying to dispose of air? An assessment of the level of void space present in construction waste skips in the west of Ireland **J. Gottsche GMIT**	Waterborne outbreak of cryptosporidiosis – An Economic Assessment **D. Morris NUIG**	An investigation into elemental concentrations and distributions in shallow water sediments in Dunmanus Bay, Ireland **N. Coleman UL**	Septic Tank Registration and Inspection: Two Cross-Sectional Surveys of Risk Perception and Citizen Engagement **S. Mooney UCD**
10:25	Rethinking the Construction Supply Chain and its Role in a Circular Economy **M. Kelly GMIT**	Localising and assessing groundwater discharge to lakes using natural environmental tracers **J. Wilson TCD**	Does release from enemies facilitate the invasion success of a barnacle species? **M. Gallagher UCC**	Whole genome sequence analysis reveals diversity among antimicrobial resistant E. coli isolated from meats in the Irish market place **D. Morris NUIG**

Oral Presentations Sessions (13-16): Thursday 24th March, 11:20 - 13:00

	Session 13 Biodiversity and Ecosystem Services (Room C1060)	**Session 14 Sustainable Land use 2 (Room C1061)**	**Session 15 Environmental policy and communication; socioeconomics (Room C1062)**	**Session 16 Novel applications in sustainability and research innovation (Room C1063)**
11:20 - 11:30	**Chair Prof. John Breen (UL)**	**Chair Address**	**Chair Address** David Tobin (Cement Manufacturers Ireland)	**Chair Address**
11:30	Introducing ESManage: Objectives, Approach and Challenges **M. Kelly-Quinn UCD**	Cow dung pats influence earthworm distribution in grassland **M. Bacher UCD**	Moving Towards a Low Carbon Society: Building Capacities for Transition and Transformation **T. Hume QUB**	A graphene-copper composite film as an anti-bacterial agent for water treatment applications **D. McGlade DCU**
11:45	Ecological Focus Areas: Enhancing and Maintaining Biodiversity on Tillage Farms **J. Larkin Teagasc**	Assessment of greenhouse gas emissions related properties of horticultural peat **A. Efretuei UL**	Smarter Travel: Are we there yet? **R. Manton NUIG**	The Ecotoxicological effects of silver nanoparticles in the freshwater ecosystem: A review of existing data and experimental design **I. Murray Athlone IT**
12:00	What controls the abundance and diversity of soil animals? - a manipulation study using mesocosms in a controlled laboratory setting **T. Dirilgen UCD**	Life Cycle Assessment of Greenhouse Gas Balances in Irish Short Rotation Forestry **M. Clancy UL**	Engaging Communities for the Sustainable Energy Transition **K. Meade UCC**	The role of graphene oxide coated diatoms in water decontamination applications **S. Dervin IT Sligo**
12:15	The Role of Microarthropods in the Sequestration of Carbon in Grassland Soils: A Microcosm Experiment **E. Dix UCD**	Using Geographical Information Systems (GIS) to identify Nitrogen critical loads in the Irish Natura network **D. Kelleghan UCD**	How social science could help usher in a new era in energy efficient urban building construction and renovation design practices **R. MacSweeney UCC**	Anatase to rutile transition in titanium dioxide nanomaterials for environmental applications **C. Byrne IT Sligo**

12:30	Carbon dioxide dynamics of a rewetted peatland forest on Blanket Peatland **C. Rigney UL**	Microbial interactions of the novel bacterium *Ensifer adhaerans* OV14 with economically important crops **A. Dunne IT Carlow**	MOREFISH-enhancing production and sustainability in Irish aquaculture: A Life Cycle Assessment (LCA) of a semi-recirculating rainbow trout (Oncorhynchus mykiss) farm **R. Cooney NUIG**	An investigation into plant parasitic nematode and endophytic bacterial interactions **A. Egan IT Carlow**
12:45	Sustainable development of Greenways: Analysis of ecological connectivity to improve design of greenways as ecological corridors **J. Carlier IT Sligo**		Use of constructed wetlands to treat alkaline leachates **D. Higgins UL**	The Galway Bay Observatory: From Vision to Reality **A. Berry Marine Institute**

Environmental Sciences Association of Ireland

Annual Review 2015

ESAI Chairpersons Address from Dr Tom Curran

2015 was a very successful year for the Environmental Sciences Association of Ireland (ESAI) both in terms of events, activities and planning for the future. The highlights are as follows:

- Environ 2015 - 25th Irish Environmental Researchers Colloquium hosted by Institute of Technology Sligo (April 8-10, 2015)

- "Peatlands - A New Conversation" with the Irish Peat Society, Tullamore, June 7-11, 2015

- "Food Processing Waste: Maximising Hidden Resources for Sustainable Food Processing" with UCD Institute of Food and Health, Dublin, June 8, 2015

- "Innovation in Water & Wastewater Technology" with CIWEM, Cork, November 27, 2015

- ESAI Postgraduate Researcher of the Year Award

- ESAI Grassroots Workshop Support Scheme

- ESAI College Liaison Network

- Free ESAI membership offer for undergraduates

We had a record attendance at Environ 2015 at Institute of Technology Sligo and this is reported separately. We thank Dr Frances Lucy (Director of CERIS) and the IT Sligo committee for hosting ENVIRON and for assembling a very comprehensive programme. ESAI provided administrative support and registration facilities for "Peatlands - A New Conversation" with the Irish Peat Society and this was deemed a great success. Thanks to Sinead Macken for the smooth running of this collaboration.

We were also involved with organising "Food Processing Waste: Maximising Hidden Resources for Sustainable Food Processing" with UCD Institute of Food and Health and "Innovation in Water & Wastewater Technology" with CIWEM. Both events were well attended. A report on the food waste event is due to be published shortly and the water/wastewater technology seminar will be highlighted in our ESAI ezine in due course.

Thanks to Dr Martina Prendergast for co-ordinating the "ESAI Postgraduate Researcher of the Year Award" and "ESAI Grassroots Workshop Support Scheme" and to all the Council members who assisted in the assessments. The applications for researcher of the year were evaluated according to the criteria: Scientific excellence

and originality; Impact (economic/environmental/societal) and; Dissemination (conferences, outreach and media). Congratulations to the 2015 ESAI Postgraduate Researcher of the Year, Luke Prendergast from UCD. The workshops supported in 2015 were "Citizen Science and GIS Training School" in NUIG, August 20 – 23 and "Green Shoots vs Green Transport Workshop", August 27, NUIG. Details of both schemes can be found on the back cover of this book.

One of our major initiatives for this past year was to reach out to colleges more than we have done in the past. As part of this, we welcomed on board an ESAI Liaison in each college. These staff members act as a contact point for ESAI activities and information flow. We have also offered free membership to all undergraduates in relevant courses in each college and we were delighted with the initial response from students across several institutions. The list of third level environmental education programmes on our web site is being updated as part of this process. We hope that this approach will facilitate more engagement with students and in particular will raise awareness and stimulate interest in environmental research. We have been encouraged by the growing number of non-research based students (e.g. taught Masters) attending Environ over the past few years and we would anticipate that this trend may extend further to undergraduate students through this process.

A key ESAI meeting was held in March 2015 to decide on future strategy. We would like to be the association of choice for environmental researchers on the island of Ireland. We would also aim to provide the best networking opportunities for environmental science research.

While the YouTube and Photography Competitions attracted entries in the past, the ESAI decided not to run these activities in 2015 in order to focus on other initiatives, which may be of more significant benefit to members. A decision was also made to remove the Directory of Expertise from the ESAI web site as it was not being used to any significant extent. In addition, the EPA has a more comprehensive catalogue of experts at http://erc.epa.ie/h2020catalogue/.

On the communication front, we launched a new format for the ezine which we believe is more interactive and effective. I would like to thank Elizabeth O'Reilly for co-ordinating the launch of the new format and editing the initial two issues. As always, we welcome your input. Remember to keep in touch with ESAI through social media on Twitter, Facebook and LinkedIn. Thanks to Mark Nolan, our Communications Officer for maintaining our news flow through these channels.

At ESAI Council level, we are seeking new members as always but particularly representatives of our core members to come forward, i.e. early stage researchers. Please attend the ESAI AGM on Wednesday March 23rd if you wish to become involved.

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As I sign off as outgoing Chair of the Environmental Sciences Association of Ireland, I would like to acknowledge the excellent contribution of all members of the Council who continue to work to make the ESAI an organisation of which we can proud. I would particularly like to acknowledge the ESAI administrator, Sinead Macken, for her excellent work, dedication and support during my term as Chairman over the past two years.

Best wishes to all for the year ahead.

Dr Tom Curran is a lecturer in UCD School of Biosystems and Food Engineering and has been on ESAI Council since 2008, served as vice-chair in 2013 and was conference convenor at the 2012 ENVIRON in University College Dublin. He has served as Chair of ESAI from 2014 to 2016.

ESAI Goals and Objectives 2015

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

• Provide a forum to facilitate exchange of specialist information and advice amongst environmental researchers, policy makers, environmental management practitioners and other stakeholders, within Ireland and elsewhere.

• Promote a fuller awareness of the role that higher-level education institutions may make in finding solutions for the urgent environmental problems confronting contemporary society.

• Provide a forum for networking amongst environmental researchers both at national and international scales.

• Facilitate an annual conference aimed at providing postgraduate and other researchers with an opportunity to learn about each other's work, and for postgraduates to present and publish papers within a supportive community.

• Promote high professional standards amongst environmental researchers and professionals.

• To ensure a platform for science-based research on the environment in Ireland.

• Provide a Code of Ethics for Environmental Professionals in Ireland through its membership.

• To maintain growth in the membership base.

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Membership

Make the most of your Membership

Benefits of Membership

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

• Discounted rates at Environ, the annual Irish Environmental Researchers Colloquium, one of the major activities of the Association. It is now one of the largest national scientific meetings in Ireland attracting over 300 delegates each year.

• Discounted rates for selected workshops, seminars, further education courses and conferences.

• Access to ESAI listserver

• Eligibility to apply for ESAI Postgraduate 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 of over 2,300 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://www.twitter.com/esai_environ

http://www.facebook.com/esaiweb

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

Contact Details

ESAI Chairperson
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Website: www.esaiweb.org

2015 Events

Date	Event
Jan 31st	**Photocompetition** Winner of the ESAI 2014 Photo competition is announced
April 8th-10th	**Annual Conference** Environ 2015 co-hosted by IT Sligo 25th Annual Irish Environmental Researchers Colloquium, IT Sligo, Sligo
April 8th	**Workshop** 14:00-17:00 Introduction to how to use R in Environmental Statistics, IT Sligo
April 8th	**Workshop** 14:00-17:00 Communicating Research, IT Sligo
April 8th	**Launch** ESAI Postgraduate Researcher of the Year Award Launch
April 8th	**Launch** ESAI Grassroots Workshop Support Scheme Launch
April 9th - 10th	ESAI CV Clinics at Environ IT Sligo
April 9th	ESAI AGM, 1.30-2pm IT Sligo, Sligo
April 10th	ESAI Student Competition Prize Giving Ceremony
June 7th - 11th	**Conference** Peatlands - A New Conversation, hosted by Irish Peat Society, cosponsored by ESAI, Tullamore, Offaly
June 8th	**Workshop** Food Processing and Waste: Maximising hidden Resources for Sustainable Food Processing, co-hosts with UCD Institute of Food and Health, UCD, Belfield, Dublin 4
August 31st	ESAI Postgraduate Researcher of the Year Competition Winner Announced
August 31st	ESAI Grassroots Workshop Support Scheme Call Closes
July	ESAI Environews Summer Edition available online www.esaiweb.org
October 30th	ESAI Grassroots Workshop Support Scheme Call Closes
November 27th	**Workshop** Innovation in Water and Wastewater Technology, co-hosts with CIWEM, Maryborough House Hotel, Cork
November	ESAI Environews Winter Edition available online www.esaiweb.org
December 31st	ESAI Grassroots Workshop Support Scheme Call Closes

Environ 2015

The 25th Irish Environmental Researchers Colloquium (Environ 2015) was held at IT Sligo from April 8th to 10th and was co-hosted by the School of Science and the Environmental Sciences Association of Ireland (ESAI) (environ2015.org).

The ENVIRON colloquium is the largest annual gathering of environmental researchers in Ireland with over 280 researchers attending this year. The event continues to provide a wonderful platform for postgraduate students and postdoctoral researchers to present their research to a wide audience. Since its establishment, one of the main strengths of the colloquium has been that it attracts delegates from a wide variety of disciplines providing a unique opportunity for specialist researchers to learn what is happening outside their own research area.

In today's research world there is an increasing emphasis to tackle societal challenges and impacts, in other words to look beyond our laboratory and field work, and by engaging with stakeholders, find sustainable solutions to real life issues. This was reflected in the theme of this 25th colloquium, 'Environ 25: Sustainability and Opportunities for Change'. The colloquium theme addressed the need to review environmental change since 1991.

The conference began on Wednesday April 8th with two workshops on: 'Introduction of the use of R in Environmental Statistics' (Dr Cóilín Minto, GMIT) and 'Communications in Science' (Dr Cara Augustenborg, Impact Research Management and David Dodd, DECLG). These workshops were attended to full capacity and the feedback was very positive from those that engaged in both the statistics and the communications training.

Environ 2015 opened on the evening of Wednesday April 8th with a question and answers style panel debate, open to the public, on the popular topic of **'Paying for our water: quality and quantity matter'**. The panel comprised of Jerry Grant (Head of Asset Management, Irish Water), Fiona Regan (Director of DCU Water Institute), and Michael Fitzmaurice (Independent TD for Roscommon-South Leitrim). The lecture hall was full to capacity, with over 100 in attendance. The debate was ably chaired by Austin O Callaghan, Communications Manager at IT Sligo and each speaker had five minutes to present their views on the topic. This led to questions from various members of the public to the panel about the water charges issue. The debate was very lively with informed and individual replies from each of the panel members.

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The colloquium was formally opened on Thursday morning by Professor Vincent Cunnane, President of IT Sligo followed by four keynote speakers: Dr Richard Thorn (President Emeritus IT Sligo), Dr Micheál Ó Cinnéide (EPA Director), Marianne Kettunen (Senior Policy Analyst, Institute for European Environmental Policy) and Dr Brian Motherway (CEO, Sustainable Energy Authority of Ireland). Each speaker had a theme specific to their own expertise in the arena of sustainability.

Four concurrent sessions followed the plenary session for the rest of Thursday and for Friday morning. These sessions spanned 15 environmental topic areas, with a total of 110 oral presentations. For the first time in the Environ series, there were sessions on Invasive Species, Nanotechnology, Environmental Socioeconomics, and Sustainable Agriculture – these are cross-disciplinary research areas which were largely unknown or unexplored in the early years of Environ. There were also 85 posters on display, covering the spectrum of sessions, which were viewed during each the coffee breaks and the lunch-breaks. In reviewing the abstracts for oral and poster sessions, we were amazed by the diversity of the research within all the sessions, which is a testament to the researchers, their supervisors and to the vision of the funding organisations.

The poster sessions were held in the lower section of the new IT Sligo Food Court, and this space also held a wide range of exhibitors from environmental agencies, organisations and suppliers. During the breaks delegates had the opportunity to visit these sponsors, who are an integral and valued part of Environ colloquium.

On the Thursday night, the social event was held in the Clarion Hotel. The event was kicked off by the IT Sligo traditional music society, providing a lively ambience to the wine reception. Over 100 delegates came to the event, enjoying a buffet meal and socialising with fellow students and researchers. For mature delegates, there was the chance to catch up with old friends from all parts of Ireland. Postgraduates meeting for the first time at Environ 2015 are likely to cross paths many times during the course of their careers.

The Winner of the Best Oral Presentation at Environ 2015 was Alwynee McGeever, TCD student, for her presentations entitled 'Scots Pine: A native Irish Tree?' Kate Moore was the winner of Best Poster Presentation at Environ 2015 for her work entitled 'Deer exclusion Rhododendron cleared sites promote the recovery of plant communities and invertebrates in the oak woodlands of Killarney National Park.' The joint prize sponsors for both these presentations were the School of Natural Sciences TCD, EPA, and the Family of Maximillian Von Sternburg. There five other prizes including the Biodiversity prize won by Pamela O'Boyle, IT Sligo for her presentation on 'Typology of High Nature Value farmland in a Northern Atlantic pastoral landscape' sponsored by the Institutes of Technology, Ireland (IOTI).

Throughout ENVIRON2015, there was a great opportunity for the 320 delegates to network with fellow researchers, and with industry, agencies and policy makers. We hope this continues to inspire them to think 'outside the box', to explore global research trends and technologies in search of a cross disciplinary vision.

I would like to acknowledge the ESAI Council and especially Sinead Macken for her expertise in organising and managing Environ 2015. Many thanks to all involved at IT Sligo, including the postgraduates, organising committee, IT Services, building office and administration. Thanks to those, independent of IT Sligo and the ESAI, who volunteered to present keynote addresses and chair sessions especially our generous sponsors. We are extremely grateful for the continued sponsorship of Environ by all sponsors, but especially by the EPA whose support is invaluable.

Dr. Frances Lucy

Convener Environ 2015,

Director CERIS research centre, IT Sligo

DRAFT ESAI INCOME AND EXPENDITURE ACCOUNT

For the year ended 31 December 2015		
Opening balance as at January 1st 2014*		4612.26
Income		
Membership	2668.85	
Environ 2015 - Delegate Fee	26477.59	
- Sponsorship	16640	
Environ 2015 Prizes	2056	
Environ 2016 Delegate Fee	100	
IPS Workshop	32320.53	
Grassroots Workshop Funding	3000	
Bank charge Refund	3000	
Total Income	**83991.61**	
Expenditure		
Environ 2015 (inc prizes)	31359.06	
Environ 2016	474.18	
Environ 2015 Refunds	375	
IPS Workshop	33670.25	
Workshop Administration	345	

Website	2577.09	
Administration	9576.05	
Travel	349.88	
Postage/Stationary	815.69	
Bank Charges (inc. Merchant banking)	1757.87	
Ezine	280	
Insurance	907.5	
Photography Competition	321.01	
Total Expenditure	**82808.58**	
Excess Income over Expenditure		1183.03
Closing Balance as at 31st December 2015		5795.29
Balance per Bank @ 31/12/15		6175.8
* The balance includes the Biodiversity Workshop 2000 surplus of €1982.56		

ESAI Council Members 2015

Chairperson	**Regular Members**
Dr Tom Curran	
Email: chairperson@esaiweb.org	Dr Dorothy Stewart
Honorary Secretary	Ms Aoife Delaney
Dr Kevin Ryan	
Email: secretary@esaiweb.org	Dr Cara Augustenborg
Honorary Treasurer	Dr Martina Prendergast
Ms Emer Cosgrove	
Email: treasurer@esaiweb.org	Ms Rebecca Mooney
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Environmental Sciences Association of Ireland

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Environ 2016

University of Limerick

March 22nd -24th

Ecosystem Services for a Sustainable Future
26th Irish Environmental Research Colloquium

ABSTRACTS ORAL PRESENTATIONS

Waste Management 1

Thermodynamic evaluation of anaerobic digestion and integrated gasification for waste management and energy production within wastewater treatment plants

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Wastewater treatment (WWT) plants consume over 180 MJ per person every year. This will continue to increase due to more rigorous effluent quality regulations and demands. A WWT facility can produce between 10 and 30 dry t sewage sludge (SS) per 1000 p.e.-year. Sludge treatment and transportation to disposal sites increase WWT energy requirements by 20%, and therefore these demands increase the carbon footprint of the plant. Sites with a capacity over 100,000 p.e. can implement anaerobic digestion (AD) to manage sludge and improve energy efficiency economically. Gasification of SS/digestate represents a potential route for sludge management and further energy recovery through CHP generation at small and large scale plants. This study evaluated the energetic integration of gasification and combustion as sludge management technologies using a thermodynamic pseudo-equilibrium approach, using AD and drying as primary management processes in WWT facilities, in addition to thermal conversion. Various CHP configurations, including steam and gas turbines, and combined cycles, were assessed. Based on energy coverage, internal combustion engines gave the best performance for a large WWT plant (1.6 Mp.e. capacity). Emphasis was given to the effects of process parameters and reaching thermal and electrical sufficiency for sludge/digestate drying and AD heat. Potential electricity generation for the study case reached up to 0.5 kWh per m3 of treated water or 35 kWh per p.e.-year, while providing electricity and heat on-site in excess for operation. The proposed concept represents an energy-sufficient alternative for sludge management when sludge transportation and land spreading are unfeasible or cost prohibitive.

Keywords: sludge management, wastewater, energy, gasification, combustion, anaerobic digestion

Use of IASBR to treat dairy processing wastewater: A laboratory scale study

Emma Tarpey[1,2], William Finnegan[1,2], Kelly Fitzhenry[1,2], Eoghan Clifford[1,2], Xinmin Zhan[1,2]

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Dairy farming has been a part of Irish society for over 6000 years, and the dairy industry still plays a large part in Ireland's economy. The industry accounts for over 30% of Ireland's agricultural products. However, compared to other industries, its potential environmental impact is quite high, generating an average of 2.28 litres of wastewater per litre of milk processed. In Ireland, the dairy industry is experiencing a period of growth due to the abolition of European milk quotas in 2015, with predicted increases of up to 50% in milk processed by 2020. This increase in production will lead to a corresponding increase of wastewater generation. The aim of this project is to investigate the efficiency of the intermittently aerated sequencing batch reactor (IASBR) technology in treating dairy processing wastewater, in terms of pollutant removal, energy consumption and operational cost. The IASBR is a novel technology, which is being developed at NUI Galway. It has the potential to remove nutrients and organic content from dairy processing wastewater in a more energy and cost efficient manner than the widely-used existing technologies. Many dairy plants in Ireland currently remove phosphorus from their effluent using chemical precipitation techniques, which tend to be costly. The IASBR has demonstrated excellent biological phosphorus removal in previous studies, with the added benefit of producing less sludge than chemical methods. Three laboratory-scale ISABR units were set up at the environmental engineering laboratory at NUI Galway, where the duration of the experiment was 200 days. The nutrient removal rates were investigated during a number of different aeration phases. The results show ortho-phosphate removal of up to 97% during the most efficient of these aeration phases. Alongside the nutrient analysis performed at NUI Galway, molecular analysis on biomass samples taken during the experiment will enable correlation between the microbial community and performance of the laboratory-scale reactors. This analysis will inform the design of the pilot-scale experimental study, which is the next stage of the project.

Keywords: dairy processing wastewater, intermittently aerated sequencing batch reactor, milk processing, wastewater treatment

Environ 2016 University of Limerick

Waste Management 1

Phycoremediation potential of indigenous microalgae in landfill leachate treatment

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Microalgae have been shown to have potential for treatment of various wastewater discharges. The information available on treatment of landfill leachate has not been extensive. This type of effluent contains high levels of dissolved salts, ammonia-nitrogen and various organic substances. These pollutants may be used by certain species of microalgae as a source of nutrients whilst the substrate can be highly toxic to others. This study aimed primarily to isolate and select microalgal species that have a predisposition to grow in, and effectively remove, nutrients from landfill leachate at relatively low temperature and light intensity. Altogether 35 microalgal cultures were generated from samples collected in coastal areas of North West Ireland, a peat bog from Inishbofin and a number of leachate samples from a municipal landfill. The strains were subjected to a screening process predominantly based on their potential to grow in landfill leachates. The strains isolated from leachate samples collected at the landfill site demonstrated higher adaptability and growth potential than strains isolated from less polluted environments such as freshwater, brackish or marine habitats. Four strains were selected and used in batch experiments in order to evaluate their ability to reduce total ammonia nitrogen, oxidised nitrogen and orthophosphate in landfill leachate. The Chlamydomonas sp. strain SW15aRL isolated from raw leachate achieved the highest level of pollutant reduction whereby a decrease of 51.7% of ammonia-nitrogen was observed in 10% raw leachate (~100 mg/l NH4-N) by day 24, at 15°C and low light intensity (14:10 hrs, light:dark, 22 µmol.m-2.s-1). However, in the experiment conducted with 10% raw leachate supplemented with phosphate, a decrease of 90.7 % of ammonia nitrogen was obtained by day 24 whilst also achieving higher biomass production. The experiments pointed to phosphorus as being a limiting factor in the microalgae-based phycoremediation of landfill leachate.

Keywords: bioremediation, landfill leachate, microalgae, ammonia, phosphate, batch experiments

Advancing the circular economy in Ireland – increasing material reuse in Ireland

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In 2013, Irish consumers produced more waste (581 kg per capita) than the EU average (481 kg per capita) (Eurostat, 2015) – and this is during a time when the Irish government has advocated a transition to the circular economy. Reuse organisations in Ireland help to divert materials from landfills and disposal, and provide other social, economic and environmental benefits. This project *Development of a Material Reuse Framework for Irish Consumers (2014-RE-DS-4)* explored reuse practice in Ireland through surveys, interviews, and workshops with reuse organisations, charity shops, and reuse networks. A key finding from the survey showed that the majority of reuse organisations have existing policies, practices and licencing in place; however, wide variance exists within the sector in terms of priorities, operations and scale. Interviews and workshops also confirmed that Irish reuse organisations face many of the same challenges as their counterparts in other European countries. The research builds on these findings with guidance addressing high level objectives and specific material streams in the post consumer and post manufacturing sectors. Further practical tools are presented to improve material reuse practices in Ireland. Therefore, this research offers a pathway to increase a transition to the circular economy and a more sustainable future.

Keywords: circular economy, waste management, material reuse, environmental policy

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Waste Management 1

The use of bauxite residue for phosphorus recovery in wastewater

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Aluminium production by the Bayer process generates bauxite processing residue (red mud) at a rate of approximately 120 Mt per annum. Some 2.7 billion tonnes have been produced to date with most in landfill or land storage facilities. There is a growing need to find re-use of this by product and this study will examine the potential of bauxite residue (red mud) to be used in the removal and recovery of phosphorus from wastewater effluents. The sustainability of phosphorus and its use is one of the greatest challenges facing this century. Phosphorus resources are depleting, along with phosphorus being the primary nutrient causing eutrophication, another major environmental issue on a global scale. The mineralogical composition typically comprises residual iron oxides and residues can exhibit large specific surface area. Laboratory trials on different residue types and residue treatments were conducted to determine residue characteristics in relation to P adsorption/ sequestering and are presented. Ongoing and future work will include batch trials determining P adsorption rates and recovery potential.

Keywords: bauxite residue; adsorption; filter; wastewater; phosphorus

Successful resource benchmarking: banding Irish wastewater treatment plants using discharge licence data

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Benchmarking has been utilised for many years as a means to sustainably manage and improve the performance of wastewater treatment plants (WWTPs) (Möller et al. 2012). Applying benchmarking methodologies to WWTPs empowers plant managers to learn from other WWTPs in a systematic manner and implement new and improved practices based on this learning. However, comparing the performance of WWTPs, without first assessing the disparities between the operational conditions which WWTPs must adhere to, can lead to incorrect deductions from benchmarking. Irish wastewater treatment plants, often characterised by size using the organic biodegradable load entering the plant, are subject to the 2007 Wastewater Discharge (Authorisation) Regulations. Under these regulations, WWTPs of a certain size and greater must apply for a discharge licence which, amongst other conditions, details the emission limit values (ELVs) for which the effluent wastewater must not exceed. ELVs, calculated on a plant-by-plant basis, are commonly supplied as mass concentrations of carbon, nitrogen and phosphorus discharges; however WWTPs seldom exhibit identical ELVs. Banding Irish WWTPs based on the organic biodegradable load entering the plant and the licence ELVs, constructs sets of WWTPs with similar operational condition, therefore decreasing the risk of unfair benchmarking. The bands used to define the boundary of each set are cognisant of the 2007 Wastewater Discharge (Authorisation) Regulations and take into account the level of difficulty associated with meeting ELVs, which over recent years are trending towards complete carbon, nitrogen and/or phosphorus removal. For example, the banding system prevents the comparison of two WWTPs (A and B) where WWTPA has a more stringent ELV than WWTP B. The more stringent an ELV is, the greater the amount of energy consumption required to meet it; therefore comparing WWTP A and WWTP B in terms of energy consumption is unfair and will potentially lead to incorrect deductions. Benchmarking a WWTP against WWTPs from within the same banding set, facilitates a fair and accurate comparison of WWTP performance, ultimately facilitating the identification of the process improvements with the greatest potential to be rewarding.

Keywords: Wastewater Treatment, Benchmarking, Resources, Discharge Licence.

Atmospheric cold plasma treatment of microbiological and organic pollutants in wastewater

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Generation of wastewater is one of the main environmental sustainability issues in the food industry sector. The food industry ranks third after the chemical and refinery industries in terms of water consumption and wastewater discharge rates (UNEP). The constituents of food process effluents are often complex to predict but the wastewater streams are subject to microbiological and chemical criteria which often require high energy and processing for compliance. Thus, innovative treatment approaches are required to mitigate environmental impact in an energy efficient manner. High voltage dielectric barrier discharge atmospheric cold plasma (ACP) was evaluated for control of key microbial indicators; Escherichia coli, *Enterococcus faecalis* and Clostridium perfringens and the removal rate of wastewater quality parameters including COD, BOD, TOC, TSS in model wastewaters. Model dairy and meat effluent were evaluated with respect to organic content and ACP process parameters of treatment time, retention time, voltage level. Retention time emerged as a critical processing parameter for microbial inactivation and retention time of 10 minutes with 80kv of voltage was sufficient for efficient bacterial inactivation in model dairy effluent. Death rates of E. coli in dairy effluent were not significantly ($P > 0.05$) affected by increasing the milk fat in dairy effluent but were significantly reduced ($P < 0.05$) by prolonging the treatment time to 5mins. ACP treatment in dairy effluent reduced bacterial population by 2 Log CFU ml-1 with 120s of treatment and to undetectable levels after 300s. Treatment times required for degradation of organic matter were longer, where the maximum abatement of organic content after 30 min treatment in dairy effluent was 35% BOD and more than 50% for both COD and TOC. Bacterial indicators and organic content in meat effluent were more sensitive to plasma treatment, with most bacterial populations completely inactivated after 180s of treatment, with a removal rate of 41% BOD and more than 55% COD and TOC achieved after 80kV for 30min of plasma treatment. A modified pseudo-first order kinetic model was proposed for organic removal in model effluents by plasma treatment. This study demonstrates the potential of ACP treatment for complete inactivation of pertinent microbial targets and enhancement of organic removal in complex and nutritious wastewater effluents.

Keywords: Wastewater treatment, food industry effluent, dairy effluent, meat effluent, atmospheric cold plasma, organic removal, bacterial pathogens, inactivation

Degradation of organic pollutants using a novel dielectric barrier discharge plasma in water

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Non-thermal plasma has exhibited significant potential for the degradation of wastewater contaminants with widespread applications. Liquid phase and gas phase plasma discharges have been utilized to produce plasmas for wastewater treatment. Here, we propose a novel development for wastewater decontamination using a water-sealed air dielectric barrier discharge (DBD) scheme, with efficacy demonstrated for the degradation of organic dyes. This system consists mainly of a coaxial DBD electrode configuration and a porous diffusor nozzle to maximize diffusion of non-thermal plasma species into the water. DBD plasma was driven by a high frequency high voltage AC power source. The electrical and optical emission spectroscopy (OES) measurements were used to characterize the DBD plasma performance. Voltage-charge (V-Q) Lissajous figure was measured for evaluation of the discharge power. The OES revealed the generation of reactive nitrogen and oxygen species which were responsible for degradation of the organic dyes. Methyl orange and bisphenol-a were selected as the model organic pollutants for the degradation study and patterns were evaluated as a function of applied voltage, gas flow rate and treatment time. Results show that within 2 minutes of treatment the degradation rate reached 90% which exceeded that achieved using under-water discharge plasma. Degradation of pollutants followed pseudo-first order kinetics. GC-MS analyses showed that the degraded compounds and intermediates formed were less toxic than the parent pollutant. Moreover, the proposed non-thermal plasma water purification configuration allows enhanced stability of plasma discharge and more freedom for the integration of gas phase plasma into the water reactor chamber, thus expanding application and treatment conditions.

Keywords: water treatment, organic pollutant degradation, dielectric barrier discharge, plasma diffusion

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Water Quality And Resources 1

Modelling the sources of nutrients in Irish catchments

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A data-driven model for predicting the sources of nutrient loads (phosphorus and nitrogen) has been developed by the EPA Catchment Tools Project. This model enables catchment data and information to be considered in an integrated manner and provides useful outputs to enable characterisation of Source-Pathway-Receptor relationships. The Source Loading Apportionment Model (SLAM) is designed as a flexible framework for incorporating the best available national data and research to represent nutrient losses from both point discharges to surface waters (urban wastewater, industry and septic tank systems) and diffuse sources (pasture, arable, forestry, peatlands etc.). Hydrological controls have a strong impact on nutrient fluxes, particularly in agricultural catchments, and have been incorporated into the diffuse nutrient models where applicable. The SLAM framework is an ArcGIS-based model linked to relevant national data sets, with individual modules for each sector to facilitate development and collaboration. The pasture module, for example, uses the Land-Parcels Identification System (LPIS), and the urban wastewater module incorporates data from annual environmental reports. Results for the Suir catchment show that pasture is the dominant source of nitrogen, whereas direct discharges are the dominant source of phosphorus. Within the Suir, there are large variations between sub-catchments in the percentage contributions from direct discharges for phosphorus ranging from 2% to 95%. Model results can be used to assess the relative dominant sources of nutrients by sector to support catchment scientists and managers in (i) characterising catchment nutrient behaviour and (ii) implementing appropriate management strategies.

Keywords: Nutrient Load Apportionment Modelling, Phosphorus, Nitrogen, Integrated Catchment Management

Comparisons of intermittently loaded laboratory filter systems to treat dairy soiled wastewater

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Dairy soiled water (DSW) is produced on dairy farms as a result of washing down milking parlours and livestock holding areas. Land application is mainly used to dispose of DSW, but filtration through various media is also relatively common. The aim of this study was to examine the impact of filter depth, type of media, and filter loading rate on the treatment of DSW by filtration. Two types of media (sand and woodchip) of two different filter depths (0.6 and 1 m) and three different organic loading rates (OLRs) (20, 50 and 100 g chemical oxygen demand (COD) m-2 d-1) were examined. The laboratory study comprised 100 mm dia. aerobic filters filled with either 10 – 20 mm graded Sitka spruce woodchip or silica sand. Influent DSW was pumped four times per day onto each filter using a peristaltic pump. Preliminary results indicate that filter depth was significant in the performance for woodchip media: there was no nitrogen (N) or phosphorus (P) removal from the 0.6 m filter at an OLR of 100 g COD m-2 d-1, but the 1 m-deep filter had removals of 87% ammonium-nitrogen (NH4-N), 72% total nitrogen (TN) and 36% total phosphorus (TP). The reductions were predominantly in the form of particulate P and N removal. Ammonium-N removals for sand and woodchip media (at 97% and 98%, respectively) were not significantly different at a filter depth of 1 m and an OLR of 20 g COD m-2 d-1. However, the woodchip had a greater removal rate of total N (89%) compared to sand (30%). Removals of TP for sand and woodchip filters were 93% and 78%, respectively. These results suggest that filter depth may be a significant factor in the design of on-farm filter systems and that media type may not be as significant as previously thought.

Keywords: Dairy soiled water, filters, phosphorus, nitrogen

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Water Quality And Resources 1

Quantification and characterisation of nitrogenous components of three native Irish seaweeds

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Macroalgae (seaweeds) are protein-rich, abundant foods that have been traditionally harvested in Ireland. The biochemical components of seaweeds vary with season and location of harvest. This is of particular interest to marine aquaculture, as an understanding of the parameters that affect growth can be used to influence controlled crop management and harvest times. The species under investigation are the red seaweeds, *Porphyra dioica, Palmaria palmata* and *Chondrus crispus*, gathered periodically from three sites on the West coast of Ireland over a one year period. The quantification of total nitrogen (TN), protein nitrogen (PN) and non-protein nitrogen (NPN) as a function of season and geographical location has been quantified for each of these species. Seasonal variation of the nitrogenous components has been observed, for example, P. dioica harvested in Spiddal in July and December, had PN contents of 19.03±0.5 and 43.03±0.1 mg/g dry weight (dw) respectively. Electrophoretic analysis showed substantial differences in the protein profiles of *P. dioica* harvested at different times of the year. Similar trends have been observed for *P. palmata* and *C. crispus. P. dioica* protein extracts were hydrolysed with the food-grade proteolytic preparations, Alcalase 2.4 L and Flavourzyme 500 L. The Oxygen Radical Absorbance Capacity (ORAC) and Ferric Reducing Power (FRAP) values of the hydrolysates ranged from 229.5-1015.3 and 4.1-28.7 µmol Trolox Equivalent (TE) per gram of dry matter, respectively. The P. dioica hydrolysates also inhibited angiotensin converting enzyme inhibitory activity (half maximal inhibitory concentration, IC50: 0.42–1.78 mg/mL). Significant seasonal differences were observed in all in vitro bioactivity assays. Ongoing research will investigate the bioactivity of the protein hydrolysates for the other species.

Keywords: Macroalgae, nitrogenous components, bioactivity

Marine And Costal 1

Valuing Ireland's Blue Ecosystem Services (VIBES)

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The marine and coastal ecosystems around the island of Ireland provide many valuable benefits to the Irish economy and society. These benefits, generated by nature, are known as 'Ecosystem Services' (ESs). While the value of some these goods such as fish and aquaculture are somewhat easier to measure, the value of many other benefits such as carbon sequestration, waste treatment and recreation are not captured in any market. Without incorporating these values into the decision making processes, these benefits may be ignored or underestimated and changes within coastal and marine zones may incur a net loss to Irish society. The EU through its 2020 Biodiversity Strategy aims to protect, value and where necessary restore nature both for biodiversity's intrinsic value and for its contribution to human wellbeing and economic prosperity through ecosystem services. There are a number of frameworks which have been used for assessment of ecosystem services. This project will use the Common International Classification of Ecosystem Services (CICES) framework to identify those services which coastal, marine and estuarine ecosystems provide to society. CICES breaks down ESs into three main groups: provisioning services, regulating services and cultural services. The various services in each grouping will be valued using market prices where available or non-market valuation methods such as value transfer. Where there is sufficient data, the ESs will also be mapped as this is useful for communication between different stakeholders and will allow up- or down-scaling of values from national level to local level and vice versa. The Valuation of Ireland's Blue Ecosystem Services (VIBES) project will build on previous work done by SEMRU in valuing marine and coastal ecosystem services and is funded by the EPA under the Research Strategy 2014-2020.

Keywords: marine, ecosystem services, valuation

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Marine And Costal 1

Reducing the impact of pathogens and disease in the Irish Pacific oyster Crassostrea gigas by understanding Environment: Host: Pathogen interaction

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Pacific oysters Crassostrea gigas have been farmed in Ireland since the 1970's. However, since 2008 oyster mortality events have been associated with herpesvirus infection, in particular the variant OsHV-1 µVar, and pathogenic strains of the bacterium *Vibrio aesturianus*. This study is looking at practical control measures to reduce the impact of oyster pathogens and to better understand how these pathogens might sustain themselves outside the host in the marine environment. Environmental factors have a significant impact on pathogen and disease development. In this study the effect of salinity on pathogen development in *C. gigas* at high and low/variable salinity was assessed in relation to the oyster's ability to grow while resisting infection. The field trial was conducted in 2015 in Carlingford Lough. Immune function of oysters was better when oysters were held at lower salinity regimes. In addition, growth rates almost doubled in the older oysters held at the low salinity site, however in contrast seed oysters had a greater growth rate at the high salinity site. The overall prevalence of herpesvirus was low (<5%) in oysters at both salinities for both age groups and mortalities were minimal. These results were attributed to the lower than average seawater temperatures (<16°C) experienced, which when elevated act as a trigger/stressor for disease outbreak. Results from the field trials would indicate that active husbandry and movement of oysters between areas of different salinity during the culture cycle can maximize growth and immune capability and minimize pathogen and disease impact.

Keywords: Crassostrea gigas, summer mortalities, ostreid herpes virus, Irish oyster culture

Marine And Costal 1

Examining the usefulness of exoskeleton waste for controlled release of fatty acids in bioprocessing

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The crustacean processing sector produces approximately 6,000 tonnes of crab waste annually. Specific methods, laid out by the Animal By-product Regulations, must be employed in order to dispose of this waste correctly. Current methods of waste disposal include landfill and incineration. It can cost up to €60 per tonne for waste to be disposed of in landfill.

The exoskeletons of crustaceans contain micro-pores which may provide an ideal structure for the controlled release of materials. The project aims to examine the usefulness of the exoskeleton waste for controlled release of fatty acids with an application in bioprocessing. Butyrate is a fatty acid which can affect changes in gene expression through its role as a histone deacetylase inhibitor. These effects are non-specific and so may also result in increased apoptosis due to activation of pro-apoptotic proteins. This research will investigate the use of crustacean exoskeletons as materials for controlled release of butyrate through analysis of recombinant protein production and cell survival in a bio pharmaceutically relevant cell line.

Crustacean samples have been de-mineralised and de-proteinised by chemical methods. Sodium butyrate has been loaded into the exoskeleton and the exoskeleton placed in a mammalian cell culture. The amount of sodium butyrate released into culture and rate of release will be measured by gas chromatography. The effect of butyrate on protein production will be measured by assaying for insulin/GFP recombinant fusion protein expression in a CHO-K1 adherent cell line. The absolute amount of this protein will be determined by fluorescent measurements and cell viability will be measured by a luminescence based cell viability assay. Results to date include protocol set-up for fluorescent protein expression and measurement, gas chromatography protocols and initial butyrate infusion of crustacean exoskeletons.

Keywords: exoskeleton, controlled release, Butyrate

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Marine And Costal 1

Serum Amyloid A as a biomarker for stress in fish

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The Acute Phase Reaction (APR) is a mechanism employed by an organism's immune system to protect the body in response to stress and physical damage such as burns, infection and tissue damage. When stress or damage occurs, the APR is activated which in turn causes an increase in Acute Phase Proteins (APP). Serum Amyloid A (SAA) is a major acute phase protein which raises in concentration when the organism is exposed to a stressor. In farmed fish these stressors can include the habitat, location, water quality, competition with other fish, food intake and pollutants. As farm bred fish are becoming a much more convenient way to produce large quantities of fish for market it is essential that the fish are kept as stress free as possible to allow for the fish to be healthy and fit for consumption. Using farmed *Oncorhynchus mykiss* as the initial test species, mRNA was extracted from the internal organs (liver, heart, kidney and reproductive organs) and from some fatty tissue located just below the ribcage. Two standard curves were designed for qPCR using *Oncorhynchus mykiss* DNA of known concentration. One standard curve is for the gene of interest (SAA) and the other for the housekeeping gene, β-actin. By comparing the concentration of SAA transcripts in the unknown samples to that of the standard curves it is possible to determine the concentration of the unknown mRNA samples. Once this technique has been optimised for *Oncorhynchus mykiss*, it can then be used to measure stress levels in other fish species.

Keywords: SAA, *Oncorhynchus mykiss*, APR, APP, mRNA, qPCR

Marine And Costal 1

A geo-statistical investigation of agricultural and infrastructural risk factors associated with primary (sporadic and index) verotoxigenic *E. coli* infection in the Republic of Ireland, 2008–2013

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Ireland reports the highest incidence of verotoxigenic Escherichia coli (VTEC) infection in Europe. This study investigated potential risk factors for confirmed sporadic and outbreak primary VTEC infections during 2008–2013. Overall, 989 VTEC infections including 521 serogroup O157 and 233 serogroup O26 were geo-referenced to 931 of 18488 census enumeration areas. The geographical distribution of human population, livestock, unregulated groundwater sources, domestic wastewater treatment systems (DWWTS) and a deprivation index were examined relative to notification of VTEC events in 524 of 6242 rural areas. Multivariate modelling identified three predictors of VTEC notification: private well usage (odds ratio (OR) 6.896, p <0.001), cattle density (OR 1.002, p <0.001) and DWWTS density (OR 0.978, p = 0.002). Private well usage (OR 18.727, p <0.001) and cattle density (OR 1.001, p = 0.007) were predictive for VTEC O157 infection, while DWWTS density (OR 0.987, p = 0.028) was significant within the VTEC O26 model. Findings indicate that VTEC infection in the Republic of Ireland is particularly associated with rural areas due to the ubiquity of pathogen sources (cattle) and pathways (unregulated groundwater supplies). The results from this study, along with future research, will aid in the development of more proficient disease surveillance and will subsequently facilitate the implementation of systematic, preventive public-health interventions.

Keywords: Shiga-like toxin-producing E. coli, Environmental management, Public health, Epidemiology, Water-borne infections

Environment And Human Health 1

GO GREEN EX going outdoors: gathering research evidence on ENvironment and EXercise in a community based interdisciplinary intervention

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This abstract outlines the activities of an interdisciplinary team, from psychology, applied physiology and environmental science, investigating the benefits of green exercise on wellbeing and physical and mental health. It addresses both national priorities (e.g., Healthy Ireland initiative) and H2020 societal challenges (e.g., mental health; sustainable environment). This novel intervention is being undertaken in collaboration with Mental Health Ireland and Clarisford Park (i.e., a community based enterprise) and will involve the interdisciplinary team of researchers engaging in translational research that will investigate both the potential of both "blue" and "green" spaces to promote physical activity on mental health and wellbeing as well as evaluating the potential mechanisms underlying these effects. We plan to augment conventional interventions with innovative strategies that focus on the potential of ecosystems benefits for health. Clarisford Park's vision is for the community Killaloe-Ballina to become the first healthy town in Ireland. By developing a model of best practice this model can be implemented across other communities. This research will also address a number of scientific questions designed to determine to impact and specific health benefits of exercising in the natural environment. The natural environment offers a low-risk, low cost, sustainable and accessible lifestyle behaviour which for many may have appreciable mental and physical health benefits. In support of this contention, Walsh (2011) has recommended green exercise as one of eight of therapeutic lifestyle changes to increase positive mental health and wellbeing. Green exercise refers to activity undertaken in natural environments. Accumulating evidence suggests that exercise in green/blue spaces benefits wellbeing, increases exercise adherence with associated health benefits, and reduces perceived exertion compared to indoor activity. Current public awareness and understanding of the positive impact of green exercise is low and our scientific understanding of the mechanisms underlying green exercise effects remains unclear.

Keywords: Mental Health, Green Exercise, Physical Activity, Lifestyle Behaviours

Environment And Human Health 1

Perceived versus actual air quality and how this impacts on levels of green exercise in communities

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This research sets out to establish the links between perceived and actual air quality and how this relates to population health and well-being. In particular, the research aims to investigate whether perceived and actual air quality are contributory factors in the prevalence of green exercise (activity undertaken in natural environments) in communities. The research employs a combination of structured interviews and population based questionnaires together with spatial indicators to establish public perception of air quality in certain air quality zones in Ireland. Using air quality data collected under the national ambient monitoring network, actual air quality in each region will be quantified and related to the air quality index for health. The research focuses on levels of particulate matter (PM_{10}, $PM_{2.5}$) and nitrogen dioxide (NO_2). Three separate areas are targeted with differing amounts of urban green space in the vicinity. The monitoring sites are classified as rural background, suburban background and urban centre sites. The research sets out to determine whether there is a relationship between levels of green exercise and the neighbourhood air quality and furthermore, whether willingness to exercise outdoors is related to perceived air quality. This research tackles a number of key issues that are central to efforts to reduce anthropogenic influence on the environment, while at the same time improving population health and well-being. Community involvement approaches which draw upon local people identifying what environmental issues affect them and how they can be involved in designing and implementing policy responses to the problems could lead to a greater sensitivity to environmental issues. This research is novel in that it merges fields of environmental science, psychology and physiology and employs an interdisciplinary approach to improving population health and wellbeing while at the same time improving environmental awareness.

Keywords: Air quality, mental health, water quality, ecosystem sustainability

Environment And Human Health 1

The relationship between oyster norovirus concentrations and the surrounding environment in an Irish oyster farm

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Norovirus causes gastroenteric illness in humans, and is the leading source of food-related viral illness worldwide. Infected humans shed thousands of fresh virus copies, which are released to the environment as wastewater effluent. These copies can stay infectious for several months, depending on the wastewater treatment and the environmental conditions. Even if environmental levels of norovirus are safely diluted, nearby oysters will accumulate significant numbers over time in their digestive glands. Oysters contaminated by wastewater in this way threaten both public health and aquaculture efficiency. Contamination is highest in winter months, when infections are most common in the population. However, the precise nature of this seasonal pattern, including its causes, has not been fully established. This preliminary study is part of an ongoing investigation into the varying levels of norovirus accumulation observed in commercial oysters, and the correlating environmental factors. A production site in the north-east of Ireland has been chosen as a case study. These oysters are grown in a bay with a single point of wastewater effluent present. Oysters from multiple harvest points, at different proximities to the wastewater outflow, are tested every week to quantify norovirus levels. Environmental probes log the temperature and salinity of the surrounding waters while a weather station monitors the daily rainfall, air temperature and barometric pressure. Reports of illness in the region are also considered as a source of data. The results give a clearer picture of the seasonal trend observed in the so-called winter vomiting bug, and potential mechanisms to explain it.

Keywords: norovirus, shellfish, oysters, public health, aquaculture, wastewater

Investigation of the elemental content of Fucus serratus seaweed bathwater

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Seaweed baths are traditional, holistic treatments which can incorporate the benefits of both seawater and seaweed. All seaweeds are characterized by a high concentration of minerals, due to their ability to store sea salts. The mineral content of seaweed can account for 8%-40% of its composition. Seaweed has also been shown to have an affinity for heavy metals. Analysis carried out to date was limited to the determination of total iodine in the bathwater. It is suggested that, under the same temperature and pH conditions, other elements present in the seaweed may also be released and be available for uptake by the body. It is necessary to establish the concentration ranges of these elements in order to determine their potential benefit or harm to the body. Simulated seaweed bathwater samples were prepared using *Fucus serratus*. Samples collected after 40 minutes were digested in the microwave using ultrapure nitric acid (10%) prior to analysis by Inductively Coupled Plasma Mass Spectrometry (ICP-MS) which allows for simultaneous determination of aluminium, arsenic, cadmium, chromium, cobalt, copper, lead, magnesium, manganese, mercury, molybdenum, nickel, selenium and zinc in the aqueous matrix. A multi element standard was prepared in nitric acid from certified standard reference material containing the selected single elements and bismuth, indium and yttrium were used as internal standards. The effect of increasing mass of seaweed and increasing temperature on element concentration was also investigated. Results are currently pending and will be presented.

Keywords: Seaweed, *Fucus serratus*, Trace elements, Inductively Coupled Plasma Mass Spectrometry

Potential energy generation from the anaerobic digestion of domestic household and garden wastes

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The correct disposal and management of the organic fraction of municipal solid waste (OFMSW) is of paramount importance in helping Ireland comply with the European Landfill Directive (1999/31/EC) which requires a 35% reduction in the amount of biodegradable municipal waste that is landfilled in 2016 compared to 1995 levels. Decentralised renewable thermal energy production must also increase to meet Ireland's 2020 12% renewable heating target and comply with the European Renewable Energy Directive (2009/28/EC). A number of different technologies exist to convert the OFMSW into energy, the technology of interest in this study is the production of biogas from domestic scale anaerobic digestion. It is estimated that 841,290 tonnes of organic household waste was produced by 1,649,408 Irish residential properties in 2012. This amounts to an annual national recorded generation of 510 kg of OFMSW per dwelling, but this study has found that a typical Irish household produces 1,902 kg of organic waste when other garden and human waste streams are considered which could be anaerobically digested into domestic biogas and organic garden fertilizer based on the average Irish residential property occupancy of 2.8 persons and a mean domestic garden area of 151 m^2 similar to the UK. As national building regulations improve the annual thermal energy demand of newly built domestic properties is set to fall. This study has shown that if passive house building energy regulations of 15 kWh^{th}/m^2/year were implemented across Ireland a typical 126 m^2 dwelling would require a garden area of 0.29 hectares to achieve thermal energy independence through the anaerobic co-digestion of the OFMSW and garden waste while also providing enough biogas to satisfy the annual parasitic thermal energy demand of a $2m^3$ domestic biogas plant operating under mesophilic temperature conditions.

Keywords: anaerobic digestion, biogas, organic waste streams

Energy

Developing a participatory integrated design process involving occupants and users in the design process of energy retrofit

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A growing body of research indicates that in many cases energy efficient buildings are not achieving the expected level of energy savings. While some argue that this is due to rebound effects, with lower energy costs being channeled into higher comfort levels or licensing wasteful behaviour in other areas, this paper posits that poor design choices often stem from a failure to incorporate the human dimension in the design of the retrofit. This results in the less than optimal operation of energy saving technologies or designs on the part of occupants and users. The H2020 project NewTREND aims to counteract this by collaborating with occupants and users as partners in the design process. NewTREND is developing a participatory integrated design methodology for the energy retrofit of buildings and neighbourhoods. The developed methodology and associated tools will be tested and validated in three refurbishment projects in Hungary, Finland and Spain. This paper outlines research being undertaken at UCC as part of the project into novel approaches to occupant involvement. Initial findings will be presented based on work with occupants of a building refurbishment project located in Ireland.

Keywords: energy efficiency, refurbishment, occupants, users, participatory design

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Energy

Incentivising energy-efficient building: A framework for developing new business models

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Buildings are responsible for 40% of Europe's energy consumption, creating huge potential for savings through improved energy efficiency in the sector. However, there is widespread consensus that the energy-saving potential of buildings is not being met, and that this is not due to a lack of technological solutions but rather institutional, organisational and financial barriers. Many of these problems arise from the insufficient adaption of traditional business models to energy efficient building projects, where a higher upfront cost may produce a return in the form of energy savings which is spread over the lifetime of a building. The development of novel business models, which incorporate a life-cycle perspective and spread risk (and rewards) between the different stakeholders has the potential to overcome some of these difficulties and incentivise energy efficient building activity. Based on research undertaken as part of the UMBRELLA FP7 project, including interviews with stakeholders involved in energy efficient building projects from 11 European countries, this paper will offer a framework for developing new business models capable of incentivising EeB activity. It will suggest there is a need to reconceptualise what is meant by building performance and to reconfigure the ways in which the different dimensions of value created by a building project are assessed by the market if we are to incorporate a lifecycle perspective in building and incentivise EeB. Finally, it will outline some implications for policymakers who wish to realise the huge potential of EeB to help achieve Europe's energy efficiency and carbon reduction targets.

Keywords: energy efficient building, business models, incentivisation

Energy

Development of a *Talaromyces emersonii* 'molecular toolkit', enabling the efficient expression of designer enzymes/enzyme cocktails for industrial applications

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Talaromyces emersonii (T. emersonii) is an aerobic, thermophilic fungus. In this species a broad range of enzymatic activities have been identified. Their thermostable nature means that they are very valuable for industry; they can be used in the production of glucose through complete hydrolysis of crystalline cellulose, for processing materials such as leather, or as a food additive to improve the quality of the product or increase processing efficiency. In industrial processes such as these, high temperatures are often useful to increase reaction rates and improve the efficiency of reactions. *T. emersonii* has been shown to outperform species typically used for industrial enzyme production, *Trichoderma* and *Aspergillus* that are currently industry leaders. Molecular biological techniques must be developed to transform *T. emersonii*, in order to increase product output and generate an enzyme producer that is industrially viable. To facilitate gene expression, a 'molecular toolkit' will be developed to comprise of a range of plasmids, that will enable the easy exchange of promoter, gene and terminator elements. In this research, methods of selection have been tested, and regulatory elements from *T. emersonii* have been isolated. Transformation systems typically used in fungi will be tested and compared, in order to optimise the transformation of *T. emersonii*. This will generate an efficient procedure for delivery of toolkit plasmids, and allow for future study of genes and regulatory elements in *T. emersonii*.

Keywords: Fungus, Plasmid, Biofuel, Toolkit, Industrial, Enzyme

Energy

Is the development of Net Zero Energy agricultural dairy farms possible in Ireland?

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Seven dairy farms were analysed to determine the possibility of developing Net Zero Energy consuming dairy farms in Ireland over a 12 month period from a net energy consumption versus net renewable energy generation viewpoint. The analysis was assessed through a life cycle energy assessment methodology. The net energy intensity of the dairy farms ranged from -0.34 to 1.73 MJ/L of milk with an average of 0.35 MJ/L with the largest energy consumer among the dairy farms being from synthetic fertiliser (40% of gross energy use) used for crop growth. Indirect energy use within the dairy farm was found to outweigh direct energy usage by average ratio of 4:1. A scenario basis was adopted to quantify the possibility of developing Net Zero Energy dairy farms through analysing four different types of renewable technologies which included solar, wind, biogas and biomass. It was established, that the development of Net Zero Energy dairy farms is possible from the study farms analysed. The implementation of the optimal renewable technology for each study dairy farm (AD through using cattle slurry and 10% of dairy farm land area with maize silage) achieved an average reduction in net energy of -1,494 GJ for the seven study dairy farms, ranging from -330 GJ to -4,132 GJ. This indicates that these study dairy farms could become net energy production facilities rather than net energy consuming facilities and more importantly become NZE dairy farms. Through the implementation of the renewable technologies within these dairy farms, an average of 176.5tCO_2/annum (ranging from 51.8 to 421.0tCO_2/annum) could be saved. The results of this research can aid in the development of energy neutral dairy farms in Ireland and reduced carbon emissions from the sector.

Keywords: Net Zero Energy, Dairy Farms, Renewable Energy Technology

Energy

Examining the new energy paradigm: Ireland, the energy transition and the wider European Experience

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One of the key challenges today is achieving a sustainable energy transition. This has been underscored by the recent events at COP21, Paris, with the terms set out in the agreement designed to harness international political will to meet this challenge beyond 2020, when the Kyoto Protocol expires. The EU's climate and energy strategy, in many ways, has pre-empted this development with its 2011 Energy Roadmap by projecting plans to develop its energy system out to 2050. Given the different energy infrastructures in place across the different member states, a specifically European challenge presents itself in terms of implementing an effective and integrated suite of polices that meet the shared objectives of a general de-carbonisation of the energy network with greater sustainability and security through indigenous supply. A key question in this regard is how are current policy frameworks positioned to meet these challenges? Another is looking at the Irish context for energy transition, are policies here fit for purpose? This paper presents a comparative analysis of Irish policy related to energy transition in the context of wider European experiences, specifically comparing with the policy contexts of four other European countries (France, Spain, Italy and the UK). The paper also examines how these policies are structured in an Irish context, outlining the instruments used to realise government objectives and the degree of policy integration and coherence present to ensure successful outcomes. Acknowledging the role different stakeholders play within their respective energy systems, and how these roles in turn impact on the national and supranational policy objectives is also considered. Research for this paper has been conducted as part of the H2020 ENTRUST project, an interdisciplinary research project exploring the human factor in the energy system.

Keywords: sustainable energy transition, energy policy, environment, EU, comparative policy analysis

Energy

Turning the tide on invasive species: Testing multiple methods of control on the invasive sea-squirt *Didemnum vexillum*

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Invasive species pose one of the most significant threats to biodiversity and ecosystem functioning. Fouling taxa such as tunicates show a high propensity for introduction and spread through new habitats and regions and are a major plague suffered by the shellfish industry. Investigating appropriate responses to these introductions is becoming an increasingly important component of the management of ecosystems. A field experiment was set up on an oyster farm in Clew Bay, Co. Mayo. Oyster bags fouled by the invasive tunicate Didemnum vexillum were treated using vinegar spray and desiccation (bag turning) control methods. These controls were applied individually or in combination, following six regimes of treatment that incorporated the frequency (low, high), timing (early, late) and variance (spread, clustered) of their delivery. D. vexillum percentage cover and total fouling biomass were significantly reduced by a number of treatments. Oyster survivorship was not significantly affected by any treatment. The most cost-effective treatments involved combining desiccation and vinegar treatments and applying these at a low frequency. Treatments that were spread throughout the growing season were more effective than those clustered early or late in the season. These results show that the success of invasive species control can be influenced by a range of complex interacting factors that can often be overlooked. This research builds our capacity to successfully manage invasive species and to reduce their ecological and economic impacts.

Keywords: Invasive species control, Didemnum vexillum, multiple stressors, disturbance regimes, aquaculture, tunicates

Invasive Species And Environmental Management

The invasive macrophyte Lagarosiphon major, its management and the importance of native seed banks: implications for future control

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Invasive species remain a threat to global biodiversity and ecosystem services. The European requirement to prevent and control the spread of invasive species and restore damaged ecosystems has increased the need for sustainable, long term, management options which facilitate native species recovery. The control of *Lagarosiphon* major with a novel benthic barrier made from biodegradable jute within Lough Corrib Galway has facilitated a detailed study documenting the recovery of macrophyte and macroinvertebrate communities following its application. The importance of native seed bank dynamics and the role of seed banks in natural succession was also investigated. Jute mats were used to control L. major in two bays and monitored for macrophyte and macroinvertebrate recovery over a 24 month period. Sediment core samples were retrieved under native Charophyte meadows and L. major infestations, split into three depth ranges (0-5cm, 5-10cm and 10-15cm), and Charophyte oospore densities enumerated. Significant reductions of up to 90% were observed in macroinvertebrate abundance three months after jute application. Macroinvertebrate abundance and community structure became similar to controls 15-24 months after treatment. Although macrophyte recovery was observed, Charophyte biomass remained low in jute treated L. major plots 24 months following jute application. Charophyte oospore density was significantly variable between bays ranging from 52,612 to just 81 oospores/m2. Higher oospore abundances were generally observed at a depth of 10-15cm however a discernible effect of invasive species on Charophyte seed banks was not observed across bays. Although the observed recovery of macroinvertebrates following jute application is promising, adaptive management is required to increase the recovery of the macrophyte community and reduce whole ecosystem recovery time. Change from a control orientated, to a whole ecosystem approach is required to facilitate sustainable management into the future.

Keywords: Invasive species, seed bank, Charophyte, oospore, invasive species control, adaptive management, ecosystem.

Invasive Species And Environmental Management

Diversity and detections of *Phytophthora* species from trade and non-trade environments in Ireland

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The genus *Phytophthora* is one of the most threatening genera of organisms to plant health world-wide. Statutory monitoring for *Phytophthora* species focusses on the species recommended for regulation in the European and Mediterranean region (Council Directive 2000/29 EC and the EPPO A2 list). There has been no extensive survey for *Phytophthora* diversity in Irish habitats. This research provides details for the *Phytophthora* species detected from trade and non-trade environments in Ireland between 2002- 2015. Testing of more than 10,000 samples was carried out using in-vitro and/or DNA identification using specifically designed *Phytophthora* conserved primers. This led to the detection of 21 taxa, including 8 new records for Ireland. Eight taxa were found in both trade and non-trade premises, and three undescribed species were also detected. *Phytophthora ramorum* was found on the most hosts (30 hosts), followed by *Phytophthora syringae* (6 hosts) and *Phytophthora kernoviae* (3 hosts). Rhododendron was the host on which *Phytophthora* species was most frequently detected (12 *Phytophthora* species). The role of the plant trade in spreading invasive *Phytophthora* species is discussed.

Keywords: quarantine, invasive aliens species, plant pathogens

Invasive Species And Environmental Management

Campaign to control/eradicate terrestrial Invasive species in Achill Island , Co Mayo

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Invasive alien terrestrial species are one of the biggest threats to biodiversity worldwide. A major environmental problem in Ireland is their potential to takeover vast areas of agricultural land by excluding native species. A citizen science initiative was started locally on Achill Island to address the growing problem with invasive species such as Gunnera (Gunnera tinctoria - Giant or Wild Rhubarb) and to a lesser extent Japanese Knotweed (Fallopia japonica) and possible means to control them.

In order to determine optimum management to eradicate/control these invasive species a test using different herbicide application strategies was conducted. Two different herbicides (a selective and non-selective) were compared. Both herbicides were applied at different application rates to Gunnera infested fields, in a number of test locations, in order to obtain the optimum application rate. Different spraying times were also assessed (late May compared to July/August) to ascertain if there was a difference in the control of the Gunnera plants at different stages of the life cycle of the plant. Preliminary results are presented and it appears that better control of the Gunnera was achieved with the non-selective herbicide during the first growing season. However, this observation is subject to ongoing evaluation during 2016 and in subsequent growing seasons. One of the objectives of this campaign was to establish a methodology that could be applied nationally in other areas of the country facing similar challenges from Gunnera and Japanese Knotweed and the potential for application of these outcomes will be presented.

Keywords: Giant Rhubarb, Japanese Knotweed, Citizen Science Project, Achill Island

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Invasive Species And Environmental Management

Sustainability Impact Assessment of the cascade use of Harvested Wood Products

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According to the cascade principle, wood should be used in the following order of priority: wood based products, re-use, recycling, bioenergy and disposal. However, due to increasing social and legislative pressures, the use of wood directly for bioenergy has increased so as to reduce reliability on fossil fuels. Through the application of linear regression we found that there has been a significant annual increase in the use of wood as both a domestic fuel ($F = 204.385$, $p = <0.001$. $R^2 = 0.976$) and within the forest and energy industries ($F = 74.22$, $p = 0.001$, $R^2 = 0.936$) in Ireland since 2007; resulting in the abatement of 573,000 tonnes of CO_2 in 2013 alone. However, there is debate as to whether this direct utilisation of wood for energy is sustainable. Through the cascading of wood resources, energy generation is postponed until the wood has degraded beyond practical use. As a result, cascading of wood does not contribute to short term renewable energy targets but may lead to a steady sustainable supply of wood for energy generation in the long term, while increasing carbon storage through reuse and substitution. The purpose of this study is to assess the effects of cascading the harvested wood product chain in an Irish context using the Tool for Sustainability Impact Assessment (ToSIA), developed by the European Forest Institute. We will present environmental, economic and social indicators including: GHG balances, production costs and variation to the labour force, which are being assessed using raw data from national and international databases, reference data from literature and conceptualised changes to wood chain topologies. This study will facilitate in the development of data-led policy for sustainable forest and forest based resource management in the future.

Keywords: Cascading, Harvested Wood Products, Sustainability Impact Assessment

Invasive Species And Environmental Management

Counting the cost of floodplain development in Ireland

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Significant damage has been caused in Ireland by recent flood events, such as the severe flooding experienced in November 2009 and more recently during the winter of 2015/16. This substantial damage has highlighted the need to quantify when and where development has occurred on fluvial flood plains and how best to manage limited resources to protect these areas. This study looked at the spatial and temporal extent of development on floodplains in Ireland. Floodplains were defined using the indicative (100-year return period) and extreme (1000-year return period) national flood maps produced as part of the OPW Preliminary Flood Risk Assessment. These were combined with CSO data, containing the georeferenced location and census information for every household in the country, to produce summary statistics on a county-by-county basis. These data quantify the both the number and period of construction of households lying in flood-prone areas, thus revealing both the scale of the problem and the history of floodplain development nationally. Local housing valuation statistics were used to quantify the economic value of property on flood plains, and a cost analysis was performed to relate flood risk and cost should this flooding occur. This information is useful as it highlights the scale of the problem on both a national and local scale. On a catchment scale, changes in land use can significantly affect the hydrological cycle and alter the natural flooding regime. Land use change on floodplains and within catchments between 1990 and 2012 was assessed using CORINE Land Cover data, and the possible impacts on flooding described. This study gives valuable insights into the history and cost of floodplain development in Ireland, and provides information for effective planning and flood risk management in future.

Keywords: Flooding, flood risk, development, land use, catchment

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Invasive Species And Environmental Management

Temporal patterns of soil respiration across a Sitka spruce chronosequence on blanket peat

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Total soil respiration (R_T) represents the major terrestrial source of CO_2 into the atmosphere and understanding of it is vital to monitor and predict the global carbon cycle under an uncertain climate. Studies of soil respiration in forest ecosystems repor large variability. Temperature, water table level, soil type, tree species and stand age are some of the factors that have been pointed out as responsible for this temporal and spatial variability. Empirical models of RT as functions of some of the environmental factors may be used to scale up manual measurements to forest ecosystems and larger scales. In this study, soil CO_2 efflux was measured in six Sitka spruce (Picea sitchensis (Bong.) Carr.) and one lodgepole pine (Pinus contorta Dougl.) stands on blanket peat in north-west County Cork, Ireland from April 2014 to January 2016. Within each site, seven subsites were located. Each subsite consisted of two cylindrical root-exclusion collars (inner diameter of 160 mm and length of 320 mm) and a surface collar (not inserted into the ground). Nets were used to prevent the further accumulation of litterfall within each collar and they were opened only during measurements. Manual measurements of soil CO_2 efflux, soil temperature at 10 cm depth and water table depth were conducted biweekly. Soil temperature at 10 cm was also logged every five minutes. The relationship between the environmental factors and the total soil respiration, the soil-surface CO_2 emissions and the Q_{10} values for the different sites, and the characterization of the temporal patterns of the R_T, will be presented.

Keywords: Soil CO_2 efflux, Peatland forestry, blanket peat, soil temperature, Picea sitchensis

Climate Change

Effect of early life dietary intervention with linseed oil on the ruminal bacterial community structure of lambs

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Rising levels of greenhouse gas (GHG) emissions in recent years are driving anthropogenic global warming and climate change. In Ireland, the agricultural sector is the single largest contributor of GHG emissions (~32%). Methane, a gas with 25 times more global warming potential than CO_2, is produced by a consortium of microorganisms in the rumen of ruminant animals during digestion of feed. Numerous mitigation strategies for reducing enteric methane emissions are under investigation, including dietary supplementation with oils. The aim of this study was to determine the effect of linseed oil, administered to lambs in early life, on ruminal bacterial communities and to establish if the altered microbiomes persisted once administration of the supplement had ceased. Forty five new-born lambs were blocked according to sex and allocated to one of three dietary treatments in a randomised block design; the first group received standard lamb meal throughout the study, the second group received lamb meal supplemented with 40 g kg^{-1} DM of linseed oil and the final group received linseed oil supplementation pre-weaning, but after weaning received only standard lamb meal. Ruminal microbial contents were sampled at 16 weeks, volatile fatty acid (VFA) concentrations were measured and bacterial communities were analysed using the Illumina Miseq platform and compared between treatment groups.

Keywords: Climate Change, Methane, Livestock, Dietary Supplementation

Climate Change

After Paris: A critique from the perspectives of new institutionalism and neo-functionalism in international relations

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This paper examines new institutionalist and neo-functionalist theories to explain the institutional framework in the Paris Agreement on Climate Change. I argue that institutionalist theory offers more explanatory power over why the Agreement relies heavily on voluntary national commitments to reduce global emissions of GHG_s. Institutionalist perspectives on climate change highlight the fact that institutional structures and dynamics, whether they be represented by formal or informal rules and norms, affect both behaviour and outcomes in climate negotiations. As long as the climate negotiations under the UNFCCC reproduce intergovernmental bargaining dynamics, little progress will be made in designing institutions with the effective powers and political legitimacy to curtail the problem of free-riding and internalising the social cost of carbon. On the other hand, some neo-functionalist approaches predict the rise of organisational capacity to develop supra-national regimes to address common or collective action problems. However in the case of the Paris Agreement, those key features of rule-making have not been designed into the climate institutions. Without such political and legal authority, the Agreement is unlikely to overcome barriers to collective action fast enough for the 1.5-2 degree warming limit to be realised. From a theoretical standpoint, this requires a critical application of institutional theory to reveal the effective veto-players at international level whose opposition to institutional reform has prevented climate institutions from acquiring enforcement and law-making powers. The political effect of weak international institutions is to pass climate governance and accountability back to the national level. Climate policy is thus likely to continue to be primarily driven by domestic political agendas, veto players and powerful economic actors, and the 'tragedy of the commons' will not be halted.

Keywords: climate change; global environmental institutions; Paris Agreement.

Climate Change

The impact of the Irish dairy processing industry on climate change

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At the end of 2015, climate change once again came to the fore as a topic of discussion in Ireland as world leaders negotiated the Paris Agreement at the 2015 United Nations Climate Change Conference (COP21). This global agreement outlines the methods and aims for the reduction of climate change. Currently, the Republic of Ireland is on the brink of a new era for the dairy industry as quotas, which restricted milk production since 1984, were abolished in March 2015. As a result, milk production is expected to increase by 50% by 2020, based on the reference years 2007 to 2009. Furthermore, if Ireland is to meet their climate and energy targets, as outlined in Food Harvest 2020, the efficient use of resources and fuels within the industry will need to be increased. The primary aim of this study is to estimate the contribution of the Irish dairy processing sector to climate change and, consequently, highlight a number of areas where plans may be implemented in order to achieve more 'environmentally friendly' production of dairy products in Ireland. In order to achieve this, the global warming potential (GWP) associated with the manufactured of dairy products in the Republic of Ireland is assessed through life cycle assessment. Initially, a macro-scale cradle to processing factory gate study examining the GWP associated with the Irish dairy industry is performed. The study is then developed by estimating the GWP, along with a number of other environmental impact categories, using data obtained from a number of Irish dairy processing plants. The data used includes details of volume of raw milk processed, production statistics, raw milk transportation to the plant, electrical and thermal energy usage, water consumption, packaging materials, cleaning chemicals, wastewater treatment and solid waste produced. The results of the two analyses are compared and discussed. The results of this study will serve as a benchmark for the Irish dairy industry as individual producers and processors can evaluate and compare their performance in comparison. The results of the current study may also be used as an international comparison for macro-scale studies.

Keywords: climate change, dairy, global warming potential, Ireland, life cycle assessment, milk processing

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Climate Change

A question of quality: Soil carbon sequestration in deep horizons of Irish grasslands

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Soil Organic Carbon (SOC) enhances soil fertility, improves aeration and water infiltration. Soils play a key role in carbon (C) sequestration. SOC models and inventories tend to focus on total SOC values in the top 30 cm of soils.. Association of C with microaggregates (53-250 µm) and silt & clay (<53 µm) is considered C sequestration because these fractions offer the greatest protection against mineralization. This study assessed the role of aggregation in C sequestration throughout the profile of 30 Irish grasslands. One kg sample was collected for each horizon, sieved at 8 mm and dried. Through a wet sieving procedure, four aggregate sizes were isolated: large macroaggregates (>2000 µm); macroaggregates (250-2000 µm); microaggregates and silt&clay. SOC associated with each aggregate fraction was analysed. Our results indicate that sampling at 30 cm only provides information on the labile C fraction in soil, disregarding the longer term C sequestration potential.Only when looking at the whole profile, two clear trends could be observed: 1) soils with a clay increase at depth had most of their C located in the silt & clay fractions, which indicates their enhanced C sequestration capacity, 2) free-draining soils had a bigger part of their SOC located in the macroaggregate fractions. These results indicate that current C inventories and models that focus on the top 30 cm do not accurately measure soil C sequestration potential in soils, but rather the more labile fraction. However, at depth, soil forming processes have been identified as a major factor influencing C sequestration potential in soils. This has a major impact in further quantifying and sustaining C sequestration into the future. Soils with a high sequestration potential at depth need to be managed to enhance the residence time to contribute to future off-setting of greenhouse gas emissions.

Keywords: carbon sequestration, soil, aggregates

Climate Change

Assessing organic carbon in Irish afforested mineral soils by soil-type, horizon, and depth

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Studies on forest soil organic carbon (SOC) storage, quality and dynamics are essential for understanding the role of forest soils in climate change mitigation. Six afforested sites (three Podzols and three Cambisols) aged ≥ 20 years, were sampled to c. 0.6 m depth. 127 mineral-soil samples were collected (with soil-horizon depth measurements). Individual samples were bulked by horizon (separately for each individual site), dried, sieved < 2mm, and milled. Any carbonate was removed before elemental analysis on CE440 Elemental CHN Analyser (Exeter Analytical Inc.). Concentrations (dry mass-percentages in fine-earth < 2mm) were normally distributed after natural-logarithm (ln) transformation. A significant negative linear relationship was found between ln(C%) and average horizon mid-depth. Although not statistically significant, Podzols showed higher C% than Cambisols. Significant differences appeared between surface (A) and subsurface (BC) horizons, with the average C% ranging from 4.43% (A-horizons), to 0.55% (BC-horizons). The C/N ratio (an indicator of soil-quality and SOC-turnover) showed a somewhat decreasing pattern from upper horizons (A & E) to B- and BC-horizons. A significant difference in C/N ratio was observed between the two soil-types. The results show the importance of assessing the differences in SOC concentrations and quality of different Irish forest mineral-soils, and their potential causes. The results also suggest that deeper soil-horizons should be included in soil studies/surveys, not only due to presence of SOC beyond 30 cm depth (although in lower concentrations), but also due to potential differences in SOC quality and turnover at greater depths.

Keywords: Soil organic carbon, afforested mineral-soil, climate change

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Climate Change

Economic sustainability of short rotation forestry in Ireland: a market survey

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Growing short-rotation woody crops is expected to increase in Ireland in response to both the increasing demand for fibre products and renewable fuel for energy targets. Forest policy is already promoting afforestation for fuel and fibre through targeted support measures. However, grants may not be enough to convince farmers to shift their land use to Short Rotation Forestry (SRF) in the absence of knowledge on real market opportunities and financial revenues for growers. A survey of the Irish wood processing and solid biofuel sector on market opportunities for SRF was carried out, with the aim of researching price paying potential, material requirements, market scale and infrastructure. A comprehensive database of wood-using industries including the energy, fibre and sawmills sectors throughout Ireland was developed. A total of 76 companies were identified and 30 of them were interviewed. Survey responses were classified and analysed using NVivo. Questions focused on the timber assortments, dimensions and other requirements for each sector, and on the prices they are willing to pay for the raw material. The range of raw material intake was from 400 to 650 000 tonnes per annum and the prices varied from €25 to €80 per cubic metre roadside for softwood, with price aligned with roundwood piece size but not quality. Preliminary results show a general tendency for users to first reject the suitability of SRF due to lack of knowledge. However, when some information was provided, the majority of companies showed interest and reassessed the potential of SRF as a raw material source. This survey will help to clarify the potential markets of Short Rotation Forestry in Ireland, aid in determining return on investment of SRF relative to other crops to growers and the economic sustainability of these crops, which is a key principle of sustainable forest management.

Keywords: Short Rotation Forestry, market survey, forest economic sustainability, wood energy market, fibre market, wood mills

Sustainable Land Use 1

Nutrient cycling in conifer forests in Ireland and implications of management and disturbance on their sustainability

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The services that forests provide such as fibre, fuel, water quality and climate mitigation depends on the long-term stability of their biogeochemical cycles. In semi-natural systems, nutrient cycling is relatively closed—most nutrients are cycled internally with little inputs or losses to the external environment. Nutrient cycling tends to optimize the limited pool of available nutrients and makes them available for tree nutrition. However, when cycles are disturbed—due to management activity or environmental causes, nutrient cycles can become open, with losses from the system. These in turn can take a long time to be regenerated. In Ireland, forests are predominantly located on thin, acid soils with limited nutrient and low fertility compared to agricultural areas. The sustainability of these forests depends on the maintenance of their nutrient cycles, which conserve nutrient resources. In this study we quantified the major fluxes and pools of nitrogen, phosphorus and potassium in a mature Sitka spruce (Picea sitchensis (Bong.) Carr) stand on a peaty-podzol soil in County Wicklow. We also used weekly observations of soil solution chemistry from below the forest floor and mineral soil to identify the processes controlling nutrient cycling at the plot.

Keywords: biogeochemical cycles, nitrogen, phosphorus, and potassium

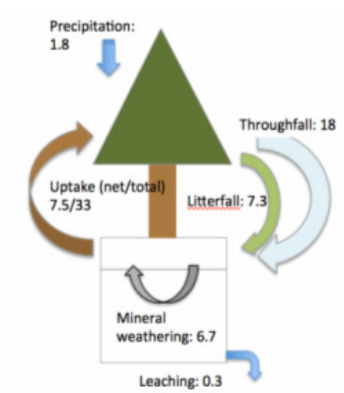

Figure: Simplified schematic of potassium cycle. All values in kg ha^{-1} year^{-1}

Sustainable Land Use 1

Temporal variation in heterotrophic respiration in afforested organo-mineral soils

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While considerable progress has been made over the last decade in our understanding of carbon cycling in Irish forests, research has not addressed soil carbon fluxes in organo-mineral soils. This project was carried out in eight first rotation Sitka spruce sites on organo-mineral soils with the following objective – (1) to measure heterotrophic soil respiration (R_H), (2) to investigate the relationship between RH and soil temperature and soil moisture content and (3) to derive carbon emission factors (EFs'). Total soil respiration was partitioned into R_H, the respiration from decomposition of soil organic matter and autotrophic respiration. This was achieved by inserting cylinders 30 cm into the soil thus severing roots. Litter was removed from the cylinders and further litter accumulation was prevented by means of a fine aluminium mesh. Seven cylinders were installed at each site. Heterotrophic respiration (R_H) was measured using a portable carbon dioxide analyser and a soil respiration chamber. Soil temperature (T_{SOIL}) and soil moisture content (SMC) were measured during each respiration measurement. The data were collected weekly over one year. Heterotrophic respiration was exponentially related to soil temperature and was linearly related to SMC at 5 cm depth. Maximum and minimum RH occurred when TSOIL was 15.9°C and 1.6°C respectively and maximum RH occurred when SMC was 0.38 m^3 m^{-3}. There was a clear seasonal trend in R_H following the change in SMC and T_{SOIL} with high values in summertime when SMC was low. Heterotrophic respiration reached a maximum of 12 g CO_2 m^{-2} day^{-1} during the summer as the soil became warmer and drier. The combined model of SMC and T_{SOIL} best explained the relationship between SMC, T_{SOIL} and R_H with improved R^2s' at each site compared to the univariate models. Inter site values for annual EFs' ranged from 0.9 to 2.4 kg CO_2 m^{-2}.

Keywords: afforestation, heterotrophic soil respiration, organo-mineral soils, emission factors

Sustainable Land Use 1

Nutrient exchanges under increased forest biomass harvesting

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Biomass harvesting in forests, where branches are removed in addition to the main stem, is expected to increase, supplying fuel to large combustion plants. Branches and foliage have higher nutrient content than does stem timber, so it is expected that biomass harvesting will remove more nutrients from forest sites than is usual at present. Whether this removal can impact on site nutrient availability in the long term requires much information that has not been available to forest managers. Site nutrient supply can be managed using fertilizers, and rock phosphate is widely used for this purpose. In addition, unmanaged nutrient sources supply essential nutrient elements. These sources are atmospheric deposition and mineral weathering. Organic-matter decomposition may be considered a further source, or can be assumed not to represent any long-term exchange. Nutrients are removed from the site in harvested materials, and in liquid loss as runoff and percolation. The ForSite project introduces a new concept, Critical Biomass Removal, the amount of long-term biomass removal below which impacts to site nutrient supply will not occur, according to current knowledge. Where outputs exceed inputs, it is expected that long-term nutrient supply will be impacted. Critical biomass removal is set at the level where long-term inputs equal outputs. Map datasets are presented of nutrient exchanges in deposition, mineral weathering, and liquid losses. Deposition from the atmosphere is a significant source of nitrogen, calcium, magnesium and potassium. Mineral weathering is a variable source of calcium, magnesium and potassium. Leaching losses are important when determining site nutrient supply. A calculator tool is proposed for assessing site nutrient balance and critical biomass removal for site types. Management prescriptions for individual sites will not be given, but comparison will allow better understanding of contributors to nutrient supply, the effect of increased biomass removals, and of potential policy and management approaches to allow sustainable resource use.

Keywords: ForSite; critical biomass removal; atmospheric deposition; mineral weathering; whole-tree harvest; stem-only harvest; nutrients

Sustainable Land Use 1

Influence of different rates of inorganic phosphorus fertilizer on soil biological properties in a soil-biota system

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Increases in world food production and fertilizer applications to soils are closely connected. However, intensive use of inorganic fertilizers can lead to poor soil quality and environmental pollution. For instance, excessive phosphorus (P) application can induce eutrophication in surface waters. P plays vital roles in many metabolic processes in plants but its primary source rock phosphate is finite. Consequently, the development of more P efficient agricultural systems is paramount. P cycling within the microbial biomass is essential to the P cycle within the soil with its key pathways for P mobilization and mineralization from various soil pools into plant available forms. In this study, soil columns were setup in a greenhouse using a P deficient soil (P index 1) collected from Moorestown Cahir (County Tipperary). The columns were planted with *Lolium perenne* and fertilized with 0, 5, 10 and 20 kg/ha inorganic P alongside a full complement of other nutrients. Results after 14 weeks of management show a significant increase in alkaline and acid phosphatase activities but no effect on the grass dry matter, bacterial abundance of heterotrophs, phosphonate, phytate and calcium-phosphate utilizing bacteria upon P fertilization. The highest P treatment had significantly lower hyphal and arbuscular mycorrhizal colonization rates, nematode abundance, enrichment index, and percentage of colonizer-persister (CP) class 1 nematodes while the maturity index and CP class 2 nematodes increased with P application. Overall, our results show that the expected effect of the P application on some of the parameters may have been masked by the low P status of the soil. Further analyses are underway to trace the fate of the applied P, bacterial diversity and function. Studies like ours are important to feed data into mathematical models on biotic P cycling.

Keywords: Phosphorus Fertilizer, Microbial Biomass, Nematodes, Bacterial Diversity

Taping into phosphorus reserves in Irish grassland soils

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Phosphorus (P) is a finite resource but an essential nutrient for global food production. P demand has been increasing over the years driven by a growing requirement for global food supply and economic targets in the agro-food sector. Due to increasing costs and intensification of P use in the non-food sector, there is now a downward trend across Europe in the application of P as fertilizer. Optimizing soil P efficiency is becoming essential for farmers and soil P reserves are being targeted as complementary source of P. As part of a national study to assess soil quality in Ireland, P resources were evaluated in 31 grassland sites under intensive and extensive management regimes. Labile and fixed P pools were characterized following P sequential fractionation procedure (Hedley et al. 1982), extracting P from soil according with its speciation and availability. Results, from the first 16 grassland sites analysed so far, show that labile P represents 7.6% of the total P in the soil, covering 4.2% of inorganic and 3.4% of organic P. Hedley's fractions (NaOH-P, NaOHsn-P, HCl-P and residual P) described as unavailable P fractions for plant uptake, represent about 90% of the soil total P. Proportions of inorganic and organic P (27.6% and 30.9%, respectively) show that organic P pool greatly contributes to the total soil P. Evaluation of P fractions indicate that Irish grassland soil contain significant amounts of unavailable P however current plant P uptake rates suggest that part of these P reserves are not been used for plant production. Soil P reserves may hold the potential to become plant available, minimizing P fertilizers inputs and ultimately reducing costs with soil fertilization and improving soil P efficiency. To use P reserves as a complementary source of P further research targeting organic P turnover will be assessed.

Keywords: P reserves; grassland; P sequential fractionation; inorganic and organic P soil pools

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Sustainable Land Use 1

Review of fat, oil and grease (fog) waste utilisation trends

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Fat, Oil and Grease (FOG) is a by-product from food processing sites, food service outlets (FSO's) and domestic dwellings. Upon entering the sewers FOG waste can accumulate with other non-flushables, such as wet wipes, to form 'fatbergs'. A well-publicised example is a 15 tonne London fatberg in 2013. Up to 75% of sewer blockages are caused by the incorrect disposal of FOG waste into the sewer network. The objective of this project is to evaluate the potential to upcycle this waste stream into viable resource opportunities through the management of FOG waste in Ireland. The Dublin FOG programme has set the benchmark in FOG management internationally since 2008. This programme requires FSO's to install grease trapping systems (GTS's). GTS's prevent FOG waste from entering sewers, retained in the form of grease trap waste (GTW). It is estimated that with proper FOG management a city the size of Dublin, with approximately 2200 FSOs, could divert 1.9 million litres of GTW from the sewers annually. The available disposal routes are dependent on the GTS. Passive GTS, which operate through gravitational separation of the FOG waste from wastewater, range from 100L to >5000L grease capacity. Due to the high volume and water content this GTW can be dewatered and utilised as a co-substrate in anaerobic digestion to produce biomethane. Mechanical GTS, which are smaller in size, skim the FOG layer daily and are maintained in-house. FOG skimmed from mechanical GTS has similar attributes to waste cooking oil, which has a biodiesel conversion rate of 95%. About 65% of this GTW stream is exported to the UK/Europe for further processing. With the right development this waste stream can be recovered and utilised nationally, therefore protecting the ecosystem by preventing pollution, thus aligning with the conference theme. Project details are available at http://ssu.ie/research/fog.

Keywords: FOG Waste, Grease Trap, Waste Management, Bioenergy Potential.

Using the red mud by-product as a source of critical raw materials

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Major parts of the world economy are confronted with an increasing supply risk of critical raw materials, which can be defined as materials with above average economic importance and supply risk. The latter is mainly caused by the fact that reserves of critical raw materials are unequally distributed, so that single countries can produce a vast majority of one raw material (for instance 97% of all rare earth elements in 2009 were produced by China). One approach to tackle this supply risk is the exploitation of secondary sources of critical materials in the frame of urban mining, for instance by extracting incineration ashes, demolition or e-wastes. One so far untapped secondary resource for critical raw materials are so called red mud, the highly alkaline residues of the Bayer process applied in aluminium refining from Bauxite. Bauxite consists mostly of aluminium hydroxy-oxides, different iron oxides and clay minerals and can contain further elements as impurities. For instance, the red mud in Ireland contained several economically interesting elements (Ni, Zn), but also critical raw materials Ce, Ga and La. Considering that the global storage of red mud is currently estimated to be over 2.7 billion tons, with an annual growth rate of approximately 120 million tons, the recovery potential for rare earth and other critical raw materials is considerate. A sufficiently detailed inventory that would allow to reliably assess the potential for critical raw materials extraction from Irish red mud is not existing to date. Therefore, this project aims at forming a solid base on critical material content of red mud to evaluate economic potential of element recovery. In addition, recent study includes a comparison of Irish red mud with red muds from different origin in Europe. Furthermore, the project aims at proofing the feasibility of (bio) leaching for selective element recovery.

Keywords: red mud, critical raw materials, recovery, leaching

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Water Quality And Resources 2

Biogas from slaughterhouse waste in Ireland: Assessment of potential energy recovery pathways

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This study investigates the potential energy recovery from the anaerobic digestion (AD) of slaughterhouse waste in Ireland. The research was approached on two fronts; laboratory scale evaluation of methane production of the industrial waste streams from cattle, pig and chicken slaughtering facilities and a life cycle assessment (LCA) and energy balance to assess the potential utilisation pathways. Of the individual waste streams tested, offals resulted in the highest methane yields ranging between 650.9 - 501.1 $mLCH_4$ gVS^{-1}. Mandatory pasteurisation applied to the offals under the animal by-products regulations did not result in an increase in methane yield, however it did increase the bioavailability of the organics causing acute long chain fatty acid (LCFA) inhibition. Methane yields achieved from the combined waste streams increased when compared to digesting one tonne of the mixture in its individual components. A stabilising effect was also seen from mixing individual waste streams from the chicken and pig slaughtering facilities, with LCFA inhibition being reduced when compared to the respective pasteurised offals. The potential energy recovery from the AD of the combined slaughterhouse waste streams through a CHP unit and upgrading to biomethane for use as a transport fuel was assessed in terms of environmental savings as well as potential energy production. Both utilisation pathways investigated proved to be sustainable renewable energy pathways indicated by an energy return on investment > 1 as well as providing substantial environmental benefits in nearly all of the impact categories considered in the LCA. The optimal utilisation pathway derived from the LCA and energy balance lies firmly in the viewpoint taken of the reader; with CHP presenting as the optimum pathway for a present day short term localised viewpoint and the transport scenario offering a sounder solution for a future perspective considering a larger scale.

Keywords: anaerobic digestion, biogas, organic waste streams

Pathogen survival in farm-based anaerobic digestion

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Development of farm-based anaerobic digestion (AD) in Ireland has been limited to date, but offers significant potential as a means of organic waste management, biogas production, rural job creation and farm waste sanitation. AD is a natural process whereby multi-species microbial communities convert complex organic matter to methane (biogas). Manure, slurry and food waste can be used as AD feedstock on farms but may however contain a range of infectious bacteria, viruses and parasites, thus potentially posing a risk of pathogen transfer between farms, as well as to the environment. Preliminary evidence suggests that certain pathogens can be inactivated during the AD process, allowing for a lower risk organic fertilizer than currently used untreated slurry and/or manure. However the survivability of pathogens during AD needs to be further investigated in order to accurately assess the risks posed with this waste management strategy.

The overall aim of this project is therefore to examine the comparative risks to public and animal health associated with spreading digestate versus unprocessed manure and/or slurry. The first step will be to determine the survival of a variety of specific and representative pathogenic organisms during the AD process. Replicated reduced-scale AD bioreactors mimicking farm-based AD plants in Ireland will be established in order to examine the fate of target pathogens during the process. The impact of feedstock composition, process configuration as well as pre- and post- pasteurisation on pathogen survival will also be determined. Finally, a range of AD digestates generated under the different conditions investigated will be applied to land in controlled field trials to compare the survival and leaching of pathogens to that when slurry and manure are employed. The results of this research will contribute significantly to Irish AD policy and development at this critical juncture.

Keywords: anaerobic digestion, pathogens, policy

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Water Quality And Resources 2

Are building contractors paying to dispose of air? An assessment of the level of void space present in construction waste skips in the west of Ireland

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Previous studies carried out in the UK have found that construction waste skips can contain void space of anywhere between 25 and 70 % depending on the type of material present in the skip. If this is applied to a standard 9.2m3 skip costing €277 then the costs could range from €69.25 to €193.90. A mixed methods approach was adopted using three different methods to assess the void space (also known as a bulking factor) of waste skips within the Irish construction industry; (1) Skips were assessed with two building contractors; one was a large multinational contractor and the second was an SME building contractor. (2) Skips were assessed at two waste transfer stations in the West of Ireland on four separate days. (3) Two skips were emptied and refilled on different case study sites in order to assess the level to which the void could be reduced on site. The current waste management procedures were benchmarked on site with a focus on the level of void space present in each skip and findings show that the average void space per skip was 25.97 % with an average cost of €64.83 per skip. The level of void space present can be broken down into mixed waste skips (24.83 % for 236 waste skips); timber waste skips (30.09 % for 43 waste skips); metal waste skips (32.60 % for 10 waste skips); and 'other' waste skips (28.19 % for 12 waste skips). Key performance indicators were also calculated for the case study sites which show that void space can cost between €0.12 and €2.82 per m2 of floor area of a project or between 0.44 and 9.16 % of the project profit. Findings suggest that reducing the void space in waste skips on site provides scope for the contractor to increase profit margins and reduce waste management costs.

Keywords: Void space, bulking factor, case study, construction sector, waste management.

Rethinking the construction supply chain and its role in a circular economy

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The circular economy is one that is restorative by design with the aim of keeping products, components and materials at their highest utility and value at all times. This concept has evolved from and been influenced by ideas emerging from regenerative design, the cradle to cradle approach, industrial ecology and symbiosis, biomimicry, designing out waste and the performance economy. A key component in the circular economy is the reconceptualization of waste as a resource where products and components are intentionally designed to fit within biological or technical material cycles. This will require a paradigm shift away from the traditional linear extract-consume-dispose model to a more circular system of reuse, recycling and disassembly. In addition, a particular focus on prevention and lifecycle assessment provides a framework to evaluate opportunities across the full supply chain. The construction sector has traditionally maximised this linear approach through: extensive raw material extraction; the manufacture of building materials and components; the construction and use of infrastructure and buildings; the demolition and subsequent disposal of construction and demolition waste. Within this context, a detailed review of waste prevention and material loop practices were examined on nine selected case studies ranging from small-scale demolition works to large-scale healthcare and educational projects. It was found that although waste prevention was not a design priority, design-phase decisions (construction methods and materials selection) did have a significant impact on reducing waste production throughout the construction phase and that apart from inconsistent take-back scheme arrangements with building suppliers, most of the non-inert C&D W that was generated during the construction phase ended up being down-cycled through off-site processing into open material loops. It is proposed that considerable opportunities do exist within the construction sector to move away from these traditional linear approaches towards a more resource efficient and sustainable materials management approach.

Keywords: circular economy, construction and demolition waste, construction waste prevention, resource efficiency, case studies.

Tertiary treatment technologies for water reuse and rainwater harvesting in the Irish dairy industry

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The Irish dairy sector processes approximately five billion litres of milk annually and is Ireland's largest growing indigenous industry with exports reaching a record €3 billion in 2013. Water consumption ratios within the sector are significant with approximately 2.5m^3/m^3 of milk processed and 14.9 m^3/tonne product. Aside from product manufacturing, water is used for other activities such as steam generation and cleaning of internal piping, floors and workplace areas thus vast quantities of liquid waste is produced. Fieldwork surveys at several Irish dairy plants have revealed that the majority of this liquid waste is not reused within the plant. While this water would not be recycled for purposes pertaining to the raw product, the potential for its reuse in heating/cooling systems, truck washes and cleaning external plant areas is a viable option. In addition, legislation regarding the discharge limitations of dairy wastewater effluent is becoming increasingly stringent with survey feedback indicating the potential for an introduction of microbiological parameters in the near future. The use of tertiary treatment systems, in particular ultraviolet irradiation (UV) may play a dual role of acting as an end-point effluent treatment system as well as a disinfection system to restore dairy wastewater to reusable standards within dairy plants. This study attempts to address those themes by investigating a novel pulsed UV (PUV) system for enhanced germicidal properties in comparison to domestic continuous low-pressure UV systems. The impact of typical dairy wastewater parameters such as suspended solids and organic carbon on system efficiency will be evaluated. Furthermore, pathogenic bacterial strains of interest to the dairy sector will also be subjected to UV trials as well as highly resistant bacterial endospores to confirm the capacity of PUV disinfection. Finally, the potential for on-site rainwater harvesting at dairy plants will also be investigated.

Keywords: Ultraviolet irradiation, disinfection, water, reuse

Water Quality And Resources 2

Comparison of the contribution of carbon from aquatic buffer zones of alternative vegetation types to the diet of selected macroinvertebrate feeding groups

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The riparian zone is the area adjacent to a water body and marks the interface between aquatic and terrestrial habitats. Human impacts on the vegetation of the riparian zone may influence the structure and functioning of stream biota. Conifer plantations were in the past, planted to the edge of streams and rivers, impacting stream biota through changes to allochthonous carbon inputs. To combat the potential impacts of forestry on adjacent streams, the Forest Service introduced, stipulating the establishment of aquatic buffer zones (ABZ) (10–25m) at the time of initial planting or reforestation. To investigate whether the vegetation present in the ABZ influences the provision of terrestrial carbon to the aquatic community, streams with four distinct vegetation types in the ABZ were sampled, i.e. (1) ABZs dominated by scrub, (2) ABZs dominated by grassland, (3) sites with no forestry and (4) sites with conifers to the streams edge. Within each type, three streams were sampled, including the collection of plants from the riparian and aquatic zone along with aquatic macroinvertebrates from each of the feeding guilds (shredders, detritus feeders, grazers, predators and filter feeders). The vegetation and invertebrate samples were analysed for stable isotopes of carbon and nitrogen. The ratio of carbon 13 to 12 ($\delta^{13}C$) varies little between a consumer and its food source. Thus, if the $\delta^{13}C$ of all sources are known, the contribution of each to the consumer can be determined. Results for this study identified significant differences in the $\delta^{13}C$ of macroinvertebrates from streams with different vegetation types. However, high variability in the $\delta^{13}C$ of periphyton prevented accurate determine the percentage contribution of terrestrial carbon. The periphyton from streams with scrub vegetation in the ABZ or with conifers planted to the stream edge closely resembled terrestrial carbon sources, indicating greater quantities of allochthonous detritus may be entrained by the algal matrix. This may form an important part of the food web. Implications for riparian zone management are also discussed.

Keywords: Conifer plantation, Stable isotope, Feeding guilds

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Water Quality And Resources 2

Nitrogen and phosphorus removal in modified pyrite-based autotrophic denitrification biofilters

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In this study, simultaneous removal of nitrogen (NO^{3-}-N) and phosphorus (PO_4^{3-}-P) from synthetic secondary municipal effluent by biofilters added with thermally modified pyrite (MPy) as the biofilm substratum, which has submicron particle sizes and a porous polycrystalline structure, was investigated. The N and P removal performance in the MPy-based autotrophic denitrifying biofilters was assessed at various hydraulic retention time (HRT) ranging from 5 to12 h. The biofilm was recovered quickly when the HRT was reduced, and low effluent NO_3^--N (<1 mg/L) and PO_4^{3-}-P (<0.1 mg/L) concentrations were achieved at the HRT of 5 h. The low HRT and the low concentrations of N and P would make this technology more applicable than biofilters applied with natural iron sulfides as the biofilm substratum, which have a HRT of longer than 12 h. A half-order reaction model can be used to describe total oxidized nitrogen (TON, NO_3^--N+ NO_2^--N) profile along MPy biofilters. The TON removal rate was up to 134 mg N/(L•d) and PO_4^{3-}-P removal rate was 78 mg P/(L•d) in MPy biofilters. These results indicate that MPy biofilters can be used as an efficient technology to reduce NO_3-N and PO_4^{3-}-P in secondary municipal effluent to very low levels to meet strict discharge standards in the future.

Keywords: autotrophic denitrification, iron sulfides, nitrate removal, phosphorus removal, secondary effluent

The quantitative analysis of lithium in ground and surface water of Co. Carlow Ireland

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The Blackstairs Mountains, which straddle the borders of Co. Carlow and Wexford, are rich with rare deposits of the mineral spodumene, an important and valuable source of lithium. Lithium is a desirable resource, its availability is fundamental to the future of fossil-fuel-free electric cars, i.e. lithium-ion batteries. The advent of new light-weight lithium batteries which are much more efficient than traditional ones is about to change the global battery industry and create a new market for this natural resource. This study posed the question; does the water washing off the Blackstairs mountains down into Carlow's ground and surface water contain elevated amounts of lithium? Lithium has a high affinity for water, therefore it might be reasonable to assume that Carlow's water would be full of dissolved lithium. Spodumene is an aluminosilicate very resistant to weathering, as determined in our study. According to Hem, 1992, the average amount of lithium found in natural water is between 1 and 10 ppb. The current study has revealed that there is indeed 1-10ppb of lithium in Carlow's water; although it is not evenly distributed across the county with anomalous spikes in areas. Water samples were taken in Carlow via five sampling transects across the county in a NW-SE direction. Ninety ground-water samples were collected from private wells along the sampling lines and thirty-five surface-water samples were collected from points where rivers intersected these sampling lines. Each point was sampled four times over the period from March to September 2015. The lithium concentration of each sample was analysed, in addition to three other metals iron, manganese and zinc. Subsequently, a geochemical map of Carlow's water was created indicating the distribution of all four metals. Although metal analysis in water is common practice, lithium is an often excluded from these studies. With a wealth of mineral deposits undiscovered throughout Ireland, the geochemistry of lithium needs some attention.

Keywords: Lithium, Water chemistry, Environment, Natural resources.

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Water Quality And Resources 2

Waterborne outbreak of cryptosporidiosis – An economic assessment

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In 2007, a waterborne outbreak of *Cryptosporidium hominis* occurred in the West of Ireland. A boil water notice was in place for 158 days affecting over 120,000 people residing in the area as well as businesses, visitors and commuters. We describe the economic impact of this outbreak on those directly affected, and on the wider community. The economic impact was estimated using microsimulation techniques to overcome data limitations. The costs have a multi-level structure. Direct costs include medical and healthcare costs, cost of provision of alternative water and response costs, while indirect costs include loss of income, loss of business and productivity loss among others. The data utilised in this analysis came from different sources and where the data was unavailable or did not exist, assumptions were made in line with best practice. The ratio of the outbreak cost and the cost of enhanced protection of this supply that would have been sufficient to prevent this outbreak on a "what if" basis was also examined. The overall cost is estimated at €19 million or greater (equal to €120,000 per day of the outbreak). The estimated cost to households in the affected area is approximately €3.6 million. This translates into an average cost of approximately €87 per household (or €0.55 per household per day of the outbreak) in the boil water notice zone during the 158 days the boil water notice was in effect. The cost of enhanced protection was estimated based on the cost of the remedial work performed after the outbreak. The cost of the outbreak was higher than the cost of those measures which could have prevented the outbreak at a ratio of 11:1. This highlights the economic benefits of investing in safe drinking water supplies and water treatment enhancement.

Keywords: Cryptosporidium, waterborne infection, economics

Water Quality And Resources 2

Localising and assessing groundwater discharge to lakes using natural environmental tracers

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Nearly all surface water features interact with groundwater which means that pollution of surface water features can cause deterioration in groundwater quality and conversely, contamination of groundwater can degrade surface water systems. Groundwater-surface water interactions therefore may significantly impact surface water chemistry, water quality, biology and ecology and recent studies identify groundwater inputs as one of the main drivers of eutrophication in lakes. Despite acknowledgement of its potential impact, groundwater discharge and associated nutrient loading to lakes remains a poorly-understood and often overlooked process particularly when implementing water monitoring and management programs. This is because groundwater discharge is spatially and temporally heterogeneous which renders locating and quantifying groundwater inputs an extremely difficult task.

Here we present a comprehensive and cost-effective approach, combining two natural environmental tracers of groundwater; heat and radon, as an appropriate and powerful means to both qualitatively and quantitatively assess groundwater-surface water interactions. The approach is demonstrated for three lakes situated in the Irish midlands. Surface water temperature patterns generated from Landsat thermal images were used to locate groundwater inputs captured as anomalous cold plumes visibly emanating from lake margins during summer months. Continuous surveys of radon-222 were used subsequently to: (i) confirm the presence of groundwater, (ii) detect localised seepage points (groundwater "hotspots") and (iii) quantify total groundwater inputs. This information when combined with ancillary spatial datasets describing catchment characteristics, allows the development of simple conceptual flow models of how groundwater interacts with lakes. This information is important and can be used in support of national water policy and legislation by helping to identify for example, lakes at risk of failure to comply with Water Framework Directive (2000/60/EC) water quality objectives particularly where mapped inputs are linked to groundwater bodies classified as less than good status as per the requirements of the Groundwater Directive (2006/118/EC). Evaluating the potential occurrence and understanding where groundwater discharge occurs is the first step towards more in-depth geochemical surveys that seek to clarify the role played by groundwater in lacustrine biogeochemical budgets.

Keywords: groundwater discharge, lakes, remote sensing, Landsat, temperature, radon

Marine And Costal 2

Exploring the culture of cooperation in Indo-Sri Lankan shared waters

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The world's oceans, rivers, lakes, and groundwater systems span natural boundaries and political borders. Transboundary waters are some of the most economically important, highly stressed, and humanly populated areas on earth. Transboundary cooperation over river and lakes has a long history; the same cannot be reported for marine waters. This paper aims to address a major gap in the literature in terms of the role played by culture and context in complex transboundary marine jurisdictions and in knowledge of how best to conduct transboundary participation to resolve issues around marine environmental degradation or to address sustainable economic development in our oceans. The focus of this research is on specific mechanisms that are used in two South Asian countries in attempts to resolve multi-faceted issues through the engagement of relevant marine stakeholders in dialogue that spans administrative, geographical and cultural borders. Based on extensive ethnographic fieldwork and qualitative semi-structured interviews with representatives from industry, academia, government, and non-governmental organisations on both sides of Palk Bay, this research examines a highly contentious maritime border that separates the southern Indian state of Tamil Nadu and the Northern Province of the island nation of Sri Lanka in the southern part of the Bay of Bengal, in the Indian Ocean. Fishing conflicts in these Indo-Sri Lankan waters have progressively increased in the past decade resulting in the arrest, detention and even death of Tamil Nadu fishermen. The abundant fishing resource on the Sri Lankan side of the maritime boundary, became highly disputed between Tamil Nadu fishermen and the Sri Lanka Navy during the years of, and subsequent to, the ethnic conflict from 1983-2009. The indiscriminate expansion of the Indian trawler capacity is frequently attributed as the fundamental source of the transboundary conflict which is characterised by illegal trawling on an unprecedented scale by Sri Lanka's powerful and closest neighbour.

Keywords: marine transboundary waters, stakeholders, fishing conflicts

Marine And Costal 2

Bioremediation of tributyltin: Isolate screening and gas chromatography-mass spectrometric method development

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Tributyltin (TBT), a biocide used in marine antifouling paint, is the most toxic compound ever knowingly introduced into the marine environment. Although a global ban on the use of TBT has been enforced since January 2008 (International Maritime Organisation), impacted organisms have not recovered, and levels in affected waters still exceed the environmental quality target of 0.2 ngl-1 set by the EPA. In the marine environment, TBT binds to suspended material and deposits in benthic sediments. In these anoxic conditions, TBT bioavailability is reduced and it can persist unaltered for decades. In addition to environmental damage caused by TBT in the marine environment, concern is also raised for the safety of groundwater systems when contaminated dredged sediments from harbours and estuaries requires disposal primarily in landfill. In the current study, the microbial biodegradation of TBT into the less toxic species, monobutyltin (MBT) and dibutyltin (DBT) in contaminated sediment was investigated. Microorganisms were isolated from sediment and soil from TBT-contaminated sites, at Haulbowline harbour and a boatyard on Dinish Island, Co. Cork. Growth assays were used to determine the suitability of the isolated strains to degrade TBT, and also TBT resistance and ability to utilise TBT as a sole carbon source. Successful candidate microorganisms were inoculated individually into triplicate TBT-contaminated assays which were incubated at 28°C for 21 days. Liquid samples were withdrawn on days 0, 14 and 21 and analysed by gas chromatography-mass spectrometry (GC-MS) for the identification and quantification of TBT, MBT and DBT. The analysis of organotin compounds consists of four steps: extraction, formation of volatile derivative, separation, detection and quantification. Results revealed that 12% of microorganisms isolated from sediment and soil samples had the ability to breakdown TBT to its less toxic species, at concentrations much greater than at any reported contaminated site.

Keywords: tributyltin, microorganisms, gas chromatography

Marine And Costal 2

Impact of intertidal oyster trestle cultivation on the ecological status of benthic habitats

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A considerable number of Ireland's shellfish production areas co-occur with or are adjacent to Natura 2000 sites which are protected under European legislation. To investigate the general interaction between trestle oyster cultivation and the surrounding intertidal environment, six sites were selected within designated Natura 2000 sites. At each trestle site three treatment areas were sampled. One treatment area corresponded to potential impacts associated with cultivation activities occurring at trestle structures (designated the Trestle Treatment), while one treatment area corresponded to potential impacts due to cultivation activities occurring along access routes (the Access Treatment). An area not subject to any known anthropogenic activity was used as a control (the Control Treatment). Potential impacts associated with Trestle Treatment areas included changes in sediment total organic matter (TOM) levels underneath trestles due to the bio-deposition of faecal/pseudofaecal material while the predominant impact associated with Access Treatment areas was compaction of sediments due to heavy vehicle traffic. In this study, macrobenthic communities at the sites were highly variable and exhibited low levels of diversity, which prevented the detection of general effects of cultivation activity on community structure, diversity and secondary production. To overcome this variability, the Infaunal Quality Index (IQI) was used to assess impacts on Ecological Status (ES) of benthic communities (sensu Water Framework Directive). Relative to Control and Trestle Treatment areas, activities occurring at Access Treatment areas had a significant negative impact on ES. This study highlights the potential of the IQI for the management of aquaculture activity and provides validation for the use of the IQI in Irish intertidal environments. This study also highlights the IQI as a potential tool for assessing the conservation status of designated habitats in Natura 2000 sites.

Keywords: Intertidal Oyster Cultivation; Ecological Impact; Macrobenthic Community Composition; Biomass and Secondary Production; Ecological Status Assessment; Infaunal Quality Index (IQI)

Commercial and experimental scale IMTA research

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Integrated Multi-trophic Aquaculture (IMTA) combines, in the appropriate proportions, the cultivation of fed aquaculture species (e.g. finfish/shrimp) with organic (e.g. bivalve molluscs) and inorganic extractive species (e.g. seaweed). IMTA incorporates species from different trophic positions or nutritional levels in the same system. This method of cultivation allows for the fed aquaculture species' uneaten feed, waste, nutrients, and by-products to be recaptured and converted into feed, fertilizer, and energy for the other crops. The potential of commercial IMTA in an Irish context was assessed as part of the IDREEM (Increasing Industrial Resource Efficiency in European Mariculture - http://www.idreem.eu/cms/about-project/) project, an FP7 project that aims to investigate the implementation of IMTA systems for different habitats in Europe. Work has also been conducted at an experimental scale through the use of maraponics. Maraponics merges the principles of hydroponics (a well-established concept for producing plants in a soilless, organically enriched aquatic medium) and IMTA and was utilised to identify a compatible suite of plant and animal species to fill each of the trophic levels of an IMTA system. Water quality and growth rates of seaweeds, mussels, sea cucumbers, Japanese abalone, and purple sea urchins were monitored in three recirculation maraponic systems in two trials (Trial 1 - December 2014/January 2015 and Trial 2 – June/July 2015). Pre- and post-trial 1 samples of all species and the system's feed components were collected for fatty acid analysis to track the flow of energy through the system.

Keywords: IMTA, maraponics, IDREEM

An investigation into elemental concentrations and distributions in shallow water sediments in Dunmanus Bay, Ireland

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In marine and coastal environments, detailed geochemical mapping of the seafloor is important as this data can contribute to future planning in a diversity of areas such as coastal mapping, flooding prediction, marine habitats and fisheries, climate change, environmental protection and policy. Here we map the concentration and distribution patterns of a number of major elements (Ca, Fe, Ti, Sr) and trace elements (Ba, Mn, Zr, Sc, Rb) in Dunmanus Bay, Co. Cork. A recent publication funded by the INFOMAR project has shown that the bay contains areas of methane seepage and an objective of the project is to elucidate any differences in elemental composition influenced by this fluid flow. The seepage appears to have resulted in the formation of small pockmarks on the seafloor that are similar in appearance to lunar pockmarks that we are familiar with and are thought to form from active gas seepage. Twenty-two surficial sediments were collected throughout the bay, both within and outside the pockmark field, during a sampling expedition in 2009. Particle size analysis (PSA) and field-portable x-ray fluorescence (FP-XRF) were used to assess sediment samples and determine element concentrations. The concentration and spatial distribution patterns of both major and trace elements showed that all were associated with all sediment types both within and outside the pockmark regions. The concentration of Fe, Ti and Ba were broadly similar to soil levels found in the surrounding landmass. Ca concentrations were high throughout the bay, suggesting a large biogenic influence in the sediment. Sr followed similar trends to Ca. Mn was lower in the surficial sediments compared to regional soil concentration. Overall statistical analysis indicated that there was no significant difference between median concentrations in the pockmark field and the rest of the bay for Ca, Ti, Ba and Zr, but a significant difference was observed between the two areas for Fe, Sr, Mn, Sc and Rb.

Keywords: marine, sediment, pockmark, elemental composition

Marine And Costal 2

Does release from enemies facilitate the invasion success of a barnacle species?

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Within their new ranges, invasive species escape the effects of predators and pathogens, which are present in their native distribution. This is termed the enemy release hypothesis (ERH) and has been attributed to the success of invasive species at new locations. These successful invaders pose a major threat to native biodiversity and ecosystem structure and function. Although ERH has been well documented, there have been few studies actually examining the role it plays in the invasion process. The Australasian barnacle species *Austrominius modestus* has been present in Europe since the 1940s and it is now widespread on European coasts. Parasites play an important role in intertidal marine communities. They may alter ecosystem function, by changing a host's physiological functions, population dynamics and community structure. During this study, levels of parasitism of *A. modestus* and a local barnacle species were compared at three distinct geographical locations (Scotland, Ireland and Portugal) representing the northern, western and southern limits of the invaded rage of this species, over an eighteen month period. Sampling was carried out on a monthly basis in Ireland and biannually in Scotland and Portugal. There were fluctuations in the intensity and prevalence of infection throughout the study period, but overall the local barnacle species had a higher level of infection than *A. modestus.* Highest levels of infection were recorded in Scotland, followed by Ireland and no infection was recorded in Portugal. Interestingly, at the northern and southern sampling locations, *A. modestus* remains significantly less abundant than native barnacle species, despite being either free of parasites, or experiencing lower levels of parasitism than native species. This indicates, that although it may play a role in invasion by *A. modestus*, enemy release is not a key factor in the successful establishment of this species.

Keywords: Enemy release hypothesis, barnacle, Austrominius modestus, invasion ecology

Environment And Human Health 2

The effect of different resting water depths on schmutzdecke development and treatment performance in biosand filters

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Biosand filters (BSFs), domestic scale slow sand filters, have been identified as both a reliable and efficient method to treat drinking water for people who remain without access to a safe drinking water supply. A unique design feature of BSFs is the height of the outlet pipe, which ensures water remains on top of the sand column during the filter resting period, i.e. the period during which there is no discharge from the filter. In combination with a diffuser plate, the resting water depth should dissipate the initial force of the water during filter recharge, in order to avoid biolayer disturbance. The resting water level must also provide the biolayer or schmutzdecke with nutrients and maintain a saturated environment during the resting period. While the resting water depth commonly used in BSFs is 5 cm, a number of studies have observed resting water depths to range from 2 to 7 cm. This study investigated the effect of varying resting water depths on the development of schmutzdecke and filter treatment performance. Bench-scale filters (n=4) were used in the study, with resting water depths of 2, 5, 8 and 11 cm. A series of biological and physiochemical parameters were measured over the 119 days of the experiment. The results of the study indicated that while schmutzdecke disturbance was observed in filters with lower resting water depths during filter recharge; a reduced filter performance was not observed. Ultimately, optimizing the operating conditions of BSFs will maximise the treatment efficiency and provide improved drinking water quality for users, thereby reducing the adverse health effects associated with the consumption of unsafe drinking water supplies.

Keywords: Biosand Filter (BSF), Point-of-use (POU) water treatment, domestic drinking water treatment, resting water depth.

Environment And Human Health 2

Plasmid mediated colistin resistance encoding gene *mcr-1* not detected In Irish *E. coli*

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The plasmid-mediated colistin resistance gene, *mcr-1*, was first described in November 2015 by Liu et al in *E. coli* isolated from food, animals and humans. Colistin resistance is a major cause for concern as it is one of the very few antimicrobial agents available for treatment of infection associated with carbapenemase producing *Enterobacteriaceae*. Subsequently, others have isolates *E. coli* harbouring *mcr-1* from meat and human specimens, as well as in *Salmonella* Typhimurium isolated from food samples. Prior to these findings, colistin resistance was found to be mediated by mutations in chromosomally encoded genes and the dissemination of such resistance required the spread of carrier organisms. Whole genome sequences of 96 *E. coli* isolates collected from retail meats in Ireland and Northern Ireland (November 2013 - September 2014) and 96 *E.coli* isolates collected (2005 – 2011) primarily from residents of long term care facilities were examined. Genomes were hosted in and analysis was performed using a local installation of BIGSdb. The *mcr-1* sequence of Liu et al was used to conduct a BLASTN search against all 192 Irish human and food *E. coli* genomes. No significant matches were returned indicating the absence of the gene in this set of genomes. The absence of *mcr-1* in this limited collection of food and human genomes from Ireland suggests that it has not yet been disseminated widely in food animals or humans in this region though further testing including retrospective will be required to confirm this. Use of colistin and related compounds in human health care on the island of Ireland is very limited. The recent finding of a transferable colistin resistance mechanism in China and more recently in Europe and North America is of major concern and underlines the necessity of continuous surveillance.

Keywords: colisitin resistance, plasmid, *E. coli*

Environment And Human Health 2

Whole genome sequence analysis reveals diversity among antimicrobial resistant *E. coli* isolated from meats in the Irish market place

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Antimicrobial resistance is recognised globally as a major public health concern. The role that food plays in the dissemination of antimicrobial resistant bacteria and resistance genes is an area of increasing concern. This study examined the role of food in the dissemination of antimicrobial resistant bacteria. In total 600 raw meat samples were purchased from retail outlets throughout the island of Ireland between November 2013 and September 2014. All samples were tested for antimicrobial resistant *E.coli* (AREC) and 496 AREC isolates were obtained. All AREC isolates were characterised by a series of phenotypic and genotypic tests and based on these results 96 isolates were selected for whole genome sequencing. Isolate genomes were hosted in and analysis was performed using a local installation of BIGSdb. The O25b:H4-ST131 EC958 reference genome was used for whole genome pairwise comparisons amongst the genomes. There were 46 seven locus sequence types (STs) and twelve clonal complexes. There were 61 ribosomal sequence types (rSTs) with the most common, rST-1544, accounting for 15% of isolates. There was an association with this rST and source as 92.9% were from chicken samples (13/14). The majority of rSTs were diverse but there were some groupings and, the largest of which, rST-1544, consisted of two groups: ST162 (469 Cplx) and ST1431 (Unassigned). 4981 loci were compared for all genomes and the fewest differences (n=39) were found in 2 chicken meat isolates within the rST-1544 grouping. None of the rST-1544 group were ESBL producers. AREC found in Irish retail meats were relatively diverse. Interrogation of whole genome databases for emerging antimicrobial resistance determinants provided a rapid low cost approach to evaluate the extent of dissemination prior to recognition and will become a more powerful tool as databases expand.

Keywords: Antimicrobial resistance, food, whole genome sequencing

A Monte Carlo simulation model to evaluate emerging risks from spreading biosolids on agricultural land

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The application of biosolids to agricultural land as a fertiliser can offer an excellent source of nutrients (nitrogen, phosphorus and potassium) and trace metals, increase organic matter, increase water absorbency and reduce the possibility of soil erosion. It is also a cost effective way for a county to reuse its municipal waste without over reliance on landfill. Although biosolid spreading replenishes the land with nutrients etc. they are also a sink for contaminants that reside in the biosolids. The aim of the present study was to identity potential hazards (chemical) present in biosolids that are capable of causing adverse human effects through surface water. A suite of 16 contaminants identified in the literature were analysed in a risk ranking model to include hazard and health based risk endpoint (LC50). A probabilistic model was constructed in Excel (incorporating @Risk 6.0) to estimate human exposure to organic contaminants that are contained within biosolids destined for land application. Probability density distributions were used to take account of uncertainty and variability in inputs. The highest rank obtained for PEC_{soil}, PEC_{runoff} and $PEC_{groundwater}$ were the surfactants nonylphenols (NP, NP1EO and NP2EO). The LC50 combined with PEC_{runoff} and $PEC_{groundwater}$ revealed that NP NP1EO and NP2EO ranked the highest. The use of these contaminants are heavily restricted in the EU however, their persistence, bioaccumulation and toxicity still remain in the environment. Emerging contaminants triclosan and triclocarban also ranked high and may be considered more harmful as they have only recently been restricted and are known to cause adverse health effects. A Sensitivity analysis revealed that Koc and SOC were the most important parameters that affected model variance (correlation coefficient -0.89 and -0.30, respectively), highlighting the significance of contaminant and soil properties in influencing risk assessments.

Keywords: Biosolids, contaminants, health, risk assessment, water

Environ 2016 University of Limerick

Environment And Human Health 2

An initial investigation of environmental factors affecting neighbourhood health in Ireland

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Protecting human health through protection of the environment was one of the principle drivers for establishment of the EPA both in Ireland and the USA. One measure of human health is self-reported health. This captures both physical health and mental well-being and although it has been criticised as somewhat subjective, it has been shown to be a predictor of mortality. This paper uses the Likert scale self-reported health data from the CSO Census 2011 at small area (SA) level to examine Irish neighbourhood health. Then using other SA data from the Census 2011 and GIS, a spatial neighbourhood environmental dataset was created which includes waste licenses, Integrated Pollution Control (IPC) licences, radon mapping and the land cover data from the CORINE 2012 dataset. A fractional logit regression analysis was used to examine what variables affect neighbour health in Ireland, which was followed up by a spatial regression model. Initial results suggest that social factors may have a stronger effect on health than environmental factors for the general Irish population.

Keywords: self reported health, landcover, landscape

Environment And Human Health 2

Septic tank registration and inspection: Two cross-sectional surveys of risk perception and citizen engagement

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A high proportion of domestic wastewater treatment systems (DWWTSs) across rural Ireland are poorly sited and/or maintained, thus constituting a significant threat to both human health and the aquatic environment. Cussen (2010) reports that up to 120,000 of these systems may be responsible for surface water contamination, while a further 25,000 are a likely source of groundwater contaminants. Accordingly, the Environmental Protection Agency (EPA) have developed a National Inspection Plan (NIP) comprising approximately 1,000 annual septic tank inspections in concurrence with septic tank registration and a citizen engagement strategy to promote appropriate DWWTS management. The current study sought to quantify levels of awareness and risk perception among DWWTS owners before and after initiation of the NIP as they represent both primary system managers and the potentially affected population. Approximately 1,100 owners completed a closed-structure questionnaire in the year prior to NIP initiation (pre-engagement), with a further 520 surveys completed approximately one year later (post-engagement). Questionnaires were undertaken using two distinct surveys modes, namely online completion and focus groups. Overall, a higher level of risk perception was exhibited by respondents supplied by public mains than those associated with private unregulated sources (primarily wells). Prior to initiation of the NIP, 65.2% of respondents stated that they had not been supplied with information regarding system operation or maintenance; post-engagement, this figure stood at 69.8%. While 84.3% of post-engagement respondents agree that DWWTS constitute a potential threat, pollution from these systems was ranked fourth behind agriculture, urban wastewater discharge and industrial leakages/spillages in terms of importance. No significant change was noted between pre- and post-engagement in terms of self-reported levels of DWWTS desludging. Results of the survey highlight the importance of holistic and structured citizen engagement strategies and may be used to inform future public engagement strategies, both in Ireland and further afield.

Keywords: Citizen Engagement, Public Health, Risk Perception, Socio-Hydrology, Wastewater Management

Biodiversity And Ecosystem Services

Introducing ESManage: objectives, approach and challenges

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ESManage is a 3-year interdisciplinary project, funded by the Irish Environmental Protection Agency, with the overall objective of harnessing the current knowledge base and existing tools to facilitate the integration of the ecosystem services approach into policy and decision-making for sustainable management of Ireland's freshwater resources. The project objectives will be achieved through analysis of existing and new information from the physical/biological sciences and economics and its incorporation into useful tools. The research has started with a synthesis of information on Irish freshwater resources in the context of ecosystem services including identification of key ecosystem services. Scenario analysis will be undertaken to show the responses of ecosystem service providers and associated ecosystem services to various stressors/drivers and land-use management changes. The results of the scenario analysis will be presented to stakeholders to inform the valuation of key aquatic ecosystem services in Irish rivers. Finally, the outputs from these tasks will be used to determine how the ecosystem services approach can be embedded into tools to assist policy and decision-making related to management of freshwater resources. This paper will present an overview of the project objectives and challenges, and outline the ecosystem services relating to Irish freshwaters and their relative importance.

Keywords: Ecosystem services; freshwater

Ecological focus areas: enhancing and maintaining biodiversity on tillage farms

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The reform of the Common Agricultural Policy has seen the introduction of three "Greening" measures aimed at increasing agricultural sustainability. These measures are crop diversification, the maintenance of permanent grassland and the establishment of Ecological Focus Areas (EFAs). The EFA measure requires farmers with over 15 hectares of arable land declare 5% of this land (rising to 7% in 2017) as "Ecological Focus Areas". Ecological Focus Areas are landscape features and practices that are ecologically beneficial and will have a positive effect on biodiversity and the environment. In Ireland, current eligible EFAs include hedgerows, drains, and riparian buffer strips. These and other semi-natural habitats are vitally important for maintaining and enhancing biodiversity. It is hoped the establishment of EFAs (coupled with the associated ecosystem services they provide such as food, fresh water, pollination, flood protection, clean air etc.) will help halt the loss of farmland biodiversity and contribute to sustainability and environmental targets (e.g. Biodiversity Strategy 2020, Water Framework Directive, Climate Change Strategy). It is unclear what percentage of Irish tillage farmland currently qualifies as EFA ; this study undertook a farm habitat survey on intensively managed tillage farms in Ireland to determine the proportion of farm area currently under semi-natural habitat cover. The survey included quantification of habitats that are eligible as EFA and habitats that are not currently eligible under Irish and/or EU specifications. Thirty-seven tillage farms throughout Ireland were surveyed. Preliminary results indicate the majority of surveyed farms exceed the current 5% EFA requirement; however, our analysis suggests that approximately 30% of farms may experience difficulties in meeting the revised 7% requirement in 2017, if assessed under current eligibility prescriptions. This study indicates that hedgerows account for approximately 80% of eligible EFA and are often the only semi-natural habitats on certain farms. This highlights the importance of appropriate hedgerow management prescriptions if quality habitats are to be achieved. Other common EFAs surveyed include drains and buffer strips.

Keywords: Agricultural Biodiversity, CAP, Greening, Ecological Focus Areas, Intensive Farming Systems

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Biodiversity And Ecosystem Services

What controls the abundance and diversity of soil animals? - a manipulation study using mesocosms in a controlled laboratory setting

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Microarthropods are abundant and diverse in most temperate soil systems. The relative contributions of bottom-up and top-down factors in determining community structure are not fully clear. There have been numerous studies where resource availability was altered both in field based or microcosm studies. However, there have been a limited number of experiments which alter the density of populations while keeping the resources unaltered in order to observe the effect of resource availability on community structure. Here we report on a laboratory study where intact soil cores (844 in total; 5cm diameter, 5cm depth) were taken from an agricultural grassland site and used to set up a mesocosm experiment. The cores either contained the field density of microarthropods (control) or two elevated densities achieved by adding the extracts from 1 or 7 additional cores. The effect of available pore space was assessed using cores which had been compressed to 70% of their overall volume and densities manipulated in the same manner. Microarthropod, enchytraeid and nematode populations and microbial biomass were assessed 7 days, 67 days and 127 days after establishment of experiment. These results are presented and interpreted in the context of the role of resource availability in structuring soil communities.

Keywords: microartropod, resource availability, community structure, mesocosm

Biodiversity And Ecosystem Services

The role of microarthropods in the sequestration of carbon in grassland soils: a microcosm experiment

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Agriculture is the primary source of greenhouse gas emissions in Ireland and it is therefore vital to determine the role of the agricultural soil communities in the sequestration of carbon while maintaining the soils economic value for agriculture. Microarthropods i.e. mites and Collembola, play vital roles in decomposition, nutrient cycling, and regulation of microbial communities in grassland soil systems. The aim of this research project is to ascertain the effects of microarthropods on carbon sequestration in the soils of grassland systems in Ireland. In this paper we report on a microcosm experiment designed to assess the influence of microarthropods on carbon and nitrogen dynamics in intensively and non-intensively managed soils. CO_2 production and the loss of nitrogen in leachates from the microcosms were measured over a period of 22 weeks. The results suggest that grassland management has a greater influence on nutrient cycling than the animal communities present. However, experimental manipulation of the soils also affected the C and N dynamics. Higher amounts of CO_2 and less nitrogen were lost from un-manipulated soil columns as compared to those which had been manipulated to remove animals.

Keywords: Carbon sequestration, microarthropods, soil, grasslands, microcosms

Biodiversity And Ecosystem Services

Carbon dioxide dynamics of a rewetted peatland forest on blanket peatland

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In recent years the emphasis in peatland management has moved from productive functions towards restoration and rehabilitation. This is generally done by rewetting degraded peatlands with the overall aim of restoring the hydrology, ecosystem functions and biodiversity values characteristic of intact peatlands. Restoration of degraded peatlands is considered as a mitigation tool to combat climate change as it can restore the carbon sink function of these ecosystems. In Ireland, Coillte has rewetted 1212.3 ha of formerly forested blanket peat. To date, little is known about how these ecosystems function in terms of carbon dioxide (CO_2) dynamics. This project aims to measure carbon dioxide (CO_2) fluxes in a rewetted peatland forest on blanket bog and investigate their relationship to environmental and climatic variables such as soil temperature, water table depth and vegetation type. CO_2 emission factors will be derived from the results of this study. Eight steel collars were inserted into the soil and CO_2 fluxes were measured using a 60 x 60 x 30 cm static polycarbonate chamber, fitted with a battery operated fan and cooling apparatus, which is inverted over the soil surface. Carbon dioxide concentration (ppm) in the chamber headspace is measured with a portable analyser and CO_2 fluxes are calculated from the linear change of CO_2 concentration in the chamber headspace as a function of time, temperature and chamber volume. Results will be available for presentation at the conference.

Keywords: Carbon dioxide, blanket peatland, rewetted, restoration, deforested

Biodiversity And Ecosystem Services

Sustainable development of Greenways: Analysis of ecological connectivity to improve design of greenways as ecological corridors

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Greenways can deliver cultural ecosystem services such as recreational, health, aesthetic appreciation and economic benefits, and are generally promoted as excellent sustainable tourism projects. European Greenway developments 'recycle' old disused transport corridors and construct new, multi- use, non-motorised infrastructure within a safe environment. Ireland is beginning an important development of Greenway networks, following the success of the Great Western Greenway in Mayo. Prior to development, such disused corridors are often regained by wildlife, allowing a return of semi- naturalness and species transit through connectivity within the wider landscape. This project researches the potential Greenway role as an ecological corridor. A baseline map of habitats and ecological corridors along the cross- border Sligo, Leitrim, Northern Counties Railway (SLNCR) Greenway project is digitised using ArcGIS, existing data and satellite based imagery. The mapped area which covers 70km^2 is ground-truthed and assessed for accuracy, building an understanding of the abandoned railways ecological structure and function. Semi-natural habitats such as woodlands and hedgerows are then subjected to connectivity analysis using Morphological Spatial Pattern Analysis and their importance as habitat patches and links are evaluated. The area is dominated by wet grassland, improved agricultural grassland and conifer plantation habitats covering 41%, 31% and 6% respectively, with semi natural woodland and grassland habitats occurring throughout. 874km of hedgerow are mapped within the area. Recommendations for the development of the Greenway are made to ensure habitat connectivity is not lost and the development is complementary to its natural surroundings. The project can inform Greenway Best Practice guidance and the realisation of Greenways as true sustainable tourism projects.

Keywords: Greenway, sustainable development, ecological corridors, morphological spatial pattern analysis.

Environmental Policy And Communication; Socioeconomics

Cow dung pats influence earthworm distribution in grassland

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The assessment of earthworm abundance (Annelida, Lumbricidae) in grazed pastures using a random sampling design poses a risk of sampling errors because areas around cow dung pats are not sampled representatively. The hypothesis of the present study is that cow pats influence the spatial distribution of earthworms, generating temporary, aggregated distributions of some species but not others; implicating that random or pat-avoiding sampling on pastures underestimates the abundance and biomass of some species. The present, preliminary study took place in spring 2015 on a 1 ha site on a permanent grassland farm in SE Ireland. The sampling campaign, commencing after one week's grazing by cattle and lasting 10 weeks, samples were taken every second week under cow pats (treatment) in five replicates and five replicates under pasture without cow pats present (control). Earthworms were extracted by hand sorting, preserved, counted, weighed and identified to species level. Earthworm abundance was up to 222 individuals per 0.023 m3 in the treatment and as low as 45 in the adjacent control. The abundance ratio in corresponding treatment–control replicates was on average 3.25, with a maximum of 4.62 times higher dung-associated abundances than in the control. Earthworm abundance in the treatment showed an increase over time, starting at 97.8 per 0.023 m3 in the first sampling week, reaching a peak of 140.4 eight weeks after the grazing and decreasing to 82.4 thereafter. These results show a significantly higher abundance of earthworms under cow pats than in other areas of the same pasture, suggesting that earthworms move to and aggregate under cow pats. The temporal change in earthworm abundance suggests that the attractiveness of the cow pat environment is changing through high ammonium content in the beginning and decreasing nutrient availability later on. A new approach is required for earthworm sampling in pastures that includes area affected by cow pats in a representative manner.

Keywords: Earthworms, Pasture, Cow pats, Sampling, Biodiversity

Environmental Policy And Communication; Socioeconomics

Assessment of greenhouse gas emissions related properties of horticultural peat

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Peat and peatland ecosystems are key components of Ireland's Land Use and Energy sector Greenhouse Gas (GHG) profile. The peat industry in Ireland produces about 4 million tonnes of peat per year. Part of this peat is utilized for horticultural compost. Although significant advances have been made regarding the GHG balance of peatland and peat use in Ireland horticultural peat has not been addressed. This study will establish a baseline of horticultural peat properties. Assessing the GHG balance of peatlands is time consuming and expensive requiring the establishment of field sites and deployment of chambers or eddy covariance systems to measure gaseous exchange. However, considerable insight can be gained by combining elemental analysis with methods reported in the scientific literature. Peat samples have been collected from each of the 13 sites where Bord na Móna currently extracts horticultural peat in the Irish midlands. Elemental analysis to determine the carbon, nitrogen, hydrogen, sulphur and ash content is currently ongoing at the Celignis laboratory, University of Limerick. The data will be analysed to determine if there is a significant difference in the measured properties between sites.

Keywords: Horticultural peat, oxidative ratio

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Life Cycle Assessment of Greenhouse Gas Balances in Irish Short Rotation Forestry

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Short Rotation Forestry (SRF) has the potential to increase biomass production and contribute to the EU Renewable Energy Directive target for Ireland of 16% renewable energy by 2020. SRF can also offset Ireland's greenhouse gas (GHG) emissions from the combustion of decreasing reserves of peat and fossil fuels through their displacement in industrial and domestic heat and power plants. This study aims to investigate the GHG balance of SRF silviculture systems through the use of Life Cycle Assessment (LCA) methods and software tools. These tools will enable the assessment of Irish SRF plantations from initial establishment and operation, through to biomass harvesting and bioenergy products end-use. The LCA will attribute energy inputs and GHG outputs to each phase of the SRF life cycle and compare those values to a conventional forest management reference system to determine the strengths, weaknesses, opportunities and threats posed by SRF silviculture. The LCA will further examine the GHG balance consequences of several SRF management options, e.g. use of deciduous or evergreen SRF species, single or multiple rotations, and on-site or off-site processing of the fuelwood. The results of the GHG balance investigations will also aid in calculating the pay-back period for the GHG emissions from land-use change and site disturbances due to SRF plantation establishment by above- and below-ground carbon sequestration over several rotations.

Keywords: GHG emissions, bioenergy, biomass, renewable energy, land-use change

Environmental Policy And Communication; Socioeconomics

Using Geographical Information Systems (GIS) to identify nitrogen critical loads in the Irish Natura network

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Critical loads are a tool for assessing the risk of atmospheric Nitrogen pollution to sensitive habitats. If a habitat is in receipt of atmospheric Nitrogen higher than its critical load, then there is expected to be an observable negative impact. The impact can vary depending on the type of habitats present, hence knowing the location, extent and type of habitats within the Natura 2000 network is vital when assessing potential impacts. CORINE (Co-ORdinated INformation on the Environment habitat maps were first produced in 1990 by the European Community (EC) as a means of recording the spatial environmental information in a standardised and comparable manner within the European Union. This project mapped the landcover of certain habitats within Ireland and other EU countries. Where past projects have mapped the Nitrogen critical loads for Ireland, using the CORINE dataset, they did not focus on Natura 2000 sites or the potential for nitrogen overloads to significantly impact on conservation objectives of these habitats and species. The current study investigates the potential for combining the CORINE landcover data, with site specific Natura 2000 data in order to establish accurate critical loads for habitats within each Natura 2000 site, thus aligning well with the theme of the Environ 2016 conference. Further details of the overall EPA-funded research project can be found at http://ssu.ie/research/ammonian2k/.

Keywords: Critical Loads, CORINE, Natura 2000

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Microbial interactions of the novel bacterium *Ensifer adhaerans* OV14 with economically important crops

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By 2050, the world's population is estimated to reach 9.6 billion, raising fears that current farming practice cannot meet increased demand for food stocks. In 2015, the Food and Agriculture Organization (FAO) published the "Regional overview of food insecurity: Europe and Central Asia" placing emphasis on increasing industrial farming and intensive agricultural practices worldwide, including a move towards genetically modified (GM) crops, to reach prospective requirement.

Plant biotechnology utilises molecular tools to create GM crops with desirable characteristics, including drought and pest resistance and higher tolerance to salinity, opening up new territories available for crop cultivation. To date, the generation of GM crops is dominated by the patent restricted *Agrobacterium*-mediated transformation (AMT), making it unfeasible to develop commercial products using this platform. A potential alternative, *Ensifer adhaerens* OV14, with capabilities to genetically transform plant cells at an equivalent rate to AMT, is being investigated by researchers at Teagasc, Oak Park, Carlow.

To assist in the understanding and development of an Ensifer Mediated Transformation (EMT) platform, the current research aimed to answer fundamental questions about OV14; Is OV14 endophytic or epiphytic? Can OV14 compete in a natural soil environment? What are the colonisation rate of OV14 in commercially important plants? The effect of OV14 on germination rates and plant growth parameters? To determine the answers to these questions a green fluorescent protein (GFP)-labelled OV14 strain has been generated to visualise plant –microbe interactions. This labelled OV14 was used to inoculate three plant species *Pisum sativum sp., Brassica napus sp.* and *Arabidopsis thaliana* using two different seed coating methods. The above plant trials are underway with preliminary results indicating that OV14 is affecting the germination rates of the different species when compared to control plants. In addition, soil free laboratory trials indicate OV14 may confer growth promotion with *Arabidopsis thaliana sp.*

Keywords: *Ensifer adhaerans*, economically important crops, putative tumefaciens replacement

Environmental Policy And Communication; Socioeconomics

Moving towards a low carbon Society: building capacities for transition and transformation

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The transition to a "low carbon, climate resilient and environmentally sustainable economy by the end of the year 2050" was conceptualised as the "national transition objective" in the 2015 Climate Action and Low Carbon Development Bill. This arguably represents the first formal articulation of Ireland's ambition to engage in a radical, long-term and far-reaching transition process, and raises a myriad of questions over how this can be operationalised, resourced and whether it can maintain political momentum. A range of perspectives on these issues is provided in the growing body of literature on transition theories (Rotmans et al 2001, Markard et al 2012) and the EPA-funded CC Transitions project, based at QUB, represents an attempt to translate this into the context of Ireland's institutions and technological profile. This presentation provides an introduction into how transition theory can help Ireland to tackle these challenges. It will review the international research on sustainability transitions, which conceptualises transitions as multi-level, multi-phase and multi-actor processes, and present the preliminary results of an Irish case study of policy and technology, drawing from this theoretical perspective. As such, it highlights some of the capacities for transition required in Irish society: where these exist, how they are being built or enabled, and the barriers to wider social change.

Keywords: sustainability transition, transition management, multi-level perspecti

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Smarter travel: are we there yet?

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The Irish transport sector faces extreme challenges in delivering reductions in Greenhouse Gas emissions, predominantly due to reliance on the private car for personal mobility. Walking and cycling as modes of travel, on the other hand, have the potential to deliver significant environmental, social and economic benefits at both the individual and societal levels. In Ireland, after arguably a century of car-dominated transport policy, the promotion of walking and cycling was officially adopted in *Smarter Travel* policy in 2009. Since then, funding for 'soft' and 'hard' active travel measures has been increased and there have been some positive developments in cycling, at least. However, there have been many limitations to the implementation of sustainable transport policies. Most importantly, questions arise on whether there has been any fundamental change in the direction of mobility patterns or whether the *Smarter Travel* policy was a 'stop gap' measure at a time of economic crisis and low capital investment. Indeed, developments during recent 'green shoots' of economic recovery suggest that the latter may be the case. The role of this presentation is fourfold: (i) to analyse and clarify targets in the *Smarter Travel* policy, (ii) to assess its performance to date and outline the challenges remaining in the context of other government targets, (iii) to outline a set of alternative indicators for walking and cycling policy, and (iv) to make recommendations for the collection of Irish national travel statistics, for future policy and for further research.

Keywords: walking; cycling; active travel; transport policy; Smarter Travel

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Engaging communities for the sustainable energy transition

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This paper reports on research being conducted as part of the H2020 ENTRUST project, an interdisciplinary research project exploring the human factor in the energy system. The challenges of climate change and finite fossil fuel resources mean that the current energy paradigm is unsustainable, and such challenges are important drivers of the transition to a more sustainable, low-carbon energy system. Many contributions at envisioning this low-carbon energy future focus on technology to the exclusion of human and societal aspects, however the sustainable energy transition required for this decarbonisation cannot be achieved without the involvement of communities. This paper describes research which seeks to engage and empower citizens to become active participants in shaping their sustainable energy future. The research explores how human behaviour around energy is shaped by both technical and socio-demographic factors, including in particular: age, gender, and socio-economic status. An intersectional approach is being taken to explore how multiple identities and social positions combine to shape energy-related practices and attitudes. In order to explore the socio-technical issues involve, six varied communities in five different European countries are being engaged: an Irish rural community; a cohort of university students; residents of an eco-village in a large French city; the urban customer base of a Spanish utility company; 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. As such, they provide great insight into the different obstacles faced by communities to transition to a more sustainable energy system. This paper will look at how and why the communities were chosen and the value they bring to the research. It will detail the participatory research methods being undertaken and report on the initial findings arising from the interactions with the communities.

Keywords: sustainable energy transition, community engagement, low-carbon energy system, intersectionality, participatory research

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How social science could help usher in a new era in energy efficient urban building construction and renovation design practices

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For millennia building design revolved around hand drawn design until the Computer Aided Drawing/ Design (CAD) era began in thfe 1980s. The evolution was not instantaneous, but it was totally transformative. Designers were able to do much more of their own drawings, without the requirement of teams of draughtspersons, revisions became substantially easier, and design time-lines were reduced. In fact readers of Architects Journal a leading architectural publication, voted CAD the greatest advance in construction history. In recent years, the era of CAD has further evolved into the Building Information Modelling Era (BIM), which has led to another massive technological transformation in the construction industry; increasing clash detection, and reducing human error factors, as well as time consuming and repetitive activities with automated schedules, sections and elevations. In just a few more years, the BIM era could soon give way to District Information Modelling (DIM). Contributing to this move are EU research projects such as Umbrella, Entrust and NewTREND, being undertaken at UCC and involving multi-national, and multi-disciplinary teams. The DIM era offers the potential of increased interoperability between stakeholders, professions and digital file formats, shared information and knowledge, and fully integrated virtual databases of whole streets and districts. The difference with this evolution to the previous two however, will be that it is socially driven rather than technologically driven. These projects focus on stakeholder and occupant engagement, social constructs, norms and values, project management and team collaboration, interpersonal relationships, actor networks, value chains and symbiotic relationships. All of these factors will then be utilised in order to develop digital tools and databases such as the DIM. These will increase the capacity of stakeholders to interact and collaborate more productively in order to minimise waste of resources, and design to specific energy efficiency standards.

Keywords: energy, urban development, design, construction, CAD, BIM, DIM, stakeholder, actor, value, social science, and collaboration

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MOREFISH- enhancing production and sustainability in Irish aquaculture: A Life Cycle Assessment (LCA) of a semi-recirculating rainbow trout (*Oncorhynchus mykiss*) farm.

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The MOREFISH project (funded by DAFM) led by NUIG and AIT aims to enhance production efficiency and sustainability in Irish freshwater aquaculture systems. As wild fisheries production has decreased (Henriksson et al. 2011) and the demand for fish products continues to rise (Ottinger, Clauss & Keunzer, 2016), aquaculture has become the fastest growing source of fish protein (Asche, Roheim & Smith, 2015). With this growth, there have been potential issues raised regarding environmental impact. As part of the project, a life cycle assessment (LCA) on the environmental impact of rainbow trout production in a semi-recirculating aquaculture system is to be conducted to assess environmental impact. LCA is an ISO standardised framework which assesses the overall impacts in the production of a product. The impact categories to be assessed include: global warming potential (GWP), acidification (AP), water dependence (WD), eutrophication (EP), energy use (EUP) and biodiversity impact potential (BIP). The scope of this study includes the system boundary "Cradle to Farm Gate" with the functional unit being per tonne of live fish produced. The aims of this study are to identify opportunities where the environmental performance of the processes and products at various stages of production can be enhanced and to establish a baseline study which may allow policy makers and industry to make better informed decisions.

Keywords: aquaculture, sustainability, fish, life cycle assessment.

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Environmental Policy And Communication; Socioeconomics

Use of constructed wetlands to treat alkaline leachates.

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Bauxite residue is a highly alkaline by-product resulting from the extraction of alumina from bauxite ore, the world's primary source of aluminium. Despite various chemical and physical practices, attempts to neutralise the residual caustic have proved challenging with the resulting BRDA (Bauxite Residue Disposal Area) leachate remaining in the pH range of 10.5-11.5. Although the collection and management of residue leachates can be maintained during the operational life of a refinery, it is recognised that a treatment system is required post-closure due to the reserve alkalinity of the old residue. As a passive, low cost, natural alternative to technical methods of wastewater remediation, constructed wetlands have gained popularity worldwide from both regulatory authorities and industries alike. CW's are man-made systems engineered to manipulate specific characteristics of naturally occurring wetland ecosystems to improve treatment capacity of a wide range of pollutants. Historically, constructed wetlands have been predominantly used to passively treat wastes of an acidic nature. Due to the limited literature outlining the potential use of constructed wetlands in treating alkaline leachates, a constructed wetland trial was erected within the BRDA at Rusal Aughinish, Ireland. The primary objective for the 40 m^2 plastic lined reed bed is to receive highly alkaline leachate (pH circa 11) similar to that of BRDA run-off and to passively reduce the pH of such leachate below legislation standards (<pH 9) where it can be directly discharged into the surrounding environment. The performance of the wetland over 24 months in terms of its' buffering potential and sustainability in an industrial setting are presented.

Keywords: Alkaline; Leachate; Wastewater Remediation; Constructed Wetlands; Sustainability.

A graphene-copper composite film as an anti-bacterial agent for water treatment applications

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The removal of potentially pathogenic microorganisms from drinking water is an important issue worldwide. With concern over by-products from standard chemical treatment becoming widespread, the development of new systems is essential. Graphene is a relatively new carbon nanomaterial which shows potential as an adsorptive agent for contaminant removal which can be composited with biocidal metals like copper for anti-bacterial purposes. However the formation of irreversible agglomerates can be an issue during preparation. This is commonly overcome via the addition of polymers and other capping agents which may limit the potential action of the material. As such, synthesis and characterisation of a graphene copper composite (Cu-rGO) was carried out with l-ascorbic acid acting as both a reducing agent and capping agent to improve water dispersibility. The creation of a homogeneous suspension facilitates the formation of free-standing composite films via vacuum filtration. The antibacterial efficacy and the adsorptive potential of these films has been investigated with a view to their inclusion in a potential drinking water treatment system. Characterisation of composite films was carried out via a variety of techniques including SEM, FTIR, EDX and UV-vis and a composite with a copper content of 24%w/w was evaluated. Anti-bacterial testing was carried out using *E. coli* and *B. subtilis* as examples of gram-positive and gram-negative organisms. Both organisms, at a concentration of $10^5/cm^2$, were inhibited within forty minutes. Potential contaminant removal was examined via the adsorption of famotidine, diclofenac and methylene blue by the films with two out of three of the materials showing a disposition towards adsorption.

Keywords: graphene, copper, microorganisms, bacteria, microbiology, water treatment, drinking water, water, metal-composites, anti-bacterial, biocidal.

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Novel Applications In Sustainability And Research Innovations

The ecotoxicological effects of silver nanoparticles in the freshwater ecosystem: a review of existing data and experimental design

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Safety regulators have struggled to keep up with the enormous growth in nanomaterial applications and the lack of information on silver characteristics in functionalised materials due to intellectual property protections. Silver has been in widespread use for its antibacterial properties for millennia. The advent of nanoparticles in applications such as food packaging, textiles, paints and domestic white goods has led to concerns about its safety and downstream effects. This ecotoxicological study of silver nanoparticles embraces a "cradle to grave" approach to nanotechnology safety over the full material life cycle in contrast to the traditional direct toxicity concerns. A comprehensive literature review identified the relevant toxicant species of concern, sources and sinks which informed the experimental design. The extant literature suggests that silver nanoparticles partition to waste water sewage sludge. Advancements in nanoparticle functionalised materials to improve the longevity of nanoparticles adsorption suggests that ionic silver shed from functionalised surfaces and textiles may be the more likely toxicant of concern rather than the nanoparticles themselves. This study analyses the effects of silver nanoparticles and ionic silver on an ecotoxicological multi-trophic test battery which includes *Daphnia pulex*, *Pseudokirchneriella subcapitata* bioassays and aquatic piscine cell lines as well as diatoms and *Gammarus pulex* (freshwater shrimp) to improve the relevance of the data to the Irish freshwater ecosystem.

Keywords: silver, nanoparticles, ionic, ecotoxicology, multi-trophic.

The role of graphene oxide coated diatoms in water decontamination applications

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A sudden rise in population, in addition to amplified agricultural and industrial activity has resulted in the release of proliferated contaminants, such as heavy metals. Consequently an enhanced global endeavour has surfaced to develop economical and efficient technologies capable of removing these exceedingly toxic contaminants. Adsorption has become an effective means of capturing and removing inorganic species from our water sources. Orientated porous structures comprised of graphene oxide have been deemed superior heavy metal adsorbents due to the materials high surface area, hydrophilic, and oxygen rich nature. A number of approaches have been designed for the production of such hierarchical structures, however, reproducible fabrication of these precise nanoscale architectures often requires expensive facilities and toxic materials. On the other hand, complex 3D nanostructures with ordered pores, organized in a specific hierarchical pattern can be found in nature. The architecture of unicellular algae, known as diatoms, which are abundantly present in aquatic environments, offers an attractive template for the fabrication of porous 3D graphene oxide networks. The focus of this research is to exploit the desirable architecture offered by diatoms for the assemble of highly efficient graphene oxide adsorbents, by coating the outer diatom shell and subsequent dissolution of the enclosed silica wall, which can be used for the removal of inorganic aquatic contaminants.

Keywords: graphene oxide, diatom, heavy metals, water purification

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Novel Applications In Sustainability And Research Innovations

Anatase to rutile transition in titanium dioxide nanomaterials for environmental applications

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Titanium dioxide (TiO_2) has three main phases that are present in nature (anatase, brookite and rutile). TiO_2 is one of the most investigated photocatalyst because of its nontoxicity, ease of preperation, long term stablity and strong oxidising ability. Among the various crystalline phases of titania, anatase is regarded as the most photocatalically active phase of TiO_2. Anatase and brookite are both metastable and transition irriversably into rutile, which is a thermodynamically stable phase, at temperatures between 600-700°C in pure synthetic TiO2. Chemical aditives, modifiers and dopants can be introduced into TiO2matrix inorder to alter at what temperature this transition occurs at. Dopants such as Cu^{2+}, Co^{2+}, Fe^{2+}, etc., cause this transition to occur at elevated temperature, while some dopants such as SO42- and PO43- cause the transition to occur at temperatures below 600°C. There continues to be extensive research into the ability to produce a high temperature (≥ 1000°C) stable anatase phase photocatalyst for many of its applications. Environmental applications include self-cleaning tiles (for bathroom, surgical wards etc.) and anti-microbial sanitary wares (e.g. sinks). This talk will discuss the anatase to rutile transition by varying the precursor modifiers and dopants.

Keywords: titanium dioxide; anatase-to-rutile transition; high-temperature stable photocatalyst

An investigation into plant parasitic nematode and endophytic bacterial interactions

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Plant parasitic nematodes (PPN) cause billions of dollars annually in global crop damage. These micro invertebrates are round worms that invade and infect plants and their control relies heavily on chemical pesticides. Endophytic bacteria colonise and inhabit the internal structures of host plants, indirectly promote plant growth and induce plant defence. The work presented investigates the susceptibility of PPN to endophytic bacteria and the secondary metabolites they produce. This work is currently ongoing. The PPN *Meloidogyne javanica, Pratylenchus penetrans, Heterodera schachtii* and *Globodera pallida* were cultured along with two control bacterial feeding nematodes, *Caenorhabditis elegans* and *Pristionchus pacificus*. The nematodes were subjected to several strains of pseudomonad endophytic bacteria, from IT Carlow stocks. Two approaches were adopted to evaluate the sensitivity of the nematodes to the endophytic bacteria: (1) Susceptibility assays were established in 96 well plates with increasing concentrations of endophytic bacteria against different nematodes. An additional assay was conducted applying increasing concentrations of bacterial supernatant at different nematode life stages. These assays were carried out over a 24h and 48h period, after which nematode mortality was recorded. Results indicate that up to 100% nematode mortality occurs (a) in *M. javanica, P. pacificus* and *C. elegans* (*P. penetrans, H. schachtii* and *G. pallida* to be tested) in the presence of endophytic bacteria, and (b) in *C. elegans* and *P. pacificus* (*M. javanica, P. penetrans, H. schachtii* and *G. pallida* to be tested) in the presence of endophytic bacterial metabolites. Results were influenced by bacterial concentration and life stage of the nematode. (2) The effect of endophytic bacteria on nematode egg hatch and juvenile mortality in *M. javanica, H. schachtii* and *G. pallida* is currently being investigated. The results of this study will be the starting point to enhance understanding of these types of interactions, with a view towards developing efficient strategies for the biological control of PPN.

Keywords: Plant parasitic nematodes, endophytic bacteria, biocontrol

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Novel Applications In Sustainability And Research Innovations

The Galway Bay Observatory: from vision to reality

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The installation of Ireland's first subsea cabled observatory began in April 2015. The project provides critical infrastructure within Ireland's Ocean Energy Test and Demonstration Site in Galway Bay to support the trial and validation of novel sensors and prototype equipment within a real-world marine environment. Data relating to the marine environment at the site are now being transferred in real-time from the Galway Bay Observatory to the Marine Institute headquarters and onwards onto the internet. The data currently includes a live video stream, the depth of the observatory node, the sea temperature and salinity, and estimates of the chlorophyll and turbidity levels in the water which give an indication of the volume of phytoplankton and other particles, such as sediment, in the water. The observatory equipment will allow ocean energy developers to monitor how their devices are performing in the ocean as well as give ocean researchers unique real-time access to monitor ongoing changes in the marine environment. Research facilitated by the cabled observatory will have applications not only on a National and European level but also on a transatlantic scale. Areas identified for potential collaboration under the agreement include: an Atlantic Ocean observation and forecasting system; mapping critical areas of the Atlantic seafloor; identifying and recommending future research and ocean literacy and awareness initiatives. Other opportunities for potential growth can be derived from the application of the information and data generated in the pursuit of new applications to drive innovation in marine related engineering and information technology sectors. This presentation details the installation and commissioning of the cabled observatory, the currently available public data streams, and highlights areas of future research opportunity.

Keywords: observation, marine, big data, water quality, research, communications

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Ecosystem Services for a Sustainable Future
26th Irish Environmental Research Colloquium

ABSTRACTS POSTER PRESENTATIONS

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Biodiversity And Ecosystems Services

1. Ecology and behaviour of common cockles Cerastoderma edule and shore crabs Carcinus maenas at man-made habitat (oyster trestles) and natural habitat (high shore)

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The common cockle *Cerastoderma edule* and shore crab *Carcinus maenas* are abundant and widely distributed invertebrate species in the Irish intertidal ecosystem. This study examined the ecology and behaviour of *C. edule* and *C. maenas* in an undisturbed natural habitat (high shore) and a man-made habitat (oyster trestles). From the end of April until mid-August 2015 approximately 30 crabs and 30 cockles were collected at oyster trestles on the mid to lower shore and at the high shore at two main oyster culture sites in Dungarvan (Co. Waterford) and Carlingford Lough (Co. Louth). In Dungarvan, a total of 250 cockles (high shore) and 329 crabs (59 at high shore and 270 at trestles) were collected. In Carlingford Lough 446 cockles (219 high shore and 227 trestles) and 476 crabs (238 high shore and 238 trestles) were collected. Morphometrics such as shell height, weight and age for cockles and carapace width, weight, sex and color for crabs were recorded. Cockles appeared to be larger, heavier and older in Carlingford compared with Dungarvan. At high shore cockles have an average higher age while at the trestles they seem to have a larger range in ages. Larger red female crabs dominated both shore heights at each culture site while larger male crabs were predominantly green. The color of *C. maenas* is known to vary from green, brown and red and this variation in color is assumed to be related to the moult-cycle, depending on the genome but may also differ for specific environmental variables. Results from the field trial would indicate that differences in coloration and size in male and female *C. maenas* may be related to different life strategies such as shore migration, feeding, territoriality and reproductive cycle.

Keywords: *Cerastoderma edule*, *Carcinus maenas*, ecology and behaviour, morphometrics

2. Status, threats, protection and conservation of Ladybirds in Ireland

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This research is prompted by the arrival in Ireland of the Harlequin Ladybird, (*Harmonia axyridis*) (which was introduced into Europe in 1982 to help control aphids in greenhouses. Invasive species can cause large annual economic losses worldwide, including agricultural and horticultural systems, as well as threatening native species and reducing biodiversity. Ladybirds provide an important economic and ecological bio-control biodiversity service in maintaining healthy ecosystems.They are also of crucial importance as they are highly sensitive to environmental conditions and can often be used as an indicator species when studying climatic change and ecosystem health. This research will investigate the status, biology, ecology and threats to native Ladybirds in Ireland. An understanding will be gained on the biological and physical factors that impact upon the distribution of Ladybirds in Ireland. The research has an important educational component that will form part of a module on Ecology and Biodiversity that is taught in Fota Wildlife Park which will be developed from the research and results of the breeding programme. This research will develop conservation breeding programmes for rare and threatened ladybird species, for the first time in Ireland and will build upon the experiences that were developed in the United Kingdom. The research is of importance because it will make a new contribution to knowledge on a native species and the effects of the recently arrived invasive ladybird species. Its outputs will be an understanding of native ladybird populations and potential impacts of an invasive ladybird species in semi-natural agricultural and urban environments.

Keywords: *Coccinellidae*, Ladybirds, Biodiversity, Education

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Biodiversity And Ecosystems Services

3. The influence of fauna on the fycling of farbon and nitrogen in grassland soils

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With the continuous intensification of agriculture it is necessary to establish what influence this will have on greenhouse gas emissions. The agricultural sector currently represents the leading source of greenhouse gas emissions in Ireland. It has been well established that intensively managed grassland soils have much lower abundances and diversity of soil fauna than those that are extensively managed. It has also been established that soil fauna play an important role in providing essential ecosystem services, such as nutrient cycling, decomposition and regulation of microbial communities. This study aims to establish if management practice alone i.e. intensive vs. extensive, is responsible for the differences in carbon and nitrogen cycling or if soil type is also a significant factor, and how this is influenced by soil fauna. A microcosm experiment is currently underway investigating the influence of the presence or absence of animals under different management conditions and in different soil types on the release of CO_2, nitrate and ammonia.

Keywords: carbon, nitrogen, fauna, soil, grasslands, microcosms

4. Relating multi species swards to parasitoid *Hymenoptera* as diversity bioindicator of arthropod population in grassland

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Hymenoptera are well known for their role as pollinators. However, the ecological significance of parasitic *Hymenoptera* might well overshadow that of pollination *Hymenoptera*, as these most prolific and opportune of insects parasites exert a profound and subtle trophic control over other populations of arthropods, which might otherwise overpopulate and thus cause imbalance in a wide range of ecosystems. Recent research has shown that abundance of parasitic *Hymenoptera* is an effective indicator of total invertebrate diversity within agricultural grasslands. The SmartGrass experiment follows a restricted simplex centroid design, with mixtures of eight distinct proportions of grasses, legumes, and herbs. Each of these eight mixtures has been replicated at three levels of functional group richness, containing 1, 2, or 3 species per functional group, giving a total of 24 mixtures at 4 levels of nitrogen input (0, 45, 90, 135 kg N ha^{-1} yr^{-1}). Invertebrates were collected from 108 plots, using a Vortis Suction Sampler (Burkard Manufacturing), using ten second samples (100 sec in total). Samples were preserved in 70% ethanol, sorted to order and then counted. To explore the relationship between plant functional group and abundance of parasitoid *Hymenoptera*, data was analysed using a simplex regression analysis (Minitab 16) on a total of 108 samples. Results will be discussed in relation to the biodiversity support value of multispecies swards using parasitic Hymenoptera as an indicator.

Keywords: biodiversity indicators, sward mixtures, Smartgrass, Hymenoptera, agro-ecosystem

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Biodiversity And Ecosystems Services

5. Smart grassland systems: the relationship between sward diversity and Coleopteran communities in experimental grasslands.

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Terrestrial arthropods, the most diverse group being the *Coleoptera* (beetles), represent a significant component of biodiversity in most terrestrial ecosystems, agricultural ecosystems being no exception. Maintaining their diversity has been linked with both ecosystem functioning and stability and the processes underpinning these e.g. nutrient cycling, and pest control. Recent research (SmartGrass project) has illustrated the agronomic benefits of multispecies grasslands. Here we investigate their role in supporting Coleopteran diversity versus that of *Lolium perenne* monocultures. Beetle communities are of particular interest as they can be considered economically important, due to their role as predators of Tipulid larvae and gastropods. Management practices in grasslands have shown that beetles respond rapidly to habitat fragmentation, grazing and fertilisation. As such, beetles may be suitable bioindicators in studies on habitat alteration and disturbance. The SmartGrass experiment uses a constrained simplex–centroid design with nine plant species representing three functional groups (grass, legume and herb), ranging from a perennial ryegrass monoculture to a nine species mixture, with 24 different mixtures. These are replicated at four levels of nitrogen input (0, 35, 90, 135 kg N $ha^{-1}yr^{-1}$). Terrestrial arthropods were collected from the plots using a Vortis suction sampler in July and August 2014, with a pooled 100 second sample covering an area of 0.6 m^2. Samples were sorted and identified to Order. Beetle abundance data from 108 plots, at two sampling dates, were analysed using the simplex mixture model in Minitab 16. Results from this will be presented to assess the relationship between different sward types and beetle abundance, to inform the development of ecologically sustainable grassland management practices.

Keywords: SmartGrass, biodiversity, coleopteran communities, ecosystem function, agriculture

Biodiversity And Ecosystems Services

6. Evaluating the contribution of ecosystem services in Irish dairy farm production

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In order to improve the sustainability of the Irish dairy industry, we need to evaluate the environmental impacts of the dairy farm, which is usually the most significant environmental burden in the dairy product supply chain. These impacts can be wide ranging. The grass-based dairy system in Ireland requires social capital (e.g. labour, capital) from society, but also depends on services from its surrounding environment (ecosystem services). Degradation of ecosystem service will have a negative impact on Irish dairy production. To obtain a better understanding of ecosystem contribution in dairy production and its monetary value, we need to evaluate ecosystem services in a spatially explicit manner. In addressing the issue, we investigated the ecosystem service of a typical grass-based Irish dairy farm as a case study. Life cycle assessment was used to quantify the consumption of ecosystem service by first classifying impacting flows from farm system to different midpoint categories e.g. global warming, eutrophication, acidification, ecotoxicity, nature occupation, and then by aggregating these into a single score using conversion factors in the Stepwise2006 method. All activity data are from farm survey and background data are from Ecoinvent and the Gabi database. The result of this study will provide farmers with a better understanding of the environmental performance of their dairy farm by linking ecosystem services (rather than single indicators) to the financial performance of the system.

Keywords: milk production, ecosystem service, life cycle assessment, sustainability

Climate Change

7. Magnitude of soil and woody debris CO_2 efflux

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Carbon dioxide (CO_2), the concentration of which in the atmosphere is increasing at an unprecedented rate, is the most important greenhouse gas (GHG) contributing (along with CH_4 and NO_x) to global warming. The increase in the atmospheric CO_2 concentration has motivated efforts to understand how global carbon pools respond to such changes. National inventories of greenhouse gas emissions by sources and removals by sinks are therefore essential to evaluate forest ecosystem carbon dynamics. A significant proportion of the forest carbon pool exists in the form of coarse woody debris (CWD), which consists of timber and dead plant material residues left on site after harvesting or thinning operations. After clearfelling, this decaying debris is usually assembled into long regular windrows, which thereby represent an important, if impermanent, store of carbon. Despite its importance, the estimation of how much carbon is lost from this source to the atmosphere has not been carried out definitively. The main objectives of this study were: (1) to determine the magnitude of forest soil CO_2 efflux and (2) to model the additional contribution of windrowed woody debris to forest soil respiration rates. The CO_2 efflux (F_s) from windrowed woody debris and non-windrowed sampling points was measured at three different-aged Sitka spruce (*Picea sitchensis* (Bong.) Carr.) forest stands in Co. Wicklow using a portable infrared gas analyser (LICOR 6400XT) connected to customised closed-chambers.The soil CO_2 efflux is sensitive to slight changes in the relationship between soil respiration and soil temperature. Soil temperature and volumetric water content were recorded during respiration measurements near each collar at 5 cm soil depth with the W.E.T. sensor kit probe, type HH2 (Delta-T Devices Ltd, UK). To better model the seasonal trends, continuous measurements of soil temperature at 5 cm depth were recorded at 30-min intervals by means of the TinyTag loggers (Gemini data loggers, UK) Ltd).

Keywords: CO_2 efflux, windrows, closed chamber, soil respiration

8. An overview on linking Emissions Trading Schemes: the EUETS and Brazil

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This research provides an overview on the linkage of the European Union Emissions Trading Scheme (EUETS) with emerging non-EU schemes- particularly a proposed cap and trade scheme in Brazil. It investigates potential impacts and determinants of linking cap-and-trade schemes. Linkage is described as a multi-faceted policy decision which may play an important role in future international climate policy architecture. These linkages can be direct via cap-and-trade schemes or bilateral/multilateral agreements, or indirect through connections via credit systems such as the Clean Development Mechanism (CDM). The main goal of linkage is to achieve emission reductions across different jurisdictions at a lower cost. Therefore these linkages can contribute to greater cost-efficiency, enhance market liquidity, and potentially lower the risk of carbon leakage. On the other hand, linking carbon markets may generate loss of regulatory control nationally. Several studies have been carried out in order to evaluate linking with the EUETS, including the possibility of linking with non-EU schemes such as South Korea, China, Australia and California. This research is conducted along the same lines but focuses on the Brazilian case. Brazil intends to set up a carbon market but the design of the scheme has not yet been defined. Some empirical studies have simulated different scenarios and potential impacts of establishing a carbon market in Brazil. However, there is still a gap in the literature in relation to investigating and estimating the feasibility and cost of linking a Brazilian emissions trading scheme with the EUETS.This research aims to address this gap and provide policy recommendations which will facilitate the future linkage potential of any developed Brazilian emissions trading scheme.

Keywords: carbon emissions, linking cap-and-trade schemes, EU ETS, Brazil

9. Adapted carbonate-removal acid-fumigation sample pretreatment method for measuring soil organic carbon content

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Measurements of soil organic carbon (SOC) are often needed in soil carbon stock estimation surveys, which are becoming increasingly important for climate change policy. The presence of carbonates in soil samples can interfere with the SOC measurements. The fumigation method with hydrochloric acid (HCl) for removal of carbonates in soils is known to have a potential to provide reasonably accurate and precise measurements of SOC. This method is performed as in-situ acidification, on small amounts of samples placed in open silver (Ag) capsules. However, the laboratory and analytical methods often need to be adapted to be less expensive and feasible within limited project resources. An adapted HCl fumigation method for carbonate removal in soil is presented, which uses common laboratory equipment (without using Ag capsules). The work showed the importance of extended repeated vacuuming of fumigated soil samples (to remove the residues of HCl vapour), and repeated drying due to formation of hygroscopic salts. In addition, it is known that chemical reaction of carbonates with HCl results in an increase in the mass. Therefore (if the SOC analysis is not performed directly on pre-weighed and fumigated samples in Ag-capsules), measurements of sample weights prior to and after the HCl fumigation are required, as well as the measurements of dry weights of fumigated samples on which SOC analysis is performed.

Keywords: carbonate removal, soil organic carbon, climate change

Energy

10. Fuel characteristics of biomass from short rotation forestry species

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Research is underway on the potential of short rotation forestry (SRF) species in Ireland to provide material for fuel and fibre markets. It is important to identify the fuel characteristics of proposed SRF species in order to determine the suitability of the biomass for use in heat and energy production. This study investigates the fuel characteristics of specific SRF species and genera: eucalyptus, hybrid poplar, alder, hybrid aspen and birch. The fuel characteristics of interest are: energy content of the fuel (basic density and calorific value); the limiting qualities of the fuel (moisture content and ash content); potential chemical issues (corrosives and pollutants); and ash melting behaviour. A large amount of literature has been reviewed supplementing the collection of field samples and lab analysis in order to quantify the fuel characteristics of SRF biomass in Irish conditions. Results are available for eucalyptus, hybrid poplar, alder and birch partitioned into wood, bark, leaves, roundwood and branches. Hybrid aspen has not yet been identified for sampling in Ireland. The aim is to create a reference table for the fuel characteristics of each species/genus and highlight fuel quality variation and potential barriers to the use of SRF as a fuel. The results so far show that the fuel characteristics are similar for the SRF species in question. There is a lot of variation in calorific value and ash content between tree partitions but less variation between species/genera for a given partition. Chlorine content of some SRF biomass may pose a problem in boiler corrosion but absolute limiting values needs further investigation. No results have yet been determined regarding ash melting behaviour.

Keywords: short rotation forestry, SHORTFOR, SRF, biomass, renewable energy

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Energy

11. The influence of extractives on the subsequent analysis of non-herbaceous biomass

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The effects of solvent extraction on the subsequent analysis of non-herbaceous biomass with 95% ethanol, water and using both sequentially, were investigated. Samples of tree foliage, tree bark and spent mushroom compost were chosen for the study. Analyses included determination of extractives, lignocellulosic sugars, Klason lignin, acid-soluble lignin, ash and protein. The analytical methodology of the North American Renewable Energy Laboratory was incorporated to ensure a high standard of analysis. Acid hydrolysis was used in the analysis of the most important components of biomass; cellulose, hemicellulose and lignin. The effect of extraction was most pronounced for Klason lignin and there was a strong correlation between higher Klason lignin determinations and greater amounts of non-removed extractives in the cases of tree foliage and bark. Increased Klason lignin values are considered to result from the condensation of non-removed extractives during hydrolysis, hence the lower Klason lignin determinations following extraction are considered to be more accurate. Lignocellulosic sugar determinations were lower following extractions, due to the solubility of non-cell wall carbohydrates, including free monosaccharides in ethanol and various mono-/oligo-saccharides in water. Extraction only had significant impact on ash and protein determinations when water was used. These results suggest that extraction before hydrolysis is crucial where accurate lignocellulosic analysis is required and should an analyst be interested in the lignocellulosic sugar, ash or protein content, analysis of an unextracted sample should also be carried out for comparison. Where only one solvent is used, ethanol extraction will provide lignocellulosic data closest to those seen after full sequential extraction.

Keywords: extractives, biorefining, hydrolysis, biofuels, lignocellulose

Energy

12. Modelling the optical properties of nanoparticles for hydrogen sensing applications

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Hydrogen gas has excellent potential as an energy source of the future due to its abundance, high energy density, and ability to burn clean. However, hydrogen is highly explosive therefore the development of accurate, robust hydrogen sensing technology is necessary before its widespread adoption is possible. Numerous groups have investigated the use of fibre-optic sensors based on nanoparticles due to advantageous properties such as high conductivity, large surface area and improved catalytic activity. It is known that the optical properties of localised nanoparticles depend strongly on their size and shape. This behaviour could be advantageous to a nanoparticle-based hydrogen sensor as, by adjusting the particle dimensions, the sensitivity and detection accuracy of the sensor can be improved greatly. Additionally, in the case of a hydrogen sensor based on Pd or PdY, the use of nanoparticles provides an increased surface area over which hydrogen gas can diffuse into the sensor. As the interaction between hydrogen and Pd or PdY is essentially a surface interaction, increasing the surface area over which the interaction can take place will increase the sensitivity and response time of the sensor considerably. In this submission we investigate computational models describing the dielectric permittivity of Pd and PdY nanoparticles. The effect of particle size, shape and alloy fraction in the case of PdY on the permittivity is investigated.

Keywords: nanoparticles, dielectric permittivity, hydrogen sensing, numerical modelling

Energy

13. New integrated methodology and tools for retrofit design towards a next generation of energy efficient and sustainable suildings and districts

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The NewTREND H2020 Project is developing an integrated design methodology for energy retrofit specified for use for individual buildings and at the district level. The project addresses all phases of the refurbishment process and, to enable the effective application of the methodology, a toolkit will be developed. This toolkit will support each phase from concept design to implementation and operation, fostering collaboration among stakeholders, involving building inhabitants and users and establishing energy performance as a key component of refurbishments. Poor and ineffective communication often results in less than optimal design and construction processes in building refurbishment. For instance, typically occupants are not included in the design process and sometimes the installed solutions are unsuitable for the occupants or incorrectly used, thus increasing the gap between designed and actual performances. This poster presents the work being undertaken within the NewTREND project to foster the involvement of building users and inhabitants across the whole life cycle of the retrofit project through the development of 'Participatory Design' approaches and techniques.

Keywords: energy retrofit, district renovation, participatory design, occupant involvement

14. Sources of particulate matter in small rural towns in Ireland

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Particulate Matter (PM) is a key factor when legislating for air quality; a major constituent of PM is Black Carbon (BC) which is produced during the combustion of carbon based fuels when there is insufficient oxygen for complete combustion. BC impacts on human health by exacerbating symptoms of respiratory diseases and also affects climate by absorbing sunlight, thus producing a warming effect in the atmosphere. In order to develop reliable measures to reduce BC emissions, sound scientific information on the contributions of the various sources is required. Vehicular traffic and solid fuel burning are believed to be the main sources of BC in Ireland, but little information is available on their relative contributions. The aim of this work, which is associated with the EPA-funded SAPPHIRE project, is to identify the sources of BC in residential areas of small rural towns in Ireland. Field measurements were made in three small towns (Killarney, Enniscorthy and Birr) during the winter months of 2014-2015 and 2015-2016. An extensive range of instruments was deployed at all three sites including a single particles mass spectrometer (ATOFMS, TSI model 3800), thermal-optical carbon analyser (Sunset Inc. model 3rd generation), Optical Particle Sizer (OPS, TSI model 3300) and a 7-wavelength Aethalometer (Model AE33, Magee Scientific) for the identification and source apportionment of ambient particles and in particular BC. The results obtained at all three sites show a very clear diurnal variation in the number and mass concentration of particles, with low or moderate levels observed during the day which increase by up to a factor of 10 during the evening hours. This large increase in ambient PM levels is clearly associated with the burning of solid fuel (coal, peat and wood) in households for heating purposes. The Aethalometer and ATOFMS were both used to separate and quantify the contribution of each fuel type to ambient PM and BC concentration as well as identifying other sources of particles, including traffic and agricultural emissions.

Keywords: particulate matter, source apportionment, black carbon, aethalometer

15. Bioaerosol monitoring in Birr, Co. Offaly: a comparison between real-time detection techniques

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An aerosol is defined as a relatively stable suspension of a fine solid or liquid suspended in gas. Primary Biological Aerosol Particles, often termed PBAP or bioaerosols if < 10 µm, are released from a variety of natural sources. Examples include pollen (5-100 µ m), bacteria (0.1-10 µ m) and fungal spores (1-30 µ m). The presence of PBAPs in the air is of increasing interest due to the potentially adverse health effects attributed to them such as asthma, tuberculosis and chronic obstructive pulmonary disease (COPD). Other problems associated with the presence of pollen, fungal spores or bacteria in the air include their involvement in the formation of nuclei (IN) and cloud condensation nucleation (CCN) both of which can have an effect on climate change. The campaign performed in Birr, Co Offaly in December 2015 utilized two different versions of a real-time fluorescence detection instrument known as Wideband Integrated Bioaerosol Sensor (WIBS). Potential PBAP information including size, shape and fluorescence intensity was gathered for individually detected particles. The WIBS contains a diode laser operating at 635 nm and is used to determine size and shape information by optical scatter measurements. A pair of xenon flash sources operating at two excitation wavelengths (280 nm and 370 nm) are then used to excite fluorescence from the particles pumped into the system from ambient air. The aim of the project was to monitor PBAP number concentrations in a small town using WIBS, while a collection campaign for chemical aerosols was also being performed. Actual comparison monitoring was performed for one week during December 2015. Initial comparison of WIBS-4 to WIBS-4A indicate differences in particle counting efficiency with a ten-fold decrease in counts per second for the upgraded 4A model. Higher percentages of fluorescent particles were observed by the WIBS-4A as well as reduced threshold limits and sample flow rate.

Keywords: bioaerosols, PBAP, WIBS,

16. Energy system transition through stakeholder activation

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This poster provides an overview of the work being undertaken within the ENTRUST H2020 project, which is exploring the societal dimensions of energy use. The project aims to provide a comprehensive mapping of Europe's energy system (key actors and their intersections, technologies, markets, policies and innovations) and an in-depth understanding of how human behaviour around energy is shaped by both technological systems and socio-demographic factors (in particular gender, age and socio-economic status). The role of gender in this context is illuminated by intersectional analyses of energy-related behaviour and attitudes towards energy technologies, which will assess how multiple identities and social positions combine to shape practices. These analyses will be integrated within a transitions management framework which takes account of the complex meshing of human values and identities with technological systems. The importance of the energy citizenship concept is recognised and a key objective of ENTRUST is to enable individuals to overcome barriers and become active participants in their own energy transitions. This is achieved through collaboratively working with a number of very different communities across the continent to envision more sustainable energy futures.

Keywords: sustainable energy transition, community engagement, low-carbon energy system, intersectionality

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Environmental Policy And Communication; Socioeconomics

17. Enhancing sustainable development in Irish urban centres through development of an environmental and socio-economic model

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Ireland may fail to meet future greenhouse gas (GHG) emission reduction targets without significant change to current policies and actions. A growing population, increasing urbanisation and the physical effects of climate change have led to calls for the provision of more housing, necessary infrastructure support, and adaptation measures to combat extreme weather conditions. Currently, policies relating to sustainable urban development (SUD) focus predominantly on spatial planning, with little provision for consultation and involvement of communities beyond that required by planning law. Well planned SUD helps to achieve national environmental policy targets. While communities in many other countries have implemented and achieved both environmental and socio-economic gains from well-planned SUD, Irish communities have largely not done so. This research aims to examine polices at EU and national level which have either helped or hindered SUD programmes in terms of: role of government; unintended barriers; planning regulations; and financial resources available to communities. This research will evaluate successful policy implementation, community motivation for action, conditions which supported success, and steps taken. How this translates to an Irish roll-out will be examined, bringing together information relating to Irish law and conditions which will be tested in selected communities. This will be achieved through case studies of successful communities such as Adamstown (top-down planned), Cloughjordan (bottom-up experience), and Letterkenny (isolated/ tourism) to understand their motivation, ability to recognise potential for development, necessary skills employed to transform policy and technologies into action, and financial sources utilised. Also examined will be the benefits to communities from actions taken, including, how stated environmental gains are verified. Information gathered will be used to develop a decision making support tool for communities seeking to implement SUD actions. Results of this research will also be used to form the basis for reasoned policy recommendations at local and national government levels.

Keywords: GHG emission reduction, environmental policy, sustainable urban development, community involvement

18. Modelling groundwater-surface water flood risk in Gort town, Co. Galway

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Flooding is an issue of international concern. In Ireland flooding has become more frequent and extensive in recent years, and this trend is predicted to continue due to climate change impacts on the hydrological cycle. Gort Town has historically been susceptible to flooding associated with extreme discharges in the Gort River, with reported flood events stretching as far back as 1924. The extreme rainfall events of 2009 caused the worst flooding on record and as a result, Gort Town was identified as an area at significant risk of flooding during the Preliminary Flood Risk Assessment (PFRA). However, assessing flood risk poses unique challenges due to the combined effects of a lack of discharge data for Gort Town and the complexity of regional hydrology. The river forms part of a lowland karst groundwater system, where surface flow is intermittent and drainage is primarily via the subterranean karst network. The interactions between surface water and groundwater systems upstream provides an attenuating effect on flood flows through Gort Town. A model of the upstream system has been developed using a pipe network model to quantify this attenuation. Design flows and unit hydrographs were calculated using the recent Flood Studies Update (FSU) methodology. The design flows were then routed through the model to work out the attenuation effect of the conduit network and estimate corresponding design flows for Gort Town. Two real flood events, 2009 and 2015, were also routed through the model and a comparison was made between the events. This study provides the information necessary for effective flood risk management in an area significantly impacted by flooding.

Keywords: flooding, karst, modelling, groundwater-surface water interaction

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Invasive Species; Environmental Management

19. Light-related phenotypic plasticity of invasive, alien, submerged macrophytes.

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Since 1980 the greatest rate of increase in alien introductions to Ireland has been to the freshwater environment. Seven 'High Risk' freshwater plant species have been identified. Invasive alien aquatic plants (IAAP) are considered an increasing economic and ecological threat to Ireland's freshwaters. In aquatic environments light intensity controls primary production and submerged plant distribution. Research has shown species-specific morphological plasticity and physiological tolerance in macrophytes exposed to different light levels. Light-related plasticity may offer competitive advantages to invasive species. Thus, establishing the comparative light requirements and shade tolerances of invasive and native submerged macrophyte species can inform management strategies for such species. Growth and morphology of four high risk IAAP species (*Elodea Canadensis, E. nuttallii, Lagarosiphon major, Myriophyllum aquaticum*) and two native counterparts (*M. spicatum and Cerataphyllum demersum*) were compared under a range of light intensities. A combination of controlled laboratory experiments and outdoor mesocosm experiments were employed. Plant allofragments and established plants were investigated separately, in order to compare strategies at different stages of the lifecycle. Optimum growth curves showed that *Myriophyllum* species favoured low light (<100µmol m^{-2} s^{-1}) conditions while the *Hydrochariceteae* favoured medium light (200-400µmol m^{-2} s^{-1}) conditions. Different strategies were identified for each species, with respect to root & shoot morphology, leaf area, internode length and biomass allocation. Shade tolerance was evident during allofragment establishment, some species exhibited no difference in accumulated biomass or RGR between light-treatments, though morphological differences were observed. It is hypothesised that morphological plasticity allows biomass to remain constant in different light environments. Understanding invasive and native plant adaptations to light intensity furthers knowledge of their habitat requirements and informs management of freshwater systems with respect to invasive species control through light exclusion, management of riparian shade and water clarity.

Keywords: aquatic invasive species, light intensity, phenotypic plasticity, macrophyte morphology

Invasive Species; Environmental Management

20. The effectiveness & commercial potential of a novel nctive bioswale system for the treatment of farm yard waste water

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Agriculture is one of the major contributors to the Irish economy. However agriculture impacts on the environment and is recognised as one of the primary contributors to the eutrophication of Irish surface waters and pollution of ground waters. Discharges of dirty water runoff contain extremely high levels of organic matter, ammonia, phosphates and faecal bacteria. Storage of large volumes of farmyard dirty water (FYWW) poses a significant risk to the environment and added to this are the significant financial cost of storage. The central theme of the project is to establish the efficiency and reliability of a full scale prototype of a novel Active Bioswale Treatment (ABT) system in treating FYWW and therefore contribute to the environmental sustainability of farming in Ireland and Europe. The feasibility of such a system has been trialled by employing a model scale version of the ABT system. Significant reductions in COD, nitrate, ammonium,TDS and T-P were achieved, however the system had no effect on the reduction of ortho-phosphate. The ABT system has a small footprint and offers a natural, low cost approach to remediation of wastewater. ATB system is based on the use of swales reed beds systems for treating FYWW in conjunction with various media layers that reduce pollution through biochemical and physiochemical processes. The system allows for recirculation of wastewater through sprinklers until the desired pollution reduction is achieved, it also protects ground water through the utilization of an impermeable ground barrier. At present the primary focus of the project is on media that will significantly reduce the presence of ortho-phosphate and also have considerable maximum adsorption capacity. Before the project can proceed to the next stage a suitable media must be ascertain based on the knowledge gained from detailed laboratory analysis of various mediums.

Keywords: agricultural waste water remediation, nutrient reduction, natural attenuation

Invasive Species; Environmental Management

21. New area estimations of cultivated organic soils and associated greenhouse gas emissions

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Farmed organic soils, which are a large source of both carbon dioxide and nitrous oxide emissions, are a particular area of interest in Ireland, with peatlands covering 20% of the landscape. For accurate accounting and national reporting of greenhouse gas emissions, there is a need to calculate total land area used for agricultural activity on drained organic soils; data which are currently unquantified in Ireland. This research, through map overlay analysis using a GIS in combination with a probability sampling method and a ground truthing technique, re-estimated organic soils under cultivation as 1,235 ha; considerably lower than mapping estimates. Utilising the new area estimates, N_2O emissions were calculated through quantification of the C:N ratio of collected soil samples and N_2O emission coefficients. C emissions were also calculated using IPCC coefficients with the new area estimates. It was estimated that 6152 kg N_2O yr^{-1} and 9.756 Kt C/yr^{-1} of CO_2 were emitted from cultivated organic soils in Ireland in 2012. This research provides improved accounting of organic soils under cultivation and contributes to national reporting of GHG emissions at higher tiers with reduced uncertainty, thus providing more reliable information on which to base strategies aimed at reducing GHG emissions in Ireland in the future.

Keywords: organic soils, greenhouse gases, new area estimates

22. Biosorption of heavy metals using spent mushroom substrate biomass

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Biosorption refers to the ability of certain biomass or substrates to retain and concentrate molecules from aqueous solutions through passive means. Spent mushroom substrate from *Agaricus bisporus* was used as a biosorbent to remove Cu, Pb, Zn and Fe metal ions from aqueous solutions. The aim of this study was to ascertain the optimal metal removal conditions for each metal ion solution, with respect to pH, time, metal ion concentration and temperature. Batch experiments were conducted on 0.2 g of the dried and milled substrate and incubated at the desired parameters and the optimal removal rates were established using atomic absorption spectrophotometer (AAS). Percentage removal rates were calculated at each stage of the experiment and the maximum removal conditions used in the subsequent stages of the experiment. Results indicate removal rates of 81.37% for Zn, 81.80% for Cu, 87.35 for Fe and 92.94% removal for Pb. These result indicate that spent mushroom substrate has great potential in the sequestering of heavy metals

Keywords: spent mushroom substrate, heavy metals, biosorption.

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Invasive Species; Environmental Management

23. Efficacy testing under the EU biocidal products regulation

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Biocides are regulated in the European Union under the Biocidal Products Regulation (EU) No 528/2012 (BPR). A biocide is a substance or product that is applied or generated in situ with the intention of destroying , deterring, rendering harmless, preventing the action of, or controlling a harmful organism by a means other than mere physical or mechanical action. This includes products such as disinfectants, preservatives, rodenticides, molluscides, insecticides and anti-fouling products. For a biocide to be sold and used in an EU member state, a dossier on the product's/substance's human effects, chemistry, environmental effects and efficacy must have been reviewed and accepted by one of the EU member states competent authorities. In order to generate the data necessary for this dossier, a trial permit must be authorised by the Pesticides Registration and Control Division (PRCD) of the Department of Agriculture, Food and the Marine (DAFM). A trial permit is required for testing of an unauthorised biocidal substance, or of an unauthorised use of an authorised biocidal substance regardless of trial purpose (e.g. R&D, demonstration, marketing). One of the key areas of the legislation is the assessment of the efficacy of a biocidal active substance or product. Efficacy assessments carried out in Ireland require trials that are: suitable to the biocidal product type being tested (there are 22 product types), scientifically robust, carried out according to good lab practice in an officially authorised trial facility. The PRCD of DAFM (http://www.pcs.agriculture.gov.ie/biocides/) is the competent authority for Biocidal Products in Ireland.

Keywords: biocide, biocidal products regulation, efficacy

Invasive Species; Environmental Management

24. Diversity and ecology of *Phytophthora* species on the island of Ireland

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The island of Ireland has a long history with the plant pathogenic oomycete genus *Phytophthora*. Since the invasion of the late blight pathogen *Phytophthora infestans* in mid- 19th century, *Phytophthora* species have caused major changes to agriculture and plant health on the island of Ireland. In recent years, the scientific expertise built up in plant pathology and mycology on the island of Ireland has been drastically diminishing, while invasions of plant pathogens have been increasing in line with increasing globalisation and international trade in plant and plant based commodities. In order to draw attention to the increasing threat posed by *Phytophthora* to the plant health of the island of Ireland, we reviewed the records of *Phytophthora* species detected along with notes on the species' ecologies. Using published and unpublished records, we found that 27 species and two provisionally named taxa of *Phytophthora* have been recorded on the island of Ireland. The role of the horticultural trade in plants for planting in spreading invasive *Phytophthora* species was evident in the results. Areas in which future research should focus are given in order to add to the list of *Phytophthora* species detected on the island of Ireland are also discussed.

Keywords: quarantine, invasive aliens species, plant pathogens

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Invasive Species; Environmental Management

25. A secure agile wireless sensor network for coastal incident monitoring

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In this paper the design of an intelligent Wireless Sensor Networks (WSNs) system for marine coastal monitoring will be presented. The system architecture addresses the capability for remote sensor data management and the encryption of data transmitting between sensor nodes. Furthermore, the system has the capability to adapt its sensor nodes within the network in response to environmental changes or sensor condition changes. The scheme provides a travelling packet for source to end user authentication via individually encrypted links between sensor nodes. The project applies a number of security algorithms on the network, such as advanced encryption standard (AES) based WSNs. The system has been tested under real world conditions using a Waspmote sensor platform in the University of Limerick Campus. These results will be presented.

Keywords: marine coastal monitoring, wireless sensor networks. WSN, wasp mote, node.

26. The use of Phytoplankton as a biological quality element in tidal freshwater transitional waters in Ireland

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Tidal Freshwater Transitional Waters (TFTWs) are vital ecosystems for spawning fish and invertebrates as well migrating fish and wildfowl. TFTWs as sites of increased productivity are both naturally and anthropogenically stressed. Inputs of TN and TP from urban and agricultural run-off have caused many TFTWs in Ireland to become eutrophic. The Water Framework Directive (WFD, 2000/60/EC) requires all water bodies in EU member states to achieve "good ecological status" by 2015. The monitoring of Biological Quality Elements (BQEs) which include; phytoplankton, macroalgae, angiosperms, benthic invertebrates, and fish as per Annex V of the WFD is currently ongoing. The EPA reported that 48% of TFTWs were reported as moderate or worse ecological status. This study set out to characterise the phytoplankton community in TFTWs around Ireland, explore if the distribution of taxa was driven by salinity, how this affected species richness and to describe the variation in temporal taxa distribution. It was found that spatial distribution and taxa diversity was not due to salinity. Cell abundances L-1 could be used for specific harmful indicator species of in the future. A temporal pattern in taxa abundance and change in community composition emerged. The factors affecting the change in taxa composition such as the complex relationship between TN:TP ratios and their influence on community structure need to be explored in future studies. The use of pennate to centric diatoms ratio may be a useful to augment the current BQEs but would need to be correlated with current indices over a longer period of time. The use of living to dead diatoms index is not suitable for TFTWs ecological assessment.

Keywords: tidal freshwater transitional waters; phytoplankton; BQE; WFD; salinity

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Marine And Coastal

27. Molecular and chemical ecology of intertidal sand-dwelling protists in the northwest of Ireland

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Eutrophication in coastal waters has increased in the last decades around the globe owing to growing human populations in coastal areas and the development of industrial and agricultural activities. The EU - Water Framework Directive (WFD) introduced in 2000 set out measures to improve the quality of all water bodies by 2015. Phytoplankton diversity is considered a suitable biological indicator to determine the trophic state of coastal waters and its identification has traditionally been carried out by microscopy analysis. Intertidal sand-dwelling protists (protozoa and microalgae) have seldom been on the focus of attention of ecological studies compared to planktonic organisms. This is partly due to the difficulty of carrying out microscopy analysis on samples containing high amounts of detrital organic and mineral materials. Yet benthic microorganisms are present in the sediments all year round and generally do not flushed out by tidal action in comparison to phytoplankton. Populations and communities at sites along the coastline may hence be viewed as sedentary and their structure a reflection of their local environment. This study focuses on the study of sand-dwelling protists in northwest Irish beaches. The well-established molecular method PCR-DGGE (Polymerase Chain Reaction – Denaturant Gradient Electrophoresis) and HPLC-based pigment analysis were used to investigate the community structure of microphytobenthos (benthic protists) in intertidal sediments at sites in Sligo Bay. The molecular data generated will provide the foundations for the future ecological mapping of particular benthic protists species, population and/or communities. It is anticipated that the results obtained on benthic protist community diversity could permit the development of a new environmental quality index that could be incorporated in the future to extent monitoring programmes.

Keywords: sand-dwelling protists, PCR-DGGE (Polymerase Chain Reaction – Denaturant Gradient Electrophoresis), pigment analysis, HPLC-UV-DAD, environmental quality, Sligo Bay, intertidal sediments

Marine And Coastal

28. Investigation of marine boundary fog formation by use of the WIBS (Wideband Integrated Bioaerosol Sensor) located at Haulbowline Island, Co. Cork

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The Wideband Integrated Bioaerosol Sensor (WIBS) is a modern tool that is being increasingly deployed for on-line bioaerosol monitoring. It provides a real-time profile of airborne fluorescent and non-fluorescent particles by means of fluorescence spectroscopy and optical scatter. Biological particles (e.g. pollen, fungal spores) contain fluorophores (e.g. amino acids) that are detectable after light excitation. WIBS can also identify size and asymmetry (shape) of the particles by use of laser scattering. However, many chemical particles also weakly fluoresce. To date no strongly fluorescing airborne chemical particles have been detected by WIBS in the 0.5-22 µm size range over which the technique is operative. The WIBS-4 was deployed in Haulbowline Island for a field campaign over the following dates: 15th July to 31st July 2011 and 1st September to 30th September 2011. (Haulbowline is an island off the coast of Cork). The WIBS was accompanied by a Scanning Mobility Particle Sizer (SMPS) to provide a more in-depth analysis of the particles over a more extensive size range (10 ~ 450 nm). An Aerosol-Time-of-Flight Mass Spectrometer (ATOFMS) was also deployed to give information on the chemical composition of the particles (Size Range: 100 – 3000 nm). During the campaign multiple fog formation events occurred and coincided with escalations in the recorded fluorescent particle counts. The question arose then as to whether or not biological release events gave rise to the fogs. However, various properties of these particles are also consistent with the release of iodine-containing particles from sea-shore kelp. These releases give rise to molecular iodine, iodine oxides and iodochlorine (ICl) are well known to occur in coastal areas from previous studies. Therefore the spectroscopic, optical and spectrometric properties of the aerosols present were investigated to see if the results can be attributed to the release of biological particles and/or iodine-related species.

Keywords: WIBS, fluorescent particle, fog formation, aerosols, iodine, ATOFMS, SMPS

Novel Applications In Sustainability And Research Innovations

29. Investigating the role of serine proteases in basidiomycete fruiting body development and nutrient acquisition from humic-rich environments

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The basidiomycete *Agaricus bisporus* is the most cultivated mushroom worldwide and the mushroom industry represents the largest horticultural sector in Ireland. Basidiomycete fungi also have a clear ecological role, where the depolymerisation of biopolymers is the main process in the cycling of carbon, with litter decomposition in temperate forests mainly driven by fungal activity. They constitute a major fraction of the living biomass responsible for efficient degradation of numerous recalcitrant organic compounds in soil litter and the humic layer. *Coprinopsis cinerea,* (formally *Coprinus cinereus*), the ink cap mushroom, is a model mushroom that is used to study basidiomycetes due to its ease of cultivation and fast growth cycle. This research is focused on the role of serine proteases in basidiomycete fruiting body development and nutrient acquisition from humic-rich environments. Sequence analysis of the *C. cinerea* genome has revealed seven potential serine proteases. The function of these enzymes and their role in the life cycle of the mushroom, from nutrient acquisition to fruiting body development will be investigated through promoter profiling. Results to date report on the construction of expression plasmids and the isolation of the serine protease promoters by PCR.

Keywords: basidiomycetes, fungi, serine proteases, *Agaricus bisporus*

30. Bioprospecting Irish potato soils for the presence of plant growth-promoting Rhizobacteria.

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Plant Growth-Promoting Rhizobacteria (PGPR) represent a viable and sustainable alternative to conventional methods of improving crop yields in modern agricultural systems. The potato plant (*Solanum tuberosum*) is an important agronomic crop and is the fourth most widely-grown crop in the world. It is worth over €80 million annually in Ireland alone. Constraints from the European Union in terms of lessening the amount of fertilisers and the range of biocides available to farmers, along with said financial costs, is leading to the need for another solution. An ideal solution lies with PGPR, these bacteria can aid the health of the plant both directly through means of phosphate solubilisation and ACC deaminase activity or indirectly through inhibiting the growth of fungal pathogens or the production of hydrogen cyanide, to name but a few beneficial PGPR traits. To bioprospect Irish potato soils for the presence of PGPR, both conventional and organic sites were selected for screening to maximise the potential for identifying a wider array of bacterial isolates with beneficial properties. Potato cultivars British Queen and Premiere from conventional plots and cultivars Maris Bard and Colleen from organic plots respectively, were screened for the presence of PGPR with the aim of ultimately finding isolates which have the potential to offer a sustainable alternative to modern agrichemical inputs.

Keywords: potato soil; plant growth-promoting Rhizobacteria; sustainability

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Novel Applications In Sustainability And Research Innovations

31. Optimisation of compost utilisation by Agaricus bisporus through genomic analysis

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Globally *Agaricus bisporus* (common button mushroom) production has an annual value greater than $4.7 billion. Domestically, it is Irelands largest horticultural sector with a farmgate value of just under €120 million. However, like a majority of horticultural products, profit margins are quite narrow and have a degree of unpredictability. In the case of *A.bisprous* significant profits are lost due to its inability to utilise compost fully. Due to this, compost use is limited to just three flushes, before below optimum growth of the mushroom occurs, requiring the compost to be changed. This research aims to address the issues of the third flush with the goal of improving mushroom yields through improved compost utilisation and strain selection. This will be done by determining which genes and enzymes are critical in controlling yields and identifying any changes to their production throughout each flush. Genes and enzymes associated with nutrition will also be examined by microarray analysis, to determine if any differential expression is occurring at specific time points in the cropping cycle. Any genes determined to have a possible role in yield control or flushing patterns will be studied further by promoter analysis. The most promising expression profiles will be characterised by heterologous/homologous expression systems.

Keywords: optimisation compost, *Agaricus bisporus*, genomic microarray, mushroom

32. Flow cytometry for enumeration of pathogenic mycoplasma species

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Mycoplasma are among the smallest free living organisms found on Earth. These tiny bacteria are characterised by a lack of cell wall and incredibly short genomes. Missing a cell wall, they have an inherent resistance to many common antibiotics such as penicillin, which affect cell wall synthesis. In addition, the short mycoplasmal genome means many mycoplasma are incapable of synthesising common cellular molecules such as nucleotides, requiring them to be obligate parasites. Multiple mycoplasma species are pathogens of pastoral animals such as *M. hyopneumoniae*, the causative agent of chronic porcine enzootic pneumonia. *M. hyopneumoniae* remains one of the most prevalent and economically impactful pathogens affecting swine herds despite efforts at eradication and has been shown to cause a substantial loss in feed conversion and weight gain as well as comorbidity with other porcine respiratory pathogens causing porcine respiratory disease complex (PRDC). Primary causes of economic loss are due to the reduced performance of the herd and increased usage of medication. Whole-cell vaccination has been recommended as part of an effective strategy to counter *M. hyopneumoniae* infection and spread; however *Mycoplasma* spp. are notoriously hard to culture and assessing growth often requires laborious and time-consuming culturing methods such as the Colour Changing Unit (CCU) assay. A rapid alternative to CCU is the implementation of flow cytometry. Flow cytometry has the potential to rapidly enumerate Mycoplasma spp. in culture using an optimised method, and has the advantage of being a rapid, high-throughput technique. In addition, flow cytometry has been shown to have a detection limit low enough for diagnostic uses.

Keywords: flow cytometry, mycoplasma, animal health

33. Durum wheat seed germination response to hydrogel coatings and moisture under drought stress

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Technologies that can increase crop production while maintaining low pollution are essential for sustainable agriculture. This study compares germination performance of durum wheat seeds (*Triticum durum Desf.*) with synthetic and natural seed coating at two different moisture levels in the laboratory. The germination percentage, radicle emergence, germination speed, seedling length and fresh seed weight were analysed as growth rate indices and compared at a significant ($P < 0.05$) difference according to Tukey's post hoc test. Seeds were coated with synthetic polyacrylamide (PA) and natural agar/ι-carrageenan blend (AC) in varied amounts. Both synthetic and natural polymer coatings helped to improve radicle emergence, germination speed, seedling length, and seed vigour compared to the uncoated seeds at 80 % moisture level. 16 mL of (AC) coating showed a 5.8 % increase in seed vigour at 40 % moisture level, while 16 mL of (PA) coating reduced the vigour by 2.3 % relative to the control. The novel ι-carrageenan hydrogel blend has the potential to be used as an environmentally friendly seed coating agent to enhance seedling development under drought stress. Further research is under way with optimised coating to verify the same standard of effectiveness in field conditions. It is anticipated that this work will be extended to the coating of different seed varieties to promote seed growth with minimum environmental impact under extreme climate conditions.

Keywords: drought stress; Durum wheat (*Triticum durum Desf.*); hydrogel seed coating; seed germination, sustainable agriculture

Novel Applications In Sustainability And Research Innovations

34. Recent development of a novel membrane-based passive sampling technique for measurements of bioavailable chemicals in the environment

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This presentation provides a summary of the recent development of a new technology of diffusive gradients in thin films (DGT) variant using Zr-oxide based binding gels. As one of the passive sampling methods, the DGT has received increasing attention for its applications in measurements of bioavailable chemicals in soils, waters, and sediments. The Zr-oxide DGT was developed in 2010. It has relatively high capacity for measurements of oxyanions (P, As, Cr, Se, Sb, Mo and W), with 50 and 5~29 times of those of the commonly used ferrihydrite DGT for measurements of P and As, respectively. It is easy to provide high-resolution (sub-millimetre), two-dimensional spatial information of P using a gel coloration procedure, while this technique has been successfully applied to in situ monitoring labile P in a large eutrophic Lake Taihu in China. Simultaneous measurements of cations and anions, such as P and S, P and Fe, As and Fe, and As, Fe and P, have been successfully achieved through the development of several types of mixed binding gels based on the Zr-oxide gel. Successful application of this technique is also effective to investigate the mechanisms of eutrophication in lakes. More functions are being extended with this technique for measurements of other analytes.

Keywords: passive sampling; diffusive gradients in thin films (DGT); Zr-oxide DGT; dioavailability; eutrophication

Sustainable Land Use

35. Modelling ammonia emissions from livestock systems in Ireland

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At present in Ireland, 98% of national ammonia emissions are generated from the agricultural sector. Dairy and beef production systems account for approximately 72% of these emissions. To date, research regarding ammonia emissions from Irish agriculture has focused primarily on land spreading and fertilizer application emissions. There is a shortage of research related to housing and storage emissions, and additionally an integrated assessment of ammonia emissions taking into account the disparate emission sources is lacking. Simulation models provide an opportunity to carry out such assessments, and particularly when allied to a whole farm model, permit the prediction of the effects of changing farming practices on ammonia emissions using existing research data. The objectives of this study are to (i) review whole farm N flow models and assess the effectiveness for use under Irish farming conditions (ii) develop an empirically driven simulation model to predict ammonia emissions from housing, storage and land spreading of cattle manure and (iii) assess the cost effectiveness of NH3 abatement strategies using a whole farm model. This modelling study is part of a multidisciplinary four year project titled, "LowAmmo - Measurement and abatement of ammonia emissions from agriculture" and will involve development of a model of N cycling and ammonia emissions from cattle production systems. The model will be parameterised using two primary data sources; firstly, a comprehensive literature review of N flow models will be conducted and secondly, data generated from experiments carried out in the LowAmmo project will be accessed. An important outcome of this modelling study will be the prediction of ammonia emissions from Irish agriculture as well as the quantification of the abatement potentials of various emissions reduction strategies under Irish farming conditions. The whole farm model, in particular, will help to quantify whole-farm ammonia and other greenhouse impacts and thus help in development of economically sustainable NH3 abatement strategies.

Keywords: ammonia emissions; whole farm model; cattle systems

36. Stakeholder perceptions of sustainable community engagement in wetland projects: a comparison of three case studies in Ireland

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Community engagement in wetland conservation can help deliver Water Framework Directive objectives. This project assessed stakeholder opinions and perceptions relating to community based wetland projects to identify key requirements for sustainability, i.e., achieving the dual goal of self-sustaining projects and protected ecosystems. This study indicated the ancillary benefit of community engagement in fostering a shared environmental understanding by a process called *social learning* (i.e., learning together to manage together). A mixed methods study was undertaken to investigate community engagement strategies with particular reference to three wetland projects in Ireland. Surveys of different stakeholder groups involved in the projects were undertaken (i.e., project managers, visitors/volunteers and other users). These provided largely qualitative data on the projects and anecdotal evidence of successful community engagement. Q-methodology was used to analyse stakeholder perceptions and identify key factors for community wetland projects. Four common factors, which may be considered perspectives shared by stakeholders, were identified as: (i) Socio-environmental capacity building, (ii) Integrated, multi-agency collaboration, (iii) Objective, socially inclusive governance and (iv) Honest, progressive working relationships. The results show that social learning, arising from involvement of various stakeholders in projects, and its value is more perceptible to other stakeholders than project managers. Overall, 94% (n=16) of participants agreed that involving various stakeholders in projects introduces new ideas and techniques and results in social learning. The report concludes with recommendations for further research and suggests mechanisms for ensuring national support for community based wetland projects from 'top-down' to grassroots level.

Keywords: community engagement • stakeholder opinions • Q-methodology • social learning, ecosystem services.

37. Sustainable land use management for the conservation of the Freshwater Pearl Mussel: sediment flux and provenance

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The Freshwater Pearl Mussel (FPM) is a long-lived aquatic invertebrate found in coarse sand or fine gravel in clean well-oxygenated, fast-flowing and unpolluted freshwater. They are particularly sensitive to environmental pressures that cause habitat degradation and thus have undergone a severe decline over the last century. Ireland supports almost half the European populations of FPM, however, the number of recruiting sub-populations in Ireland has declined by 96% over the last 90 years. The unfavourable conservation status of the Irish FPM is thought to be due to pressures including sedimentation and pollution. This study will focus on two important FPM catchments and will encompass four primary aims. The first will establish detailed sediment budgets for each catchment by identifying the pathways and fate of fine-grained sediments arising from non-point sources. We will use high-resolution sediment flux estimation, combined with novel sediment fingerprinting, to apportion river sediment loads to respective sources. We will also develop simultaneous discharge and turbidity methods that are applicable across Irish land-use gradients. The second aim is to determine the quality of the fluvial microhabitat by characterising the structure and stability of channel substrates, with focus on bed compaction and dissolved oxygen availability. Thirdly, a combination of lake cores and mussel age profiles will be used to investigate the correlation between historical land use, sediment yields and population decline. Finally, the project will evaluate mitigation measures to limit the supply of fine sediments from critical source areas, as part of an integrated basin management strategy. The results derived from this study will highlight areas of high sediment output and assist in the efficient delivery of management practices in co-operation with the KerryLIFE project. The study will help the development of ecosystem-based adaptation (EbA) measures that both contribute to the restoration of endangered species and achieve wider sustainable land management benefits.

Keywords: sustainable land use, sediment yields, conservation

38. Diffuse reflectance infrared spectroscopy of soils

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Dairy, beef, pig and sheep farming is becoming more intensive in Ireland in order to meet the challenging growth projections set by Food Wise 2025. Sustainability of this intensification will require optimum soil quality and fertility. Soil quality and fertility are monitored by testing for parameters such as; Morgan's phosphorus (P), pH, cation exchange capacity (CEC), aluminium (Al) and iron (Fe). Soil testing for P is also required through the Nitrates Directive, to protect water quality and prevent the over-use of fertilisers. However, there are disadvantages associated with traditional soil testing methods; they are time-consuming, costly and produce a lot of chemical waste. The aim of this project is to explore the application of infrared diffuse reflectance spectroscopy (DRIFT), in combination with chemometrics, to predict indicators of soil fertility, specifically, P sorption capacities and P binding energies. Both of these parameters are indicators of soil's ability to take up and supply P. This new technique will be less time-consuming, inexpensive and will hopefully act as a surrogate for extractive and digestive techniques traditionally used to analyse soil. This work will focus on building reference laboratory data using conventional methods and calibrating these against spectral data to predict values from unknown samples using modelled data. Preliminary results, using archived soil samples, from the Irish Soil Information System have been used to develop calibrations for parameters; pH, CEC, Al and Fe. These parameters are correlated with P sorption and P binding in soil. These calibrations were generated using the Cubist modelling method, in the mid infrared (MIR) and near infrared (NIR) regions of the spectrum.

Keywords: agriculture, chemometrics, infrared spectroscopy, phosphorus, P binding energy, P sorption capacity, soil fertility, sustainability

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Sustainable Land Use

39. Quantification of in-field variation of soil nutrient for improved farming practice in small farms

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The current nutrient management in Ireland is based on soil analysis for composite samples, collected from areas of the size of several hectares, which has ignored the in-field variation of nutrient demand. The national soil database of Ireland contained a total of 1310 soil samples at the density of 2 samples in every 10*10 km grid. While the total concentrations of phosphorus (P) demonstrated good spatial patterns which are mainly related to geology (e.g., relatively high values in sandstone areas and low values in limestone areas), the plant available fractions of P showed poor spatial patterns at the national level, with a poor spatial structure revealed by variogram in geostatistics, implying the strong influences of agricultural activities. Intensive soil sampling at the farmland level has revealed strong spatial variations of available P and other nutrients at the in-field level, with nutrient index advice level ranging from the lowest to the highest. These results provide strong challenges to the currently widely-used composite sampling strategy. It is recommended that even in small farmland in Ireland, more precise in-field variation of available P should be better quantified and such information can be useful to improve the current nutrient management.

Keywords: in-field variation; small scale; nutrient management; geostatistics

Waste Management

40. Evaluation of phosphorus recovery technologies from municipal wastewater in an Irish context

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Phosphorus (P) is essential for all life. Manufactured P fertilisers, produced from mined phosphate rock are essential to feed the growing population. Of the circa 22 Mt P added to the world economy annually from mined fossil phosphate resources, approximately 80-90% is used as fertiliser, 5-7% for animal feed additives and the remainder in various applications including food additives. P cannot be produced synthetically and has no substitute in food production. Phosphate rock is finite and non-renewable, with supply vulnerable to future phosphate scarcity, volatile pricing and geopolitical tensions. This is reflected in the inclusion of phosphate rock in the EU Critical Raw Materials list in 2014. Owing to the dependence of food security on P availability, there is a global need to promote more efficient use of P as well as its recovery and reuse. Notably, almost all of the 3 million tonnes of P consumed in food per year by the global population enters the wastewater sector. Municipal wastewaters therefore represent a major point source to recover P and re-establish a circular economy. Numerous technologies have been developed for recovering/ recycling P from municipal wastewater. One of the main objectives of the current study is to evaluate these technologies with the aim of assessing their feasibility in an Irish context. Recovery technologies based on crystallization and precipitation are limited to WWTPs with Enhanced Biological Phosphorus Removal of which, to our knowledge, there are none in Ireland. Other technologies such as those based on acid leaching (of sludge/ash) or thermochemical processes can recover greater amounts of phosphorus (48-99% of influent phosphorus compared with ~10% for precipitation technologies). These types of processes are not as far along in their technical development and would require significant investment. This study also aims to examine the potential market for recycled P products.

Keywords: phosphorus, recovery, recycling, wastewater treatment

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Waste Management

41. Reusing Irish waterworks sludge in clay brick manufacturing

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In Ireland, like other places in the world, alumimiun sulphate was used as coagulant for raw water purification during the drinking water treatment process, thus producing inevitable suspended and dissolved solids, which is termed as "alum sludge". Throughout the world, alum sludge is dewatered and the resultant cakes are treated as a "waste" for landfill as their major final disposal although 11 ways of reuse/recycle have been identified. In spite of the fact that there are a number of recycling methods being investigated at present, this study is to investigate the possible incorporation of alum sludge as a partial replacement for clay in clay brick manufacturing, which has not been studied in Ireland. Alum sludge cakes and clay were separately dried, ground & sieved in preparation for making test specimens. Cylindrical clay bricks were made at different temperatures (800°C, 1000°C, 1200°C, 1100°C), incorporating different percentages (0%, 5%, 10%, 15%, 20%, 30%, 40% by dry weight) of alum sludge. The bricks were then subjected to compressive strength test and submerged water tests. Loss on ignition, water absorption and weight reduction were calculated. It was found that bricks containing up to 20% sludge, fired at 1200°C, or containing 5% sludge and fired at 1100°C have met the European and Irish Standards as set out by Eurocode 6 – 'Design of Masonry Structures'. The firing temperature and the increase in sludge content affected the final clay-sludge brick colour. By increasing the proportion of alum sludge, compressive strength decreased and the final weight of the brick reduces. Firing temperatures that are too high may result in damage to the bricks during firing. Overall, this study has demonstrated the promising potential and prospects for Irish dewatered alum sludge cakes in clay-sludge brick making.

Keywords: alum sludge, clay brick, reuse, sinter

42. Investigation of vermitechnology: A green waste management method for food waste

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Waste generation disposal is an increasing problem in the Western World. Current solutions to the problem are unsustainable. This project examines the use of vermitechnology, a novel solution which utilises earthworms to treat food waste. Other solutions are required for the many other types of waste, including; plastic, paper, household, and industrial waste. Despite having one of the lower population densities in the EU, Ireland generates over one million tonnes of household waste per year. There are currently two main forms of treatment for waste, including food waste in this country. These are landfill which is unsustainable and incineration, which poses serious environmental and human health risks and is currently politically unacceptable. This project began in September 2015 in collaboration with Full Cycle, an SME based in South Africa. A literature review has identified, a niche where previous research has been completed in this area in India and Australia, but not much work has been done under Irish conditions. Clearly there is a need for research towards developing a green waste treatment approach which will not only reduce the load on landfill, but will also have good market potential in the form of a plant growth and protection product. When earthworms break down food waste they produce an organic solution which is known as 'Vermitea'. The current stage of research focuses on applying vermitea to plants in order to determine whether or not it will enhance plant growth and afford protection against pests and pathogens.

Keywords: Vermitechnology, food waste, vermitea

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Waste Management

43. Bioaerosol monitoring at a green waste/composting management site in Co. Cork

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An aerosol is a suspension of particles or droplets in a gas and can be emitted directly or indirectly into the atmosphere. If their source is biological they are classed as Primary Biological Aerosol Particles or "Bioaerosols" if they are smaller than 10 µm. Examples are plant debris, pollen, fungal spores, algae and bacteria. Airborne pollen can cause allergies to people with hay fever and fungal spores e.g. *Aspergillus fumigatus* cause disease such as Farmers' lung. Therefore, it is important that there are methods and instruments developed to measure bioaerosols in our ambient surroundings. The aim of this project is to monitor bioaerosol emissions from a green waste/composting management site in Co. Cork. Detailed site profiles of activities (such as agitation), meteorological conditions and deliveries were recorded so that their relationship to bioaerosol releases could be determined. Two instruments were used to make measurements: a traditional impaction collector and a modern spectroscopic device. The traditional instrument used is called the Sporewatch and it collects pollen and fungal spores. This technique uses impaction onto a sticky surface which is then collected on-site and returned to the laboratory for analysis under an optical microscope. It is a labour intensive procedure and the quality of results depend on the operator. The modern on-line spectrometer used was the Wideband Integrated Bioaerosol Sensor (WIBS). The instrument determines how the bioaerosols fluoresce and scatter light to make its measurements. It determines the size, "shape", number concentration and fluorescence of bioaerosols by using a diode laser and two xenon flash-lamps. Results will be presented on a four-day campaign held in October 2015 at Site X. A comparison between the "traditional" and "modern" approaches will be made in terms of number counts of the various bioaerosols and how they relate to meteorological data.

Keywords: bioaerosols, sporewatch, WIBS

44. Integrated constructed wetland–activated sludge (CWAS) reactor for enhancing nutrients removal

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For conventional wastewater treatment processes, achieving stable and satisfactory nutrients (nitrogen and phosphorus) removal is still a big challenge. Retrofitting existed wastewater treatment facilities with available technologies is undoubtedly the most feasible and economical option. Thus, a novel concept was firstly proposed and preliminary investigated in a lab-scale sequencing batch reactor (SBR) by integrating alum sludge based constructed wetland (CW) into conventional activated sludge (AS) system to achieve the advantages of both CW and AS for enhancing nutrients removal. Particulate alum sludge (derived from the drinking water treatment plant) was packed in columns as CW and the CW was hanging evenly in the AS system which was operated in alternating anoxic and aerobic conditions in the form of SBR. This novel process owns the striking features of adding carriers of wetland substrate (i.e. the dewatered alum sludge in this case) in AS system for robust phosphorus adsorption while enriching the aesthetic value of CW in the AS system. The preliminary 3-month trial with municipal wastewater has demonstrated average removal of 96%, 99% and 90% for BOD, TP and TN, respectively. The high phosphorus removal was mainly from the adsorption of alum sludge in CW, while the interaction and cooperation of suspended sludge and biofilm in CW showed high simultaneous nitrification and denitrification (SND) efficiency, ranging between 55%-88%, which is higher than the biofilm alone system. Overall, the system could provide a novel pathway to reclaim waste and to upgrade conventional activated sludge system.

Keywords: constructed wetland; activated sludge; simultaneous nitrification and denitrification; phosphorus adsorption; A/O system

45. Microbial bioremediation and physicochemical treatment of landfill leachate

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Currently, over one million m^3 of landfill leachate (LFL) is collected and transported to urban wastewater treatment facilities in Ireland each year. The generation of heavily polluted leachate is a major drawback of municipal solid waste landfill, which requires storage, transport and costly treatment. Many methods are currently employed to treat LFL, often involving costly aerobic steps, which inadequately treat all LFL constituents including heavy metals, ammonia, and adsorbable organic halogens. The current research seeks to determine if a combination of both biological and physicochemical treatment methods can be implemented, to achieve a cost effective, on-site treatment option for LFL.? To this end, bacteria that are capable of growth in LFL have been isolated from LFL samples collected from Powerstown Landfill, Co. Carlow. Isolates have been screened for ability to grow on LFL as a sole carbon source and further screened for halo-tolerance and their resistance to heavy metals including copper, iron, zinc and nickel. Candidate isolates deemed suitable through the screening process will be further characterised and their biodegradation potential tested in a range of environmental conditions. Preliminary results indicate over ninety candidate strains including, fifty halo-tolerant isolates and twenty isolates tolerant to the selected heavy metals at a concertation of 100 ppm. Research has also begun into the identification and sourcing of adsorption materials to be used in the physiochemical treatment step. The adsorption of LFL constituents onto materials including zeolite, pumice, activated carbon, and low cost adsorbents such as peat and calcareous shells will be assessed as a potential adsorption filter. In the final stage of the project the selected bioremediation and physiochemical adsorption techniques will be combined in either a one or two phase process. This method will then be optimized and its feasibility assessed as a novel and cost effective treatment method for LFL.

Keywords: bioremediation, landfill leachate, physicochemical, treatment methods

46. The use of SRTM image sensors applied to GIS tools for the physical characterization of the Shannon River in Ireland and the Rio das Mortes in Brazil

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Geographic Information Systems (GIS) have emerged as an appropriate tool to identify physical characteristics of the environment such as river basin catchments. This study aims to utilise GIS to study the morphometric characteristics of two river basins namely the Shannon River located in Ireland and the Rio das Mortes located in Brazil. The morphometric parameters examine linear, area and relief aspects surrounding the catchments. The research is focusing on parameters such as basin area (km^2), perimeter (Km), basin order, relief ratio, hypsometry and declivity. The methodology involves downloading the SRTM image sensor data from the NASA website. A digital elevation model (DEM) was developed through the use of ArcGIS ® Desktop software 10.1. The data obtained enabled the modeling of the river water resources and mapping the morphometric patterns of the two river basins. The results when compared with existing maps developed by the federal agencies of the two countries; Ordinance Survey Ireland (OSI) and Brazilian Institute of Geography and Statistics (IBGE) showed comparable features. The methodology chosen to conduct this research has been shown useful for understanding and visually displaying geomorphometric characteristics of river basins commensurate with the scale and reality found in the study areas. The findings of this research will aid future applications of GIS in terms of climate change risk management and river basin catchment management.

Keywords: GIS, remote sensing, geomorphological mapping.

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Water Quality And Resources

47. Candidate method selection for heavy metal detection in water using optochemical strategies

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In the modern world there is an increasing demand for fast, easy to use and reliable on site detection of various pollutants in water, including heavy metals. Environmental contamination by toxic heavy metals is a serious issue, with metals such as arsenic, mercury, lead and cadmium being of particular concern because of their toxicity and tendency to bioaccumulate in organisms. Microfluidic devices have been developed for water quality parameters such as nutrients and pH. Although numerous examples of colorimetric detection of heavy metals have been described in the literature relatively few of these methods have been successful in real life application. Some of the challenges include limited specificity, interfering substances, sample colour and turbidity. An extensive literature review was carried out to find the candidate colorimetric methods for the target heavy metal detection in water. Factors such as sensitivity, selectivity, detection range, reagent stability, availability and cost were taken into account. Preliminary screening was carried out using UV-vis spectroscopy to find the most suitable methods for further study. Micro scale cuvettes were used in order to determine if the methods would work successfully in a microfluidic chip. The selected methods were optimised using parameters such as temperature, amount of reagent, pH and reaction time. This research will help to improve the water quality monitoring technologies. The EU Water Framework Directive and the growing demand for water for industrial and agricultural purposes are the main drivers for the development of cheap, highly selective and sensitive monitoring devices that can be used *in situ*. The methods developed in this project will enhance the range of techniques available for water quality analysis.

Keywords: heavy metals, colorimetric methods, microfluidics

48. The greater Dublin area: population growth, climate change risks and management plan for a future secure water supply

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Water is a basic requirement for all life forms; humans, animals and plants. Water resources management is a concern for a modern society. Water resources management in Ireland is facing two types of risks; external and internal risks. The internal risks are urbanization, population growth, wastewater treatments services and the use of limited groundwater resources. The external risks include climate change, water leakage and water contamination. The Dublin region water supply area, located on the east coast of Ireland, had a population of approximately 1.795m in 2011 and is projected to increase to 2.197m by 2031 (CSO 2013). Most of the eastern half of the country receives between 750 and 1000 mm of rainfall per year. Rainfall in the west generally averages between 1000 and 1400 mm. Air temperatures inland normally reach 18 to 20 °C during summer days, and about 8°C during wintertime (Met Éireann 2016). It is expected that 215 million litres of water per day in excess of existing capacity will be needed by 2050 for the Dublin Region alone. As a result, there is increased pressure to manage the demands for fresh potable water, to the amount of wastewater services to be provided. These complex issues faced by the greater Dublin area (GDA), requires a comprehensive management plan, that is not only successful in maintaining the stability of the GDA but also effective in improving quality of life. The aim of this work is to identify water usage, water quality, expected population growth and climate change risks in the GDA and to develop management strategy recommendations to mitigate these risks. Methods include central statistical data, water sources, usage and leakage data, water contamination incidents together with climate change modelling data.

Keywords: population growth; water usage; water quality; climate change

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Water Quality And Resources

49. Validating biological quality elements (BQEs) for tidal freshwater transitional waters (TFTWs) in Ireland

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The highly dynamic and variable conditions that describe tidal freshwater transitional water (TFTW) zones, characterised at the upper level by high mean water level/obstruction and at the lower level with salinity (≤5psu) provide an extreme habitat for organisms living therein. Consequently, the range of biota may be restricted and this in turn restricts and hampers the establishment of reliable and robust biological quality elements (BQEs) for ecological quality status - a legal requirement under the Water Framework Directive (WFD 2000/60/EC. To validate BQEs for TFTW zones, we applied a suite of well-established assessment indices to fish, macroinvertebrate, macro-flora, meio-fauna and phytoplankton samples from the TFTW zones in nine Irish estuaries. The initial results suggest that while metrics devised for other situations can be applied, the results have to be interpreted with caution. The main challenges encountered were: (a) A high degree of variability with diversity metrics, such that in some cases the signal/noise ratio might preclude establishment of meaningful quality thresholds; (b) Loss of information from the data sets, in that species-calibrated metrics may only use a small part of the dataset; (c) Derived metrics suggest low ecological quality from all TFTWs, sometimes at variance with measures from other components of the system. Our preliminary conclusion is that only a small set of available metrics can be applied in an integrated monitoring scheme for TFTW zone assessment, and that some adjustment is necessary either to the reference conditions or to the quality class boundary values of the ecological categories.

Keywords: TFTW zones, BQEs, assessment, validation, monitoring, WFD

50. Meta-analysis of the effect of UV treatment on sensitive and antibiotic resistant *Escherichia coli*

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Antibiotic resistant bacteria are of growing public health concern due to the difficulty in treating antibiotic resistant diseases. A large amount of research has been conducted on the presence of antibiotic resistant bacteria in the environment but it is important to identify methods that could prevent the release and spread of antibiotic resistant bacteria into the environment. Ultra violet light is a water treatment process that can potentially inactivate sensitive and antibiotic resistant *E. coli*, with the possibility of preventing them from entering the environment. Under investigation here is the log reduction of sensitive *E. coli* and antibiotic resistant *E. coli* from UV treatment using meta-analysis. Meta-analysis is a statistical method of combining results from comparable studies. Combining the results from multiple studies can strengthen a study by giving a weighted average rather than relying on the results from just one study. Approximately 200 data points were collected on the log reduction of sensitive *E. coli* and antibiotic resistant *E. coli* due to UV treatment. The preliminary results of the meta-analysis indicate that different strains of *E. coli* have different log reductions due to UV treatment. The meta-analysis synthesises existing data and results in an average level of UV treatment required for a log reduction of both sensitive *E. coli* and antibiotic resistant *E. coli.*

Keywords: antibiotic resistant bacteria, meta- analysis, UV treatment

51. Sediment transport on the River Bandon

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The Bandon catchment is located in the South of Ireland in County Cork forming part of the South Western River Basin District (SWRBD). The river rises in the Maughanaclea Hills northwest of Dunmanway and flows eastwards until it discharges into Kinsale Harbour. The river is 72km long and drains a catchment area of 608km^2. The town of Bandon, the largest urban settlement within the river catchment, has a history of flooding, most recently in December 2015. River improvement works including flood protection measures are planned for the Summers of 2016 and 2017. The works will involve dredging in and downstream of Bandon Town and the construction of flood walls and embankments. This project involves monitoring, analysis and modelling of sediment behaviour within the river system, both for suspended and bed sediment. Baseline conditions established include suspended sediment concentration and turbidity levels, and bed sediment particle size distributions. This is based on manual sampling at a number of locations along the reach of the river and continuous turbidity monitoring and automatic sampling over a range of river flow events at the Curranure Hydrometric Station downstream of Bandon Town. The sediment properties determined form part of the input to a developed one-dimensional Hec-Ras numerical model to be used to model potential sediment impacts within the river system.

Keywords: sediment transport, suspended sediment, Hec-Ras

Water Quality And Resources

52. A sensor-based approach to the measurement of carbon fluxes in streams from blanket peatland dominated catchments in Ireland

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The dynamics of CO_2 in freshwater streams particularly the surface water zones is an issue of importance in stream carbon dynamics - but also one which has high uncertainties attached. This is particularly true of peatland drainage systems where connectivity between streams and the peatland CO_2 store leads to significant variations in outflows and high variability in the efflux rates of CO_2. The relationship between CO_2 and other carbon species is a crucial dynamic in the overall carbon cycle of this land use type. Indeed, in the absence of an understanding of the efflux dynamics of dissolved CO_2 and catchment specific hydrological transport mechanisms it is not possible to develop appropriate water quality management strategies. This study has sought to establish a series of monitoring stations at selected location in the upland blanket peatlands of the Wicklow mountains. A series of CO_2 diffusion sensors will be placed at strategic locations in the freshwater streams of the study area. These sensors will provide a continuous record of CO_2 efflux rates and will be maintained at a constant depth in the water body by a protective float and housing mechanism. This approach requires detailed site specific meteorological conditions to be monitored on a continuous basis including temperature, precipitation and atmospheric pressure. The methodology presented is necessary to address the very real challenges of diurnal and seasonal flux rates and to aid understanding of the temporal dynamics and controlling factors of CO_2 transport in peatland dominated stream systems. Outputs of this study will have a direct bearing on approaches to water quality including freshwater biota and drinking water quality. The dynamics of CO_2 in these streams is also a parameter of interest with regard to the terrestrial–aquatic connectivity of groundwater and surface water and carbon cycling in the landscape.

Keywords: peatlands, carbon cycle, freshwaters, carbon dioxide

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53. The impact of cattle access and exclusion from watercourses on freshwater ecology

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Cattle enter streams and riparian zones in order to gain access to drinking water, to seek shelter or shade during harsh weather conditions, and to obtain succulent forage. Where stream access is permitted, deterioration in water quality is common. The effects of livestock on stream water quality are the product of a range of physical, hydrological and physico-chemical processes that occur and interact at multiple spatial scales, and ultimately potentially negatively impact on instream and riparian biological communities. This research, as a part of the multi-institutional Cattle *exclusion from watercourses: environmental and socio-economic implications* (COSAINT) project (EPA funded under the Research Programme 2014-2020), will focus on said biological impacts. Previous research emanating largely from North America and Australasia has highlighted habitat change as the dominant driver of biological community response in relation to the presence of livestock in streams. The depletion of streamside vegetation by the actions of cattle grazing and trampling leaves soils bare and prone to erosion, while the susceptibility of surface waters to diffuse inputs is augmented as a result. Accordingly, instream habitats are often impacted by sedimentation causing homogenisation and clogging of substrates, and loss of habitat variability. This research will utilise stream benthic macroinvertebrates, macrophytes and algae, as well as hyporheic zone invertebrates to assess the ecological impact of cattle access in the Irish setting. This research will build on recent Irish studies that have shown site specific responses of macroinvertebrate communities and will also examine the response of the ecology to cattle exclusionary measures. Ultimately, the results of this research will guide policy makers on the best management of Irish freshwater resources in relation to cattle access.

Keywords: Cattle access; Cattle Exclusion; Hydromorphology; Riparian; Freshwater Ecology; Bio-indicators; Best Management

54. Disinfection of selected finfish pathogens important in Irish freshwater aquaculture using pulsed ultraviolet light technology

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The aquaculture sector is becoming the fastest growing food sector in the world. The freshwater aquaculture sector in Ireland is worth an estimated €131 million, providing employment to 1,936 in rural inland communities; and these figures are continually increasing. Stringent limits on water abstraction rates necessitate recirculation of processed water. Traditional methods struggle to cope with the increasing demands on recycled water to meet food safety and environmental regulations. These methods of production and the increased bioload in recirculated water may hinder the potential development in aquaculture by promoting harmful finfish pathogens causing detrimental effects on fish stock. The introduction of advanced technology including novel non-chemical disinfection systems and aeration processes seek to improve the energy efficiency, productivity and overall sustainability of the freshwater farming industry. This study investigates the use of pulsed ultraviolet light to control selected problematic finfish pathogens in Ireland. This novel system has been validated using *E.coli* as a model organism. A bacterial population of $2x10^9$ CFU/ml of *E.coli* following treatment of this disinfection technology was reduced to a non-detectable number. The fish pathogens *Aeromonas salmonicida* and *Flavobacterium psychrophilum* were subjected to this disinfection regime and the results are presented.

Keywords: freshwater aquaculture industry, novel light disinfection technology, pulsed ultraviolet light, finfish pathogens

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55. Establishing the onset of eutrophication in a shallow lake system

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Eutrophication, or over enrichment of nutrients is possibly the most prevalent form of fresh water pollution. Human activities in catchments can increase levels of N and P, two key plant nutrients. The addition of these nutrients can lead to rapid eutrophication of previously infertile waters or in already productive lakes they can intensify productivity. Lake sediment cores can be used to infer approximate timing of the onset of eutrophication in lake waters. Lough Gur, Co Limerick is a shallow lake (≤4m) lake that has a poor water quality and is classified as hypertrophic. Large algal blooms have been present on the lake over the past decade. A palaeolimnological study of Lough Gur is currently underway, using two parallel lake sediment records. A sediment chronology and geochemical reconstruction have already been established. Sediment core correlation and biostratigraphy are being examined in this project, along with a GIS evaluation of the hydrological catchment. Organic carbon (% loss on ignition (LOI)) results confirm close correlation between sediment cores enabling cross-core application of the chronological framework. Increases in organic matter content from the 1950's and late 1990's may be evidence of the timing of lake nutrient enrichment, while early fossil diatom preparations suggest that frustules are not well preserved.

Keywords: Eutrophication, shallow lake, sediment records, organic matter

Water Quality And Resources

56. The impact of cattle access and exclusion from watercourses on freshwater geochemical and microbial parameters

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In Ireland, where agriculture is dominated by cattle-based activities, cattle access to watercourses has the potential to lead to contamination of surface waters with nutrients, sediments and faecal pathogens, resulting in deterioration of water quality. Measures to exclude cattle from watercourses (e.g. fencing) have been included in all Irish agri-environment schemes to date, including the current Green Low Carbon Agri-environment Scheme (GLAS). While there have been several studies in the USA, Australia and New Zealand, there have been limited studies on impacts of cattle access in an Irish or European context. This research is part of the *Cattle exclusion from watercourses: environmental and socio-economic implications* (COSAINT) project (EPA funded under the Research Programme 2014-2020). The project aims to assess environmental, ecological and socio-economic impacts of existing and potential cattle-exclusion measures. Work Package 3 is focused on impacts of cattle access on nutrient loading, sediment loading, and indicators of faecal contamination. Cattle access points have been selected in three moderate status catchments (Co. Lough, Co. Monaghan, and Co. Wexford), and two high status catchments (Co. Cork and Co. Kerry). Sediments will be characterised upstream of and at access sites, while sediment incubations will provide information on nutrient exchange with stream waters. In addition, high resolution sampling for nutrients, motion sensor cameras to monitor cattle activity, and sediment sensors will be used to quantify the contribution of cattle in-stream activity to changes in nutrient and sediment concentrations. Sampling of sites after cattle access restriction measures implementation will also allow a "before and after" comparison. Collected data will then be used in a dynamic catchment model to estimate nutrient, bacterial and sediment loadings at the catchment scale and allow for scenario testing. The COSAINT project will contribute to environmental policy and improved management of agricultural landscapes and surface waters in Ireland.

Keywords: water quality; agri-environmental policy; sediments; nitrogen; phosphorus; faecal indicator bacteria

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57. An integrated systems approach to analyse & design sustainable dairy wastewater treatment plants

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Milk collection within the EU-28 increased by 1.8% from 2014 – 2015. Skimmed milk powder (SMP), butter, cream and cheese production all increasing by 8.1%, 3.3%, 1.5 and 1.4% respectively. According to Food Wise 2025, the global demand for whey is also growing at 11% a year. The changes in dairy processing to produce more whey, SMP, butter, and cheese products have a significant impact on the final effluent that is required to be treated by the wastewater treatment plant (WWTP). The objective of the study is to identify the sources of wastewater throughout the processing stages as a means to characterise the wastewater to be treated but also to include the CIP (cleaning in place) chemicals and frequencies that are used and to highlight their effect on the wwtp. Another issue not addressed in the current literature but will be highlighted through the research is the sensitivity of wastewater biology and reaction rates to changes in temperature. Modern plants need to consider heat losses and heat gains to optimize performance during all climatic conditions. Once the wastewater is characterised, the next step will be to identify the existing and novel treatment systems that are available for pretreatment and secondary treatment and to analyse these systems in order to identify the best fit equipment by which to obtain maximum removal efficiency at lowest energy demand for specific wastewater parameters. To date the study has solely looked at results and information from available literature and highlighted the gaps in the literature in terms of CIP and temperature sensitivity. The results of this research can aid in the development of guidelines for design of sustainable wastewater treatment plants for the dairy processing industry, thus aligning with the conference theme.

Keywords: Dairy, wastewater, sustainable

Water Quality And Resources

58. Application of TMPyP in Bacterial Photodynamic Inactivation for Water Disinfection

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Photodynamic inactivation (PDI) is a technology that relies on the activation of a photosensitiser by light generating cytotoxic species which kill cells. The light source can be sunlight, making the technology an option in environmental applications. It is an interesting alternative approach to traditional disinfection techniques. Photosensitisers are frequently based on heterocyclic ring structures such as porphyrins. The aim of this project is to investigate the efficacy of the singlet oxygen (1O2) generating porphyrin 5,10,15,20-tetrakis(N-methyl-4-pyridyl)-21H, 23H-porphine (TMPyP), irradiated with wavelengths ranging from 400-700nm, in inactivating Gram positive and Gram negative bacteria. The response of the bacteria was monitored using culturable and non-culturable techniques. Non-sporeforming bacteria were more sensitive to the treatment than sporeforming bacteria. The response of Gram negative bacteria varied suggesting that the response of the bacterium to treatment is influenced by cell composition. TMPyP and the multi-LED lamps were shown to be a promising approach for water disinfection

Keywords: water disinfection, porphyrin, PDI, bacteria.

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